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Managing supply chain disruptions: role of firm resilience and strategic focus on innovation

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Managing supply chain disruptions: Role of firm resilience and strategic focus on innovation

by

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DEDICATION

I dedicate this thesis to my dad, Mr. Sanjay Ambulkar, who has been a role model for resolve and personal sacrifices, to my mom, Mrs. Shubhangi Ambulkar, who has taught me many valuable life lessons, to my sister, Shruti Ambulkar, who has always been proud and supportive of my work, and to my wife Manasi Ambulkar for her patience and never ending support.

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ABSTRACT

This dissertation focuses on the area of supply chain disruption management and aims to make a contribution by studying how firms can manage supply chain disruptions by (i) becoming resilient and by (ii) reducing the risk of supply chain disruption arising out of innovation. Firm resilience is the ability of the firm to: be alert to supply chain disruptions, to adapt and quickly respond to changes brought by a supply chain disruption and the ability to recover and return back to a state of greater competitiveness. In this dissertation, I emphasize the role of firm resilience in mitigating the effects of a supply chain disruption and focus on understanding factors that enhance firm's resilience. I first develop the concept of firm resilience, explore its antecedents and consequences and empirically establish its nomological and predictive validity. I then look at supply chain disruptions that result from firm's strategic focus on innovation and consider the role of a risk management infrastructure that a firm has in place in reducing the risk of these disruptions. In this dissertation I use structural equation modeling to as a methodology to test my hypothesis.

CHAPTER 1: General Introduction

1.1 Introduction

Over the past decade the concept of supply chain disruption management has become prominent. This is due to growing interest of firms in curtailing supply chain disruptions. Today business have become more and more interconnected, which have made supply chains both long and complex (Craighead et al., 2007; Blackhurst et al. 2011). Practices such as offshore outsourcing, lean manufacturing and JIT have made supply chains more susceptible to disruption (Chopra and Sodhi 2014; Wagner and Bode 2008). In a recent study by World Economic Forum and Accenture, 80% of firms reported that managing supply chain disruptions has become a top priority (World Economic Forum Report, 2013; Wright, 2013). Firms are now encouraging their managers to view supply chain risk/ disruption management as a business objective (Gaudenzi and Borghesi, 2006; Nieger et al., 2009) and are placing high reliance in them to make firms resilient to supply chain disruptions.

This dissertation addresses the area of supply chain disruption management and focuses on the question of how firms can manage supply chain disruptions through resilience and risk management infrastructure. In particular, this dissertation focuses on (i) developing the concept of resilience and (ii) managing supply chain disruptions that arise out of innovation. In this introduction, I first begin with providing existing research on resilience and supply chain disruption management and then proceed to the dissertation organization.

1.2 Existing Research

Research on supply chain disruptions has looked at many aspects: supply chain risk management strategies (Manuj and Mentzer, 2008a), managerial perceptions of supply chain disruptions (Ellis et al., 2010), supply chain disruption mitigation (Craighead et. al, 2007; Bode et. al, 2011), constituents of resilience (Juttner and Maklan, 2011; Petit et al, 2010; 2013) and responses to supply chain disruption (Bode et al., 2011). Research on resilience and use of risk management infrastructure however is still limited and mostly conceptual. Research on resilience defines it as the ability to recover from a disruption and return back to a steady state (Zsidisin and Wagner 2010). Firm resiliency is defined as a firm's strategic initiative that allows the firm to absorb disruptions or enables the supply chain to return to stability faster (Sheffi and Rice 2005). Managing resilience is a proactive method that can complement and enhance traditional risk management and business continuity planning (Petit el al., 2010). While this research is extremely informative, there still exists a research void that needs to be filled. Hendricks and Singhal (2005a) call for research to look at capabilities that enhance firm's resiliency to supply chain disruptions. Hendricks et al. (2009) notes the importance of studying the strategies that reduce the impact of disruptions. As part of this thesis, I develop and operationalize the firm resilience construct and then explore factors at the firm level that influence firm resilience. I also look at the role of risk management infrastructure in reducing the risk of supply chain disruptions arising from innovation.

1.3 Dissertation Organization

My dissertation comprises of two related essays on supply chain disruption management that follow the journal article formatting. Chapter 2 makes the first essay that is devoted to understanding the concept of firm resilience and developing and operationalizing the construct of

firm resilience. In chapter 2, I conceptualize firm resilience as a strategic capability that focuses on the alertness of the firm to supply chain disruptions, the ability to adapt and respond to changes brought by a supply chain disruption. I look at the role of risk management infrastructure and resource reconfiguration in enhancing resilience under high and low disruption impact conditions. This study not only develops, operationalizes and validates the firm resilience construct it also draws boundaries around the firm resilience construct by explaining its significance in different levels of impact (high impact and low impact). Chapter 3 comprises of the second essay that looks at how a firm's strategic focus on innovation can increase the risk of supply chain disruptions which reduces the firm's performance. The essay focuses on the use of risk management infrastructure by firms to bring about a balanced view on innovations and to reduce the risk of supply chain disruptions.

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Chapter 2: Firm's Resilience to Supply Chain Disruptions: Scale Development and Empirical Examination

A paper published in *Journal of Operations Management*

2.1 Abstract

This paper expands our understanding of factors that contribute to development of firm resilience to supply chain disruptions. In doing so, we operationalize firm resilience to understand how supply chain disruption orientated firms can develop resilience to supply chain disruptions. We find that supply chain disruption orientation alone is not enough for a firm to develop resilience. Supply chain disruption oriented firms require the ability to reconfigure resources or have a risk management resource infrastructure to develop resilience. The way in which supply chain disruption oriented firms develop resilience through resource reconfiguration or risk management infrastructure depends on the context of the disruption as high impact or low impact. In a high impact disruption context, resource reconfiguration fully mediates the relationship between supply chain disruption orientation and firm resilience. In a low impact disruption context, supply chain disruption orientation and risk management infrastructure have a synergistic effect on developing firm resilience.

2.2 Introduction

In today's turbulent and uncertain environment, every firm in the supply chain is susceptible to disruption events (Knemeyer et al., 2009). As such, an understanding of how firms can manage supply chain disruptions has become an important topic for both academics and practitioners (Craighead et al., 2007; Blackhurst et al., 2011). A supply chain disruption is an

event that disrupts the flow of goods or services in a supply chain (Craighead et al., 2007). It can have severe negative consequences on the financial, market and operational performance of the firm (Hendricks and Singhal, 2003; Hendricks and Singhal, 2005; Wagner and Bode, 2008; Narasimhan and Talluri, 2009). In a recent study by the World Economic Forum and Accenture, 80% of firms reported that resilience to supply chain disruptions has become a top priority (World Economic Forum Report, 2013; Wright, 2013). Firms, realizing that disruptions in the supply chain can have negative consequences, are now focusing on building resilience in order to mitigate the impact of disruptions (Juttner and Maklan, 2011; Melnyk et al., 2010; Wieland and Wallenburg, 2013).

The importance of resilience in the face of supply chain disruptions should not be understated. Resilient firms are less vulnerable to supply chain disruptions and are more capable of handling supply chain disruptions when they do occur (Sheffi and Rice, 2005; Ponomarov and Holcomb, 2009; Zsidisin and Wagner, 2010; Blackhurst et al., 2011; Pettit et al., 2013). Resilience allows firms to manage the supply chain disruption and continue to deliver their products and services to the customer. Sheffi and Rice (2005) note that it is important for firms to build resilience in order to deal with unforeseen and unquantifiable risks. Therefore, we identify factors which are antecedents impacting firm resilience to supply chain disruptions. Extant research suggests that resiliency is an effective way to manage risk and recover from a supply chain disruption (Chopra and Sodhi, 2014; Hora and Klassen, 2013; Blackhurst et al., 2011; Juttner and Maklan, 2011; Zsidisin and Wagner, 2010). Hendricks and Singhal (2005) note that is it critical to develop resilience as firms face disruptions and call for more research in this area. While resiliency may be the key to a firm's ability to manage supply chain disruptions, there is limited research on how firms develop resilience to supply chain disruptions (Blackhurst

et al., 2011; Juttner and Maklan, 2011). This study seeks to fill this gap by examining factors that help firms develop resilience to supply chain disruptions. Prior to examining factors that contribute to development of resilience to supply chain disruptions in a firm, it is important to provide a unified definition of firm resilience. However there is a lack of agreement regarding the definition of resilience in the literature (Bhamra et al., 2011; Ponomarov and Holcomb, 2009). Definitions of resilience at the firm level are shown in Table 1.

The lack of a unified definition of resilience has contributed to ambiguity of the concept of resilience related to supply chain disruptions noted by Bhamra et al. (2011), Ponomarov and Holcomb (2009) and Weiland and Wallenburg (2013). In this study, we contribute to the resilience and supply chain disruption literature by defining, operationalizing and validating firm resilience to supply chain disruptions as well as examining the factors that contribute to the development of resilience to supply chain disruptions in firms.

Following Gilliam and Voss's (2013) procedure for developing a construct definition based on prior literature, we compare the extant definitions of firm resilience and develop a preliminary definition. This preliminary definition is then used to develop measurement items that conceptualize firm resilience. The measurement items are subjected to an expert judging process via a substantive validity test. This is followed by an exploratory factor analysis to identify reflective measures that reduce the confusion surrounding the conceptualization of firm resilience to supply chain disruptions. These measurement items are then used to develop a refined inclusive definition of firm resilience. Firm's resilience to supply chain disruptions is defined as the capability of the firm to be alert to, adapt to, and quickly respond to changes brought by a supply chain disruption. This definition is in accordance with Gilliam and Voss's (2013) criteria of reducing ambiguity and vagueness surrounding the construct and addressing

the imbalance between conceptualization and empirical validation of the construct. The details on the development of measurement items, substantive validity test and exploratory factor analysis are provided in the methodology section.

We investigate three antecedents to developing firm resilience to supply chain disruptions. First, we examine supply chain disruption orientation, which is characterized as the firm's recognition and awareness of pending disruptions and how firms analyze and learn from prior disruptions (Bode et al, 2011). Bode et al. (2011) note that firms can improve disruption response by cultivating a strong supply chain disruption orientation. In this study, we expand our understanding of supply chain disruption orientation, noting that though it is a necessary precursor it may not be sufficient by itself for developing firm resilience. Therefore, we propose a more nuanced set of antecedents to developing firm resilience to supply chain disruptions by considering two additional factors: a firm's resource reconfiguration capabilities and a firm's risk management infrastructure. We define resource reconfiguration as the ability of a firm to reconfigure, realign and reorganize their resources in response to changes in the firm's external environment (Wei and Wang, 2010; Helfat et al., 2007; Marsh and Stock, 2006; Zahra et al., 2006). Risk management infrastructure describes a firm's structure of resources designed to manage risk in the supply chain (Blackhurst et al., 2011). In addition to the antecedents to developing firm resilience to supply chain disruptions, we also examine the importance of resilience when firms face high impact disruptions and low impact disruptions. We measured extent of the negative impact using firm's overall operational efficiency, procurement costs and delivery reliability to the customer.

In the following sections, we present the development of our hypotheses. We propose a new model with an expansive view of firm resilience to supply chain disruptions. This is

followed by a discussion of our research methodology, including a summary of the process used for developing the scale for resilience. We then offer a discussion of the results of our results and implications for researchers and managers. We conclude with a summary of the research.

2.3 Hypothesis Development

In this study, we postulate that supply chain disruption oriented firms are better able to reconfigure resources. This, in turn, enhances firm resilience to supply chain disruptions. We note that this postulation is contingent on the level of disruption impact faced by the firm.

2.3.1 Resource reconfiguration and supply chain disruption orientation

The ability to manage resources and reconfigure them according to the environmental setting is critical to firm survival and superior firm performance (Sapienza et al., 2006; Sirmon et al., 2007; Davis et al., 2009). Supply chain disruptions are events that are characterized by high uncertainty (Bode et al, 2011) and disrupt the normal flow of goods and services within the supply chain (Craighead et al, 2007). The high uncertainty shrouding supply chain disruptions creates ambiguity about the value and utility of existing resources to generate capabilities that aid in recovering from a disruption. Facing disruptions, firms may sense new threats or opportunities and may need to renew, reconfigure or realign its risk management infrastructure to mitigate threats and exploit opportunities. In situations of high uncertainty such as new product development or new market entry, the ability of the firm to restructure and reconfigure its resource base has been shown to be crucial in developing capabilities that contribute to firm survival and growth (Tushman and Anderson, 1986; Sirmon et al., 2007). Marsh and Stock (2006) and Helfat et al. (2007) note that to respond to changes in the market, firms have to reconfigure and realign existing innovation resources and processes in order to enhance their innovation capacity. Similarly, Sirmon et al. (2007) note that when firms face environmental

shock due to discontinuities in the industry, firms need to restructure their resource base. In other words, firms need to acquire, shed and reorganize their existing resource base to develop capabilities that allow them to adapt to the changing environment. A firm that is able to reconfigure and reorganize its resource base (Sirmon et al., 2007; Eddleston et al., 2008) in a dynamic environment may have a greater chance to develop capabilities that mitigate the impact of disruption (Blackhurst et al., 2011).

Having argued above that firm's ability to reconfigure resources is significant for firm to be resilient to supply chain disruptions, we expect to find that supply chain disruption oriented firms are more likely to engage in resource reconfiguration. Firms with a supply chain disruption orientation are aware that disruptions can occur based on past experience and are motivated to learn from disruptions. They proactively configure and manage resources to respond to a supply chain disruption (Bode et al., 2011). Ramaswami et al. (2009) note that firms that spend time scanning and learning from the environment are better able to develop capabilities that improve responsiveness (market oriented firms possess market-based capabilities that increase their responsiveness to changing customer demands). Helfat and Peteraf (2003) also note that firms that learn from the external environment are able to reconfigure and realign their resources and processes to develop capabilities that provide a sustainable advantage. Bode et al. (2011) conceptualize a supply chain disruption orientation as being similar to market orientation and entrepreneurial orientation. They point out that supply chain disruption oriented firms strive to learn from their past supply chain disruption experiences and proactively build capabilities that allow firms to effectively respond to supply chain disruptions.

We note that the mediating role of resource reconfiguration between supply chain disruption orientation and firm resilience is contingent on the level of disruption impact faced by

the firm (Bode et al., 2011). Firms participating in our study gave examples of disruptions they had faced and described the severity of the impact of those disruptions. Severity of impact was measured using overall operational efficiency, procurement costs, and delivery reliability to the customer. Disruptions were grouped into high impact and low impact categories based on level of negative impact on operational efficiency, procurement costs, and delivery reliability to the customer. We believe that the level of the disruption impact plays an important role in the way in which firm resilience to supply chain disruptions is developed. Bode et al. (2011) note that the motivation to act is influenced by the size of the impact of the disruption. In the case of high impact disruptions, the ability to quickly acquire new resources or restructure existing resources (Sirmon et al., 2007; Eddleston et al., 2008) is important to quickly adapt and respond to changes resulting from the disruption (Blackhurst et al., 2011). Therefore, in high disruption impact situations, the firm's ability to reconfigure resources becomes important as an intermediary mechanism that enables a supply chain disruption oriented firm to develop resilience to supply chain disruptions. Olcott and Oliver (2014) highlight an example in which firms in Japan were dealing with the aftermath of a massive earthquake in 2011. The ability to leverage and reconfigure resources was a key aspect of recovery from the disruption.

If the severity of the disruption is low, the reconfiguration of resources may not be necessary to establish resilience. Consider low impact supply disruptions in which suppliers may delay a shipment or send the wrong part. In such cases, firms that are supply chain disruption oriented may use their prior disruption experience to be better prepared to deal with them. As such, firms may not need to invest in reconfiguring and mobilizing resources but rather they may be able to absorb the impact of low impact disruptions (Melnyk et al., 2014).

H1: Resource reconfiguration fully mediates the relationship between supply chain disruption orientation and firm resilience for high disruption impact situations.

H2: Resource reconfiguration does not mediate the relationship between supply chain disruption orientation and firm resilience for low disruption impact situations.

2.3.2 Risk management infrastructure and supply chain disruption orientation

Risk management infrastructure describes a resource structure that a firm has in place to manage supply chain risks and disruptions. These resources include the presence of a department to manage supply chain risks/disruptions, the existence of information systems to manage supply chain risks/disruptions, and the use of key performance indicators (KPI) and metrics to monitor the supply chain risk management/disruption management process. Risk management infrastructure also includes the organization of assets to enhance a firm's resilience to supply chain disruptions (Blackhurst et al., 2011).

Having a proper resource structure enables firms to have a systematic approach to manage supply chain risks (Cooper, 1998; Koen et al., 2001). A risk management infrastructure provides many benefits to the firm: reduction of work ambiguity, increased task specialization, the ability to replicate learning, and enhanced information exchange (Perrow, 1986; Bonner et al., 2002). When facing a disruption, increased task specialization helps individuals and firms take quick action, which is critical when a firm is hit with a supply chain disruption. A quick response can lead to a quick recovery (Blackhurst et al., 2011; Bode et al., 2011). Firms with the proper resource structure can also use prior disruption experiences to efficiently manage similar disruptions in the future.

A risk management infrastructure, however, can also have a few disadvantages especially when firms face high impact disruptions. When faced with high impact disruptions, firms may

respond to disruptions using risk mitigation approaches that have worked for them in the past and in doing so, overlook certain contextual factors related to disruptions. These factors may call for a more creative and restructured approach to respond to the disruption (Sirmon et al., 2007). However, risk management infrastructure may act as an impediment to the development of these alternative approaches to managing disruptions. Having people, information systems and metrics in place to assess and manage supply chain risks can lead to process formalization (Wouters and Wilderom, 2008), which may result in a linear, more rigid and less flexible risk management processes (Gilbert, 2005) thereby limiting the ability of the firm to reconfigure resources and be resilient to supply chain disruptions.

In low impact disruptions, we believe that risk management infrastructure and supply chain disruption orientation can provide synergistic benefits for firm resilience. The synergistic effect implies that the interaction of a firm's supply chain disruption orientation and risk management infrastructure provides benefits to firm resilience beyond the additive effect of the factors. In other words, the impact of the combination is greater than the impact created by adding each of the factors. When faced with a low impact disruption, supply chain disruption oriented firms can use the existing resource structure to manage minor disruptions. Risk management infrastructure can allow the firm to address disruptions without the need for reconfiguration. Information systems and professionals assigned to identify and manage disruptions can often employ operational exceptions or initiate processes within existing firm activities to minimize downside effects to such disruptions. As such, supply chain disruption oriented firms can use the existing resource structure to manage low impact disruptions.

Therefore, we predict the following:

H3: Risk management infrastructure diminishes the mediation impact of resource reconfiguration for high disruption impact situations.

H4: There is a synergistic impact of supply chain disruption orientation and risk management infrastructure on firm resilience for low disruption impact situations.

Our proposed model is shown in Figure 1.

2.4 Methodology

The current research aims to develop firm resilience for further empirical study. In doing so, we developed a survey using new and existing multi-item scales (Churchill, 1979). New scales were developed for firm resilience and risk management infrastructure due to the lack of existing survey items. Pre-established scales were used to measure supply chain disruption orientation and resource reconfiguration. An overview of the steps take in our research is shown in Figure 2.

2.4.1 Pretest procedure

To develop the scale for firm resilience, we followed Churchill's method for building and testing reflective scales (Churchill, 1979; Anderson and Gerbing, 1988; Bollen and Lenox, 1991). This method consists of four major steps: (1) developing the construct and checking content and face validity; (2) testing the dimensionality; (3) checking the internal consistency and (4) ensuring convergent, discriminant, and nomological validity of the measures (Anderson and Gerbing, 1988; Churchill, 1979). In the first step, 13 items were generated from a thorough investigation of the literature. These items captured capabilities such as adaptability, responsiveness, awareness, redundancy, visibility and coordination (Sheffi and Rice, 2005; Zsidisin and Wagner, 2010; Juttner and Maklan, 2011; Pettit et al., 2013). After the initial pool

generation, a substantive validity test was used for scale purification (Lawshe, 1975; Anderson and Gerbing, 1991). The substantive validity of a measure is defined as how well the measurement item is reflective of, or theoretically linked to, the construct of interest (Anderson and Gerbing, 1991). This procedure is recommended when the construct is relatively new in the field and has seen limited to no operationalization (Lawshe, 1975). The 13-item scale, along with the definitions of firm resilience from the extant literature, was first presented to ten research faculty members for face validity and then presented to 71 industry experts. Research faculty were asked to consider each item's relevance to the concept of firm resilience. The opinions of the industry experts were collected to assess the substantive validity of the scale. In addition, industry experts were also asked to consider a disruption that their firm had faced in the last year. Each industry expert was then asked to:

(a) rate if the knowledge/ability measured by the item was either essential or not essential to the understanding of firm resilience, and

(b) use a Likert scale (1-7) to indicate how satisfied they were with their firm's implementation of the knowledge/ability captured by that that item.

The substantive validity coefficient is measured as $Csv = (nc - n0)/N$ (Lawshe, 1975; Anderson and Gerbing, 1991), where nc is the number of respondents assigning an item as essential for firm resilience, n0 is the number of respondents assigning the item as non-essential to firm resilience, and N is the total number of respondents. The values of Csv range from -1 to +1, where larger values indicate greater substantive validity. Large positive values indicate substantive validity for an item for its theorized construct, whereas large negative values indicate substantive validity for an item other than the theorized construct. Items with a Csv value equal to or greater than 0.5 were retained (Anderson and Gerbing, 1991). In this way, the scale was

reduced to four items. A similar procedure was used to develop the scale for risk management infrastructure.

The next step in the scale development process is the reliability and validity analysis. Exploratory factor analysis was conducted on the retained items in SPSS using principal component analysis, varimax rotation, and extraction criterion of eigenvalue greater than 1.00. Analysis for the firm resilience construct provided a single factor solution that explained 70.40% of the variance. The resulting Keyser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.81 and the $\chi 2$ was 125.46 (d.f. = 6, p = 0.000). A single factor solution suggests unidimensionality of the firm resilience construct. The KMO measure of 0.81 (greater than recommended value of 0.6) suggests that the sample is adequate for factor analysis and that factor analysis is likely to provide reliable factors (Black and Porter, 1996). The significance of the $\chi 2$ value also suggests that the single-factor solution is significant. The analysis for risk management infrastructure provided a single-factor solution that explained 85.60% of the variance (KMO measure of sampling adequacy = 0.735, $\chi 2$ = 345.13, d.f. = 3, p = 0.000). Convergent validity and reliability were assessed using factor loadings and Cronbach's alpha values, respectively. Each scale demonstrated acceptable levels of convergent validity and reliability. These values are provided in Table 2.

The final step was to assess discriminant validity of the constructs. We used a chi-square difference test to measure discriminant validity (Ahire et al., 1996; Stratman and Roth., 2002). In the first confirmatory factor analysis (CFA) between constructs, the two latent constructs are allowed to freely correlate; in the second CFA between constructs, the correlation between two latent constructs is constrained to one. The difference in chi-square values between the unconstrained model and constrained model is noted and checked for significance. A significant

chi-square difference value indicates two unique constructs thereby establishing discriminant validity. As shown in Table 3, the results of the analysis support discriminant validity among the constructs.

The predictive and nomological validity of the firm resilience construct were established using the scale as a part of a questionnaire administered to 199 respondents. The predictive validity is a measure of how well the construct is predicted by its antecedent variables (Narasimhan, Jayaram and Carter, 2001; Stratman and Roth, 2002). The results of the pretest procedure in scale development were shared with five academic experts and 20 industry experts (from the respondents in the pretest sample) for their feedback. Both the academic experts and industry experts agreed with the conceptualization of each construct.

2.4.2 Sample and data collection

Prior to launching the survey, the survey was pretested with six faculty members and fifteen industry experts. Feedback from the pretest sample was then used to improve the survey and prepare it for distribution to a larger sample. The survey was then distributed to supply chain professionals using an online survey hosted by Survey Monkey (www.surveymonkey.com). The supply chain professionals are all alumni from a large university with a supply chain program. As with any survey, potential respondents were pre-qualified as they needed to have in-depth knowledge of their firm's supply chain operations. Each respondent received an email containing the link to the survey questionnaire. All participants were first pre-alerted and notified about the survey (Dillman, 2000). After the first notification, the respondents were sent regular reminders to complete the survey (Dillman, 2000). The survey was distributed to 1,898 potential respondents, of which 91 were unreachable. Out of the remaining 1807 potential respondents, 199 completed and returned usable surveys, resulting in a response rate of 11.01%. Table 4

provides the demographic characteristics of the sample. The majority of respondents were engineers (33.17%), managers (30.15%) and senior-level officers (14.57%). The average experience held by respondents was between five and ten years. 79% of respondents had a role in production/supply chain in their current organization (30% worked in supply chain/ logistics, 18% worked in manufacturing, 16% worked in purchasing and 15% worked in quality engineering. 30.65% of the firms had a sales revenue of $1 billion or greater. Respondents were asked to list a disruption that they faced in the past year and were then asked to answer the questionnaire considering this disruption. Out of the 199 disruptions reported, 62 were supply glitches, 42 were logistics/delivery glitches, 44 were in-house plant/factory glitches and 51 were reported as natural hazards, regulatory issues, or political issues. Table 5 provides examples of the four types of disruptions provided by the respondents.

We tested for non-response bias by comparing early (first 30 responses) and late respondents (last 30 responses) in terms of firm revenue and number of employees (Armstrong and Overton, 1977). We found no significant differences. Multiple methods were used to check for common-method bias (Harman, 1976; Lindell and Whitney, 2001; Podsakoff et al., 2003). First, we checked for common method bias using the Harman's single factor test (Harman, 1976). In our study, the largest variance explained by any single factor was 34.54%. To further support the absence of common method bias, we conducted the latent factor test (Podsakoff et al., 2003). In this test, a latent factor is introduced to the original measurement model. We found no loss in significance of the factor loadings, further indicating that common method bias is minimized in our study.

2.4.3 Measures

Firm resilience was operationalized using four items measured on a seven-point Likert scale (1= strongly disagree, 7 = strongly agree). The items measure the ability of the firm to cope with changes due to a supply chain disruption, the ability to adapt to a supply chain disruption and provide a quick response, and the ability to maintain high situational awareness.

Supply chain disruption orientation was adapted from Bode et al. (2011). The scale consists of five items measured on a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree). The items capture the firm's recognition that supply chain disruptions are always looming, the need to be alert to supply chain disruptions, how supply chain disruptions can be avoided, analysis of an occurred supply chain disruption, and learning present in supply chain disruptions.

Risk management infrastructure was operationalized as a three-item scale based on the conceptualization of organizational resources as assets that enhance a firm's resilience to supply chain disruptions (Blackhurst et al., 2011). It was also measured using a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree). The items for the risk management infrastructure construct consider the presence of a person/department in the firm to manage supply chain risks/disruptions, use of KPIs and metrics to monitor supply chain risks and disruptions, and use of information systems to manage supply risks and disruptions.

The resource reconfiguration scale was adapted from Wei and Wang (2010) and is based on literature by Helfat et al. (2007), Marsh and Stock (2006) and Zahra et al. (2006). The construct is represented by four items that are measured on a seven-point Likert scale (1= strongly disagree, 7 = strongly agree). The items in the scale captured the ability of the firm to realign their resource base in response to environmental changes, to reconfigure their resource

base in response to the dynamic environment, the ability to restructure their resource base to react to the changing business environment, and the ability to renew the resource base in response to the changing business environment.

Disruption impact was also adapted from Bode et al. (2011). The scale measures how supply chain disruptions reported by the respondents impacted their firm's overall efficiency of operations, delivery reliability to customer, and procurement costs of supplies. The measurement items were measured using a five-point scale (1 = not at all, 5 = a great deal).

In our study we controlled for two variables. First, we controlled for size of the firm which was measured using number of employees in the firm. Large firms tend to have access to a greater number of resources. Smaller firms, while not as rich in resources, may have the ability to be nimble in the face of adversity, due to the shorter chain of command (D 'Amboise and Muldowney 1988; Ramaswami et al., 2009). Second, we control for the firm's market experience. A firm having greater market experience is more likely to have greater exposure to disruptions and more experience managing disruptions, thereby making them more likely to be able to recover from disruptions quickly and improve firm performance (Thornhill and Amit 2003; Ramaswami et al., 2009).

2.4.4 The measurement model

Reliability, validity and dimensionality of constructs were assessed using CFA. In CFA, comparative fit index (CFI), Tucker-Lewis index (TLI) and root mean square error of approximation index (RMSEA) (Anderson and Gerbing, 1988) were used to evaluate the measurement model and to ensure acceptable psychometric properties for all constructs in the model. The CFA showed a good fit, with measures being $\chi 2 = 280.54$ (d.f. = 143, $\chi 2$/d.f. = 1.96, $p < 0.001$), CFI = 0.93, TLI = 0.91, and RMSEA = 0.07 (Hu and Bentler, 1999; Iacobucci, 2010).

Table 6 shows the CFA results. All measurement items with their descriptive statistics are provided in the Appendix A.

Factor loadings, composite reliabilities (CR) and average variance extracted (AVE) estimates were examined to ensure convergent validity of constructs. All factor loadings were greater than 0.50 and significant at $p < 0.001$ suggesting high convergence (Hair et al., 2010). Convergent validity and internal consistency were also supported in an examination of the composite reliabilities. All CR values were greater than 0.7 (Hair et al., 2010). The AVE for each construct was greater than 0.5, indicating support for convergent validity. AVEs for each construct also exceeded the squared correlations of the remaining constructs, indicating support for discriminant validity. Variance extracted estimates and correlations are shown in Table 7.

Analysis and Results

2.7 The structural model

We used structural equation modeling to test the hypothesized relationships shown in Model 1 under high disruption impact and low disruption impact situations. Figures 3a and 3b show the results of the testing in each situation. To test the hypotheses under high and low disruption impact situations, multigroup analysis was performed using the disruption impact scale to separate the groups. The mean of the three items in the disruption impact scale was calculated to create a composite index. The median of this index was then calculated and the sample was split as close as possible to the median (Calantone et al., 2002; Germain et al., 2008). This lead to creation of two groups: those reporting a high impact disruption (n=81) and those reporting a low impact disruption (n = 118).

In the multigroup analysis, we noted the strength (path estimates) of the hypothesized relationships. The equivalence of path estimates is examined using a chi-square difference test.

Values are noted for both constrained and unconstrained two-group baseline model1, and the difference is checked for significance. Significance of chi-square difference suggests that across the two groups, path estimates are different (unconstrained model: $\chi 2 = 186.53$, d.f. = 122; constrained model: $\chi 2 = 1973.45$, df = 136; $\chi 2$ difference = 1786.92; $p < 0.001$). The results of the structural analysis yielded acceptable fit statistics: $\chi 2 = 186.53$ (d.f. = 122, $\chi 2$/d.f. = 1.53, $p < 0.001$), CFI = 0.94, TLI = 0.92, and RMSEA = 0.052 (0.036, 0.066).

A mediation analysis was used to test hypotheses H1 and H2. To test for mediation, we use the bootstrapping method recommended by Preacher and Hayes (2004, 2008). Bootstrapping is a nonparametric statistical procedure in which the dataset is repeatedly sampled and indirect effects are calculated. These indirect effects are then tested for significance using confidence intervals. If the indirect effects are significant, mediation is inferred in the model. In this study, we measured the significance of indirect effects by setting the number of sampling iterations (n) equal to 5000. The direct and indirect effects between supply chain disruption orientation and firm resilience were found to be significant at $p < 0.001$, inferring partial mediation. The indirect effect between supply chain disruption orientation and firm resilience under high impact disruptions was found to be significant and the direct effect was found to be insignificant, inferring full mediation (supporting hypothesis H1). The direct effect of resource reconfiguration on firm resilience was found to be insignificant under low impact disruptions, suggesting that mediation does not exist (supporting hypothesis H2). Table 8 presents the bootstrapping results.

To test the moderation effect of risk management infrastructure (hypotheses H3 and H4), we used the interaction method (Cohen et al., 2003). A cross-product term was created to

[1] To calculate the difference, the path estimates are first constrained and set equal across the two groups and then allowed to be free

measure the moderation impact of risk management infrastructure on the mediation impact of resource reconfiguration, and the relationship between supply chain disruption orientation and firm resilience. The predictor variables were mean centered to reduce multicollinearity with the interaction term (Aiken and West, 1991; Cohen et al., 2003). The results (in figures 3a and 3b) show that hypotheses H3 and H4 were supported. H3 predicted that the mediation impact of resource reconfiguration would be diminished by risk management infrastructure under high impact disruptions. H4 predicted that the supply chain disruption orientation and risk management infrastructure would have a synergistic impact (Cohen et al., 2003) on firm resilience under low impact disruptions. The interaction effects are shown in figures 4a and 4b. In Figure 4a, we find the slope estimate for the high risk management infrastructure line is 0.34 and for low risk management infrastructure is 0.62. Both slope estimates are significant at the 0.05 level. In Figure 4b, we find the slope estimate for high risk management infrastructure line is 0.05 and for low risk management infrastructure is -0.03. All the slope estimates were significant at the 0.05 level.

2.5 Discussion and Implications

In our study, we present a clear definition and operationalization of firm resilience. We utilize our newly developed scale to examine the impact of key variables on firm resilience. We begin by showing that while a supply chain disruption orientation is important in developing resilience, it is not always sufficient for doing so. The context can play a critical role in determining the ability for such an orientation to lead to firm resilience. Our findings extend the supply chain disruption literature to include a better understanding of firm resilience in two different contexts: high impact disruptions and low impact disruptions.

As we have noted, supply chain disruption oriented firms learn from prior disruptions and maintain an awareness of the environment to allow them to manage future disruptions. Our research model proposes that to achieve this resilience, firms must be able to reconfigure their resources in the face of disruptions. In the context of high impact disruptions, this path to resilience is supported. Simply having a supply chain disruption orientation and resources in place is not sufficient. Resource reconfiguration fully mediates the relationship between supply chain disruption orientation and firm resilience. While it is important for a firm to have resources to be resilient, resources by themselves cannot guarantee resilience. The ability to leverage those resources and reconfigure them is also critical to firm resilience. When facing a disruption, a firm must be able to evaluate their current resource base (i.e., identify current resource inventory and nature of resources available) and add new resources, shed existing resources or recombine/reorganize existing resource bundles. Not all resources are equally effective or hold equal value under different environmental conditions (Sirmon and Hitt, 2003). As such, acquiring valuable resources and shedding less important ones becomes crucial for a firm's resilience to disruptions. To ensure quick identification of and response to the supply chain disruptions, supply chain disruption oriented firms are engaged in developing and updating resources that ensure effective response to a supply chain disruption (Bode et al., 2011). They understand the need to acquire new resources or release unnecessary ones in order to be more adaptive to the changes brought by a high impact supply chain disruption. This is in line with Galunic and Rodan (1998), who note the importance of engaging in creating new resources through experimentally trying different resource combinations.

Our findings show a slightly different path to firm resilience under low impact disruptions. When faced with low impact disruptions, resource reconfiguration is not directly

related to firm resilience, indicating that it does not mediate the relationship between supply chain disruption orientation and firm resilience in such cases. Risk management infrastructure, however, plays a critical role in low impact disruptions. Supply chain disruption orientation and risk management infrastructure have a synergistic effect on firm resilience. As supply chain disruption oriented firms develop greater risk management infrastructure, they become more resilient. Risk management infrastructure provides role formalization and task specialization that reduces operational ambiguity during supply chain disruptions and allows the firm to take quick action against disruptions. For firms that recognize that disruptions are always looming and are motivated to work towards recovering from disruptions, having a risk management infrastructure can provide protection against low impact disruptions. Issues such as late shipments can often easily be managed by having people and systems in place to monitor and take actions to correct such problems.

High impact disruptions and low impact disruptions affect firms differently. Accordingly, each has a unique path to firm resilience. The effective development and management of resources provides the bridge between understanding the disruption environment and being prepared to succeed in the face of disruptions. We show that many supply chain disruption oriented firms will be capable of absorbing low impact disruptions by having the right infrastructure in place. However, in more severe or high impact conditions, the ability to actively manage and reconfigure those resources is necessary to develop firm resilience.

2.5.1 Managerial implications

The findings from this study should aid managers in the planning and preparation for supply chain disruptions. In particular, senior-level managers should take note of the importance of maintaining a supply chain disruption orientation. This is the starting point for establishing firm resilience as it guides management decisions regarding the establishment and reconfiguration of critical resources. The orientation can be reinforced through regular communication and measurement. In doing so, employees at all levels of the firm are likely to maintain an awareness of disruptions and take steps to learn from even small disruptions within the supply chain. Managers should also seek to establish a formal risk management infrastructure by dedicating human and information resources to specialize in managing and responding to real and perceived risks to the firm's operations. As our research shows, such an infrastructure can allow firms to easily absorb low impact disruptions. Our findings demonstrate that although the mere presence of such resources does not make the firm more resilient in the event of high impact disruptions, they can keep operations running smoothly when faced with low impact disruptions. Resources of this type should include processes and procedures for monitoring the flow of goods upstream and downstream and for expediting and re-prioritizing workflow to meet firm and customer expectations.

Managers should also play an active role in making sure that the resources of the firm are aligned with the changing needs of the firm and the marketplace. Managers must be willing and able to make changes to their resource portfolio which may involve making major adjustments. Such changes may impact product offerings, service offerings, labor, facility operations, and relationships with other entities. One example might include using alternative suppliers and

service providers to provide the firm with an array of options in the event of larger disruptions to the flow of products and services.

2.6 Conclusions

Our goal with this study was to understand what enables a firm to be resilient when facing supply chain disruptions. We extend the literature develop and operationalize a new firm resilience construct and examine its relationship with key resources and capabilities of the firm in the context of supply chain disruptions. Specifically, we show by employing our new scale you can show that supply chain disruption orientation is not the sole determinant of firm resilience to supply chain disruptions. Instead, there are important mediating and synergistic relationships that need to be taken into account. Our study contributes in a number of meaningful ways. First, this study develops, operationalizes and validates a firm resilience measurement scale. Next, the study demonstrates that a supply chain disruption orientation does not directly impact firm resilience in high-impact disruptions. Finally, the study highlights the importance of establishing a risk management infrastructure for managing low impact supply chain disruptions. As with all research, there are some limitations that should be noted. First, the data used in the analysis is cross-sectional. Cross-sectional data collection limits the ability to draw conclusions related to causality. Therefore, future research should include alternative types of data, such as longitudinal data or event studies. Another limitation of the research is the use of a single respondent from each firm. Future studies of firm resilience should attempt to acquire additional data sources for the measurement of dependent variables. Future studies should also consider other approaches to capturing resilience. Scholars should explore firm resilience through the use of different types of event studies. For example, one study could examine the effect of supply disruptions on firm resilience and another could examine the effect of a natural disaster. Our

research did not identify and test specific elements of risk management infrastructure, but future research could be directed at such exploration. Finally, we encourage scholars to extend the concept of resilience beyond the boundaries of a single firm to encompass broader supply chain resilience. Is it possible to develop relational or supply chain resilience between two or more firms in a supply chain? We believe that our research could be extended to explore such questions.

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Table 1: Definitions of Resilience at the Firm Level

Definition	**Reference**
The capability to anticipate and overcome supply chain disruptions.	(Pettit et al., 2010; Pettit et al., 2013)
A firm's ability to recover from supply chain disruptions quickly.	(Blackhurst et al., 2011)
The capacity of organizations to cope with unanticipated dangers after they have become manifest.	(Weick et al., 1999; Wildavsky, 1991)
The ability to respond to disruptions and restore normal operations.	(Rice and Caniato, 2003)

Table 2: Scale Development- Pretest Results

Construct	**Cronbach alpha (α)**	**Range of Factor Loadings**
Firm Resilience	0.86	0.67 - 0.83
Risk Management Infrastructure	0.90	0.76 - 0.91

Table 3: Test for Measurement of Discriminant Validity

Construct Pairs		**Unconstrained Model**	**Constrained Model**	**χ2 Difference**
Firm Resilience	Risk Management Infrastructure	$\chi^2 = 30.47$, d.f. = 13	$\chi^2 = 36.24$, d.f. = 14	5.77**

* p < .1
** p < .05
*** p < .001

Table 4: Demographic Characteristics of the Sample

Job Title	**Number of Respondents**
CEO/CFO/CIO/President	6
Vice President/Director/Partner/Principal/General Manager	23
Managers	60
Planner/Scheduler/Analyst/Buyer	44
Engineers	66
Type of Firm	**Number of Respondents**
Manufacturing	154
Power Management	7
Trucking/Logistics/Transportation/Shipping	17
Process Control/Chemicals	6
Retail	12
Direct Sales	3
Firm Sales	**Number of Respondents**
$10 million or less	7
More than $10 million, up to $50 million	11
More than $50 million, up to $100 million	18
More than $100 million, up to $200 million	13
More than $200 million up to $500 million	16
More than $500 million, up to $1 billion	73
More than $1billion	61

Table 5: Disruption Types and Examples

Disruption Type	Example
Supply disruption	Late shipment of inbound materials from the supplier.
Logistics/delivery disruptions	Truckload transportation provider did not pick up a load of product as they said they would.
In house/plant disruptions	Plant shutdown due to major machine breakdown.
Natural hazards/regulatory and political issues	Disruption stemming from a country whose government cracked down on illegal re-sterilization of products only intended for single use, after which those products saw high levels of unanticipated demand.

Table 6: Summary Statistics (Convergent Validity)

Construct	Average Variance Extracted	Composite Reliability	Range of Factor Loadings
Supply Chain Disruption Orientation	0.52	0.84	0.67 - 0.80
Risk Management Infrastructure	0.8	0.92	0.78 - 0.96
Resource Reconfiguration	0.56	0.83	0.63 – 0.92
Firm Resilience	0.62	0.86	0.60 - 0.89
Disruption Impact	0.52	0.76	0.54 - 0.80

Table 7: Average Variance Extracted and Correlations

Construct	1	2	3	4	5
1. Supply Chain Disruption Orientation	*0.52*	**0.02**	**0.36**	**0.36**	**0.00**
2. Risk Management Infrastructure	0.14***	*0.8*	**0.00**	**0.04**	**0.00**
3. Resource Reconfiguration	0.60***	0.07***	*0.56*	**0.35**	**0.02**
4. Firm Resilience	0.60***	0.21**	0.59***	*0.62*	**0.06**
5. Disruption Impact	0.07	0.07***	-0.13	-0.24**	*0.52*

[a] Entries in italic, on the diagonal represent the average variances extracted; items in bold and above the diagonal are square of correlations (shared variances); items below the diagonal are the inter-construct correlations.

*** $p < .001$

Table 8: Test for Mediation - Bootstrapping Results[a]

	High Impact Disruption Situation		Low Impact Disruption Situation	
Constructs	**RR**	**FR**	**RR**	**FR**
SCDO				
Total effect	0.59***	0.57***	0.2	0.27**
Direct effect	0.59***	0.17	0.2	0.21**
Indirect effect		0.40*** (0.15, 0.68)	-	0.06
RR				
Total effect		0.68***		0.32
Direct effect		0.68***		0.32
Indirect effect		-		-

** p < .05
*** p < .001
[a] The number in parentheses indicate the 95% confidence interval for n = 5000 bootstrap.
[b] (SCDO = Supply Chain Disruption Orientation, RR = Resource Reconfiguration, FR = Firm Resilience)

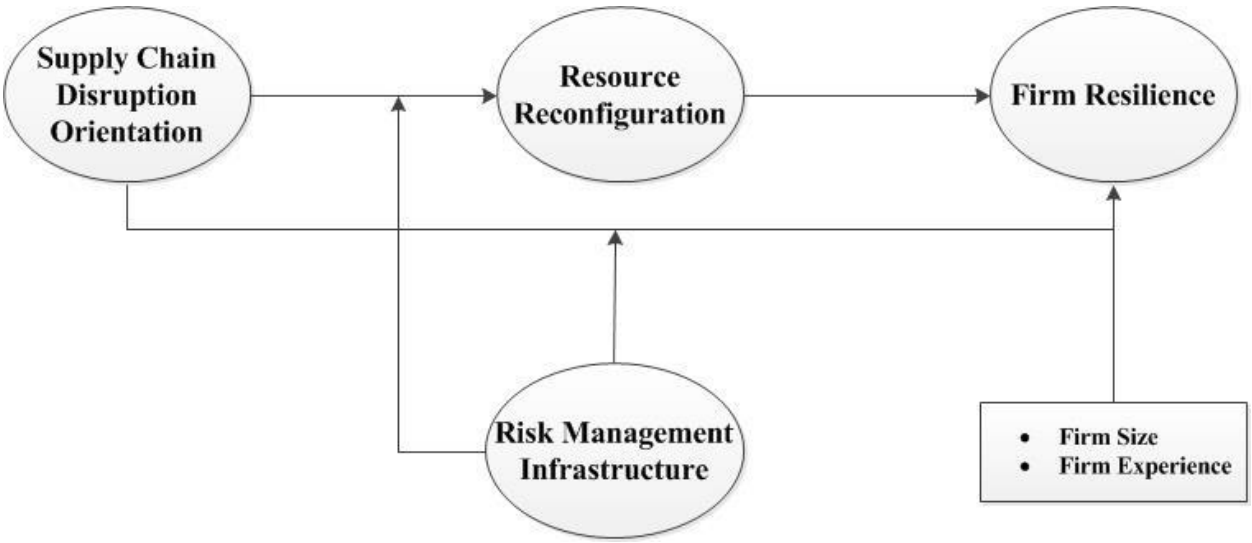

Figure 1: Proposed Model under High and Low Impact Supply Chain Disruption Situations

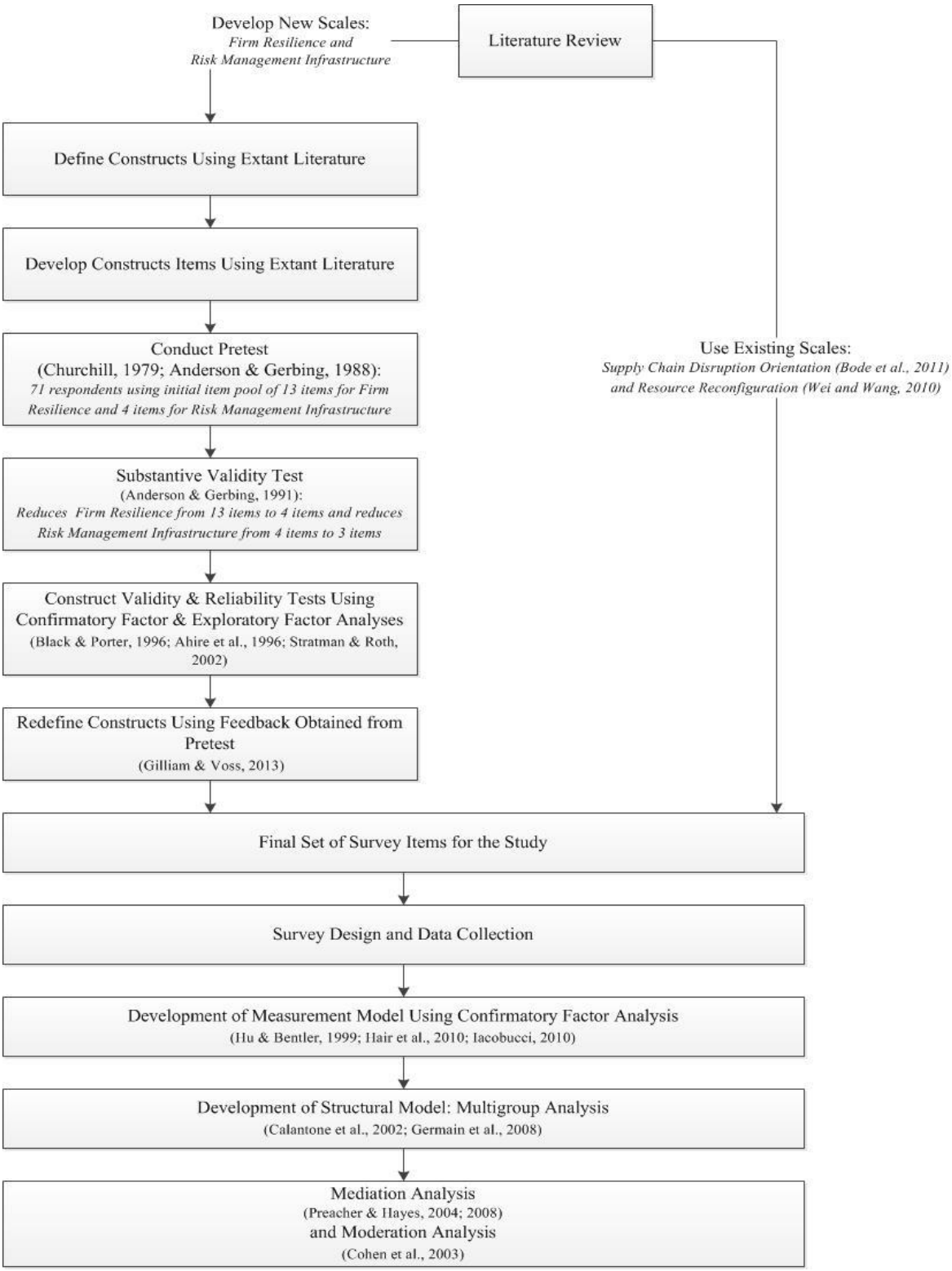

Figure 2: Research Methods Flow Chart

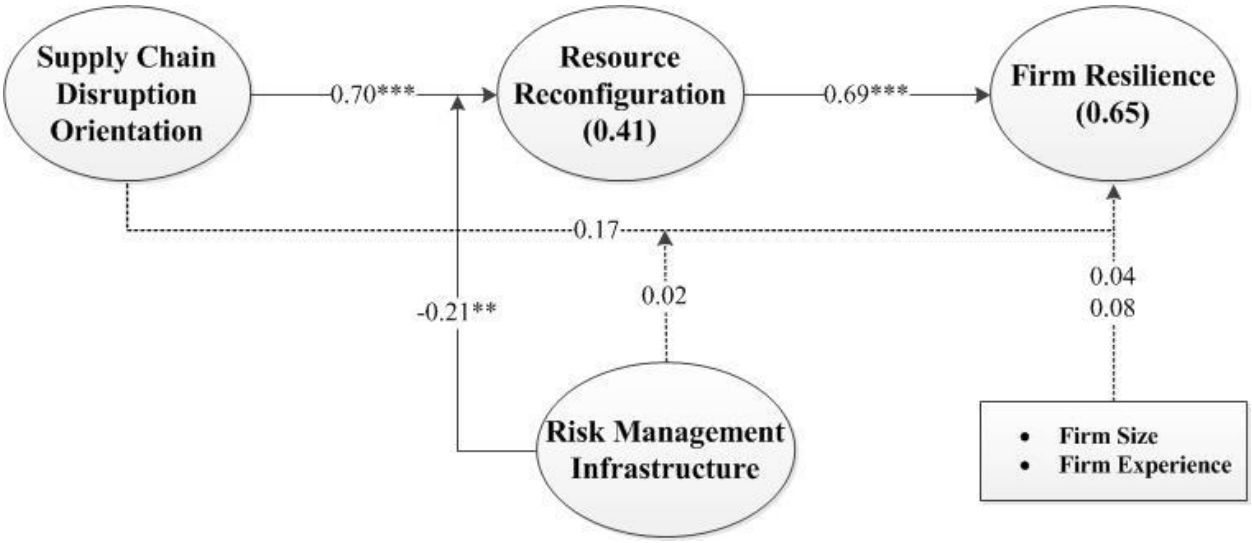

Figure 3A: Structural Model 1 (High Disruption Impact Situation)

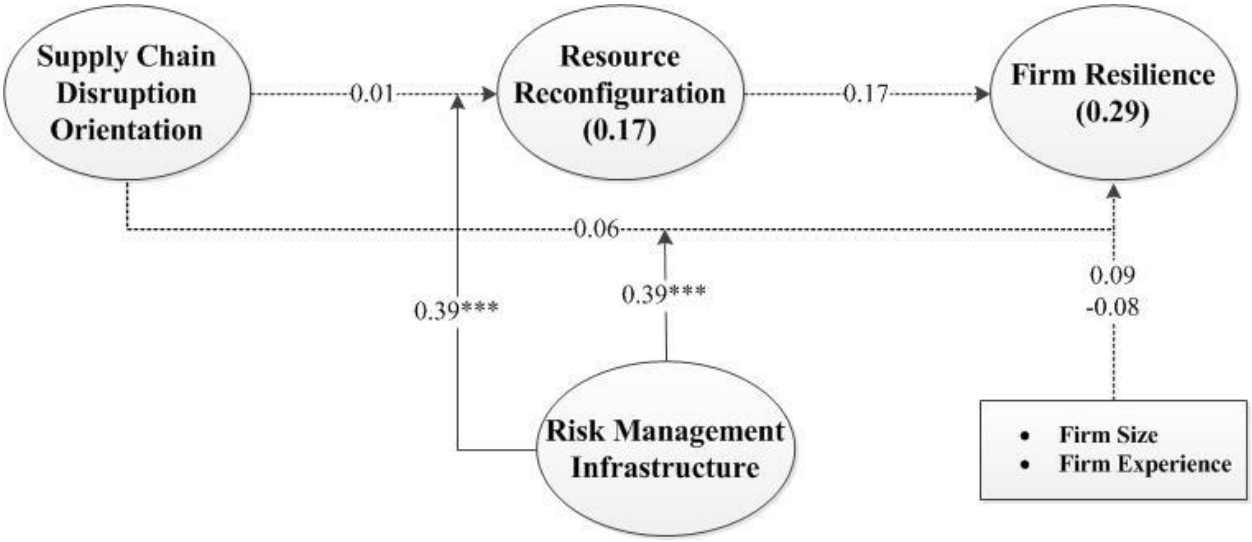

Figure 3B: Structural Model 2 (Low Disruption Impact Situation)

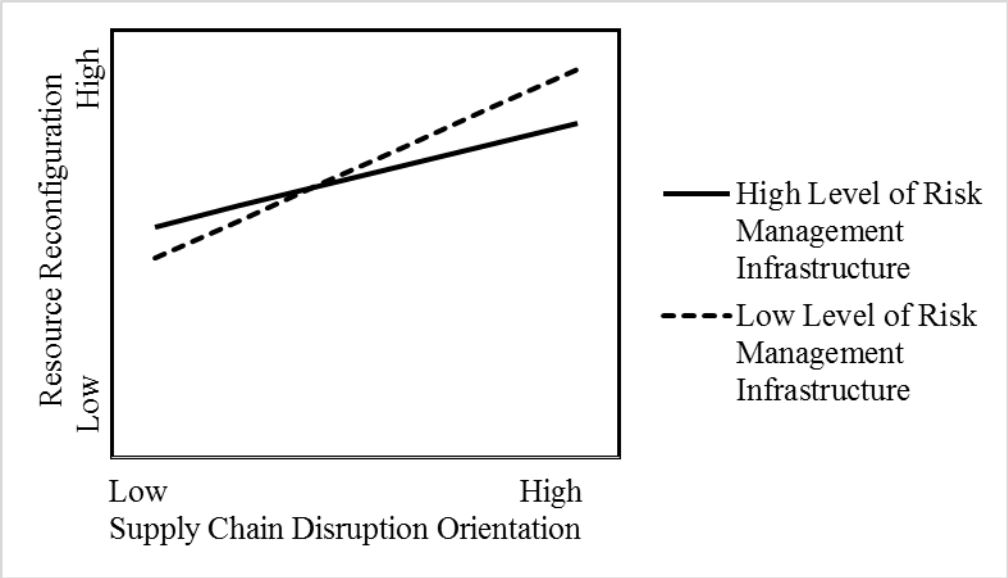

Figure 4A: Interaction Plots (High Disruption Impact Situation)

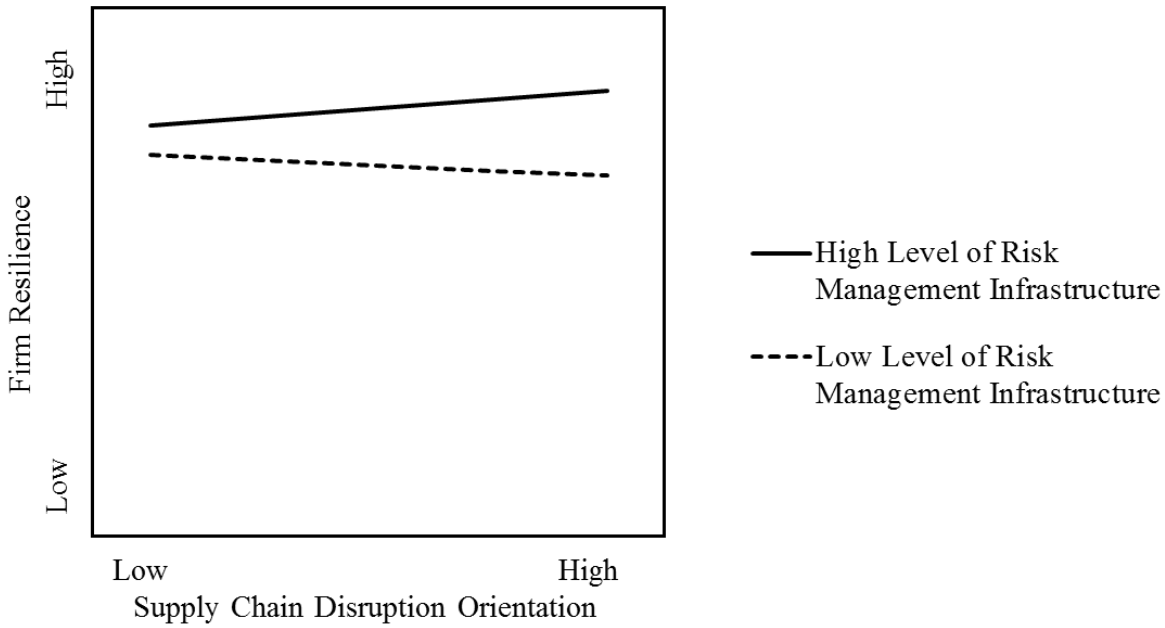

Figure 4B: Interaction Plots (Low Disruption Impact Situation)

Appendix A: Construct Items (Descriptive Statistics, Factor Loadings and Reliability) [a]

Construct		**Mean**	**Standard Deviation**	**λ**	**α**
Supply Chain Disruption Orientation					0.82
SCDO1	We feel the need to be alert for possible supply chain disruptions at all times.	5.65	1.10	0.67	
SCDO2	Supply chain disruptions show us where we can improve.	5.70	0.99	0.72	
SCDO3	We recognize that supply chain disruptions are always looming.	5.83	0.93	0.80	
SCDO4	We think a lot about how a supply chain disruption could have been avoided.	5.10	1.27	0.74	
SCDO5	After a supply chain disruption has occurred, it is analyzed thoroughly.	4.84	1.39	0.66	
Risk Management Infrastructure					0.91
RMR1	We have a department to manage supply chain risks and disruptions	4.92	1.43	0.78	
RMR2	We have KPI and metrics to monitor supply chain risk	4.97	1.35	0.94	
RMR3	We have information systems in place to manage supply chain risks and disruptions.	4.91	1.36	0.96	
Resource Reconfiguration					0.81
RR1	We realign our firm resources and processes in response to environmental changes.	4.54	1.43	0.62	
RR2	We reconfigure our resources and processes in response to the dynamic environment.	5.30	1.41	0.92	
RR3	We restructure our resource base to react to the changing business environment.	5.20	1.38	0.74	
RR4	We renew our resource base in response to the changing business environment	4.52	1.49	0.67	
Firm Resilience					0.85
FR1	We are able to cope with changes brought by the supply chain disruption.	4.75	1.15	0.89	
FR2	We are able to adapt to the supply chain disruption easily.	4.40	1.29	0.87	
FR3	We are able to provide a quick response to the supply chain disruption.	4.79	1.19	0.75	
FR4	We are able to maintain high situational awareness at all times.	4.86	1.15	0.60	

Disruption Impact: How did disruption negatively affect:					0.75
DI1	Overall efficiency of operations	3.58	1.06	0.54	
DI2	Lead time for delivery (delivery reliability)	3.43	1.27	0.80	
DI3	Purchasing costs for supplies	3.50	1.29	0.79	

[a] "λ" refers to standardized factor loading; "α" refers to Cronbach's alpha value (represents construct reliability)

Chapter 3: Dark Side of Strategic Focus on Innovation: Supply Chain Disruptions

3.1 Abstract

Studies on innovation have traditionally looked at positive outcomes associated with innovation. In this study we focus on dark side of strategic focus on innovation. The primary contribution of the study is to empirically support our position that strategic focus on innovation can lead to greater risk of supply chain disruption which can affect the efficiency of the firm. We use a sample of 173 publicly listed firms in India to build a structural model that tests the relationship between strategic focus on innovation, supply chain disruption risk and firm performance. The study also looks at the moderating role of risk management infrastructure in attenuating the negative influence of strategic focus of innovation on supply chain disruption risk.

3.2 Introduction

Innovation is viewed as the Holy Grail for organizational progress. In a 2011 survey of CEOs by PricewaterhouseCoopers (PwC), innovation was the locus of CEO's strategic agenda in almost every industry (PwC's 14th Annual Global CEO Survey, 2011). Firms have a strategic focus on innovation as they believe it can help them to generate new revenue opportunities, gain market share, outpace and outdo competitors and ensure long term profits and growth (Freeman, 1994; Shan et al., 1994; Lawless and Anderson, 1996; Eisenhardt and Brown, 1999; Schilling and Phelps, 2007).

While an innovation agenda addresses organizational call for growth and competitive advantage, it also has a dark side that is related to its impact on a firm's operating complexity (Gottfredson and Aspinall, 2005). In a Bain survey (2005), managers noted that emphasizing

product innovation typically increases the number and variety of product lines that firms offer to customers. Given demand uncertainty and associated demand forecasting errors, more product lines will mean that firms may need to hold excess inventory in order to meet market demand (Shefi and Rice 2005). An increase in product lines will also increase the number of parts and components to be held in inventory, the number of suppliers that the firm has to deal with, the cost of coordinating with more suppliers and the frequency of changes to the production set-up. All of these factors contribute to operational uncertainties that can increase the risk of supply chain disruptions which may have a negative impact on the firm's cost and profit potential (Craighead et al., 2007; Knemeyer, 2009).

Supply chain disruptions are defined as events that disrupt the normal flow of goods within the supply chain (Craighead et al., 2007). Most disruptions are difficult to predict as they occur infrequently, but they can be quite damaging (Chopra and Sodhi 2004). Previous research has shown that supply chain disruptions can have severe negative consequences on a firm's financial performance (Narasimhan and Talluri, 2009; Hendricks and Singhal, 2003; 2005).

Supply chain disruptions have also increased in frequency and magnitude because firms that have a strategic focus on innovation have shown an increasing tendency to collaborate with other firms both within and outside their markets to develop new products that provide greater value to end customers (Hagedoorn, 1993; Sampson, 2007; Schilling and Phelps, 2007; Kuepp et al., 2012). The inter-firm cooperation for innovation happens for two major reasons, (1) access to complementary assets (Sampson, 2007) and (2) potential for sharing high development costs associated with innovation that can eat into the benefits generated by innovation. However, the pursuit of co-innovation can lead to confusion about the role of firm's internal resources vis-à-vis partner's resources. Also the partner could always be playing catch up to understand the

changing needs of the firm pursuing innovation. Overall, the dependence on supply chain partners and the longer and more complex supply chain setups arising from global operations have increased the vulnerability of supply chains to disruptive environmental forces (Christopher and Peck 2004; Hendricks and Singhal 2005).

For managers, the brighter side of strategic focus on innovation, the one that leads to greater firm performance is easily visible, while the darker side, the one that leads to supply chain disruptions is often overlooked. Gottfredson and Aspinall (2005) note that profit-eroding complexity "tends to be invisible to management" (p. 2). We examine if firms (for whom complexity impact is visible rather than invisible) that address the complexity through design of a risk management infrastructure are able to reduce the negative impact of innovation focus on profits because of increased supply chain disruptions. Risk management infrastructure describes the resource structure that a firm has in place to manage risks and disruptions (Ambulkar et al., 2015). These resources include the presence of a department to manage risks/disruptions, the existence of information systems to manage risks/disruptions, and the use of a framework/policy to formalize and guide the risk management process. We suggest that the presence of risk management resources can mitigate the negative effect of innovation focus on the frequency of disruptions faced by firms. In turn, the lower the incidence and impact of supply chain disruptions, the better will be a firm's profit performance.

We use arguments from organizational attention and strategic agenda literatures to support the bright side of innovation (strategic focus on innovation → firm innovativeness → firm effectiveness). The CEO and the top management team determine the degree to which the firm should focus on innovation as an avenue for growth and profits. The innovation agenda is captured in this study by examining firm's pronouncements of the importance of innovation in

the mission, vision, value statements and company profile that is presented to the key stakeholders of the firm. Such form of communication reflects their attentional focus and helps drive the innovation efforts of employees of the firm (Tushman and Rosenkopf 1996). Firm's innovativeness is captured on firm's effort to create new products and/or add value to existing products.

For the dark side (strategic focus on innovation → supply chain disruption risk → firm efficiency), we use arguments from the organizational complexity literature, with specific focus on innovation's impact on supply chain disruptions. We also discuss the co-innovation architecture that may be employed by firms to bring in the supply chain partner base into the innovation process and complexities that may arise from it. Finally, we use the risk management literature to argue that firms which adopt a proactive stance to manage the risks arising from innovation-based complexities may enjoy better profits.

The study makes several contributions to the innovation and disruptions literature. First, it adds to the innovation literature by examining the impact that representations of a firm's identity have on its innovativeness and bottom line performance metrics. There is no known study (to the knowledge of the authors) that has linked what the firm and its leaders say about the importance of innovation to the firm and its actual market performance. Second, the study extends the innovation literature by showing its dark side—specifically how organizational asset utilization is weakened because of increased risk of supply chain disruptions to the firm. While academics have conceptually argued for the dark side, our study shows the dark effects empirically using objective measures of asset utilization. Third, it proposes and shows the usefulness of a contingent structure for reducing the dark side effects. The contingent structure used in the study is a firm's risk management infrastructure, comprising of a risk policy, risk

technology and risk governance. Fourth, in a broader context, the study contributes to the nascent literature on building synergy among business processes. It examines the impact of organizational focus on one process (innovation) on performance of another process (supply chain management) where the two processes may have conflicting goals and expectations.

3.3 Literature Review and Hypotheses Development

A firm's innovativeness is integral to its competitive advantage and superior business performance (Hitt, Keats and DeMarie, 1998; Lee et al., 2000; Rothaermel and Deeds, 2004; Zhou and Li, 2012). Innovativeness at the product level refers to the degree of newness of a product (Garcia and Calantone, 2002); innovativeness at the firm level describes the degree to which the firm consistently develops new products and/or adds incremental value to existing products. In this study we look at a firm's strategic focus on innovation and its impact on the firm's innovativeness. We view a firm's strategic focus on innovation as the attention given by the firm to innovation (Occasio, 1998; Chandy et al., 2006). Innovation is defined as the process of design, development and commercialization of new products (Chandy et al., 2006; Garud, Tuertscher, and Van De Ven, 2013).

Research on organizational attention suggests that the behavior of a firm is a function of how the firm channels the attention of its decision makers (Occasio, 1998; Weick and Sutcliffe, 2006). By setting a strategic focus on a particular issue, a firm focusses the attention, energy and mindfulness of its decision makers on that issue (Kanheman, 1973; Dutton and Penner 1993; Occasio, 1998). The decision makers then formulate strategies that set the direction of the firm (Yadav, Prabhu and Chandy, 2007). Because of bounded rationality, the number of issues that decision makers within an organization can focus on is limited (Simon,1947, 1971). Assigning

strategic status to an issue will enable greater attention being paid to it by key decision makers. By the same token, it also will divert their attention away from other issues that do not matter.

The early model of innovation being a single discrete event has been superseded by a process based model that shows innovation as a continuous endeavor that unravels over time (Damanpour 1991; Pettigrew, Woodman, and Cameron 2001; Van de Ven et al. 1999; Yadav, Prabhu, and Chandy, 2007). Firms that have a strategic focus on innovation will have decision makers paying greater attention to innovation and acquiring and manipulating resources to achieve greater innovativeness. Firms in which decision makers pay greater attention to innovation are able to convert inventions to innovations quickly and effectively (Yadav, Prabhu and Chandy, 2007). They are open to new policies, processes and systems that foster innovation related activity within the firm (Zhou, Yim and Tse, 2005). These firms also see a greater commitment of employees towards meeting the innovativeness goals (Zhou Yim and Tse, 2005).

We propose that strategic focus on innovation is a double edged sword. While it can provide revenue and profit benefits through greater levels of innovation output, it can also negatively affect firm performance through supply chain disruptions. Innovation is complex, interdependent (Usher 1954; Jelinek and Schoonhoven 1990; Dougherty and Hardy 1996; Garud, Gehman, and Kumaraswamy, 2011) and uncertain (Sorescu and Spanjol, 2008). Hence firms that have a strategic focus on innovation can face supply chain disruptions that arise from this complexity, dependencies and uncertainty (Craighead et al., 2007; Sodhi, Son, and Tang, 2012). A strategic focus on innovation requires constant changes within the firm and at partner firms related to product, process, or technology (Adner and Euchner, 2014). Such changes can bring in adoption, quality and delivery related risks from the partner's side. Innovation is a non-linear process (Van de Ven et al., 1999; Garud, Gehman, and Kumaraswamy, 2011) and firms that are

innovation focused could constantly face unanticipated requirements as well as dead ends which could lead to supply chain disruptions.

Innovation is inherently risky and not every innovation outcome meets with success (Baker, Grinstein, and Harmancioglu, 2015). Firms need to have a risk management infrastructure in place that can help them deal with the disruptions resulting from innovation complexity and uncertainty both proactively and reactively. Having a risk management system to support the focus on innovation can help firms see the blind spots that can hurt their performance the most. It can identify for the firm vulnerable nodes in the supply chain—nodes that need to be primed and guided for firms to maintain high level of innovativeness.

Figure 5 presents our theorized model.

3.3.1 Hypothesis

Strategic focus on or attention to innovation involves "noticing, interpreting, and focusing of time and effort" on innovation (Ocasio 1997). This attention on innovation is achieved through substantive symbolic actions, such as highlighting innovation in the firm's vision/mission statement, values and in its corporate profile. The vision/mission statement, values and corporate profile are formal representations of firm's strategic identity (Abratt, 1989; Dowling, 1993; Hatch and Schultz 1997) and play an important role in driving the belief systems and actions of its employees (Simons, 1994; Ocasio, 1997). By mentioning innovation in these representations, firms are able to communicate and reinforce the importance of innovation to their employees, thereby generating greater commitment from them (Kohli and Jaworski, 1990). This is necessary for firms to set up the base for innovation (Chandy and Tellis, 1998). Van de Ven (1986) also notes the importance of organizational attention to innovation for generating

new ideas that can be commercialized. Firms with a strategic focus on innovation are able to reconfigure existing resource allocation structure such that innovation related activities are allocated the resources they require to be effective. More importantly, firms are able to decrease their focus on activities lower on the priority list.

Two types of activities need attention in an innovation context—one relating to customers and markets and the second to technology. Firms need to pay attention to understand changing market needs and tastes, changing competition and new bases for competition, and changing value propositions of customers. Firms also need to pay attention to changes in technology and how these can address customer requirements. Using an innovation process view, Yadav, Prabhu and Chandy (2007) indicate that firms need to detect arrival of new technologies, develop products based on those technologies and deploy the new technology further after launch. They further state that such "mechanisms that firms employ to extract insights from the marketplace have significant implications for firms' innovation outcomes" (Yadav, Prabhu and Chandy 2007). We argue that when CEOs pay attention to innovation, employees of the firm will be focused on markets and technologies and will be quick to respond to market opportunities.

The above discussion stipulates that greater focus leads to higher commitment, resource reconfiguration and activity structuring. These actions have become particularly relevant for innovation success in today's environment characterized by shortening of product and technology lifecycles (Christensen, 1997). Prior research has noted that firms that have a focus on innovation are not only able to generate more innovations (Tushman and O'Reilly, 1996), but they do so at a faster rate (Kessler and Chakrabarti, 1996; Vázquez, Santos, and Alvarez, 2001).

The ability of the firm to generate new products and add value to its existing products (Damanpour, 1991, Hurley and Hult, 1998; Eisenhardt and Martin, 2000; Zaheer and Bell, 2005)

is a critical factor that determines the effectiveness of the firm (Damanpour, 1991; Hult, Hurley and Knight, 2004). Effectiveness of the firm is the ability of the firm to generate profits and sales. Wernerfelt (1984) and Peteraf (1993) note that using resources to generate new products provides firms with greater competitive advantage, thereby increasing their effectiveness. Today firms operate in a highly turbulent market environment and a traditional prescription to succeed in a highly turbulent market has been to innovate (Miller and Frerisen, 1982). Firms that innovate gain competitive advantage and consequently superior profitability (Roberts and Amit, 2003).

The above arguments lead us to our first hypothesis.

H1: Strategic focus on innovation has a positive impact on market effectiveness by increasing the firm's innovativeness.

While prior research has offered abundant evidence for the bright side of innovation, academic literature that looks at the dark side of focus on innovation is scant. Looking at the dark side is equally important as the bright side as it offers a more holistic view about the consequences of focus on innovation (Simpson, Siguaw, and Enz, 2006). In this study, we posit that strategic focus on innovation can increase the risk of supply chain disruptions that can affect the efficiency of the firm. Efficiency of the firm is defined as the ability to firm to use its assets to generate more sales (asset turnover) and more profits (ROA).

Firms with a strategic focus on innovation are likely to increase the breadth and depth of the products they are able to provide (Simpson, Siguaw, and Enz, 2006), as well as increase their reliance on the supply chain network to provide meaningful contributions to their innovation efforts. Both of these actions are likely to increase the frequency and impact of supply chain disruptions with deleterious consequences for the bottom lines of firms.

Greater focus on innovation, particularly in the global marketplace that firms operate in, implies they will be attempting to increase development of new product lines and product variants in order to adhere to local tastes. Mobile phone makers, for example, introduced 900 more varieties of handsets in 2009 when compared to 2000 (Malik, Niemeyer and Ruwadi 2011). From a manufacturing perspective, this implies an increase in the number of parts and materials coming from different suppliers. Using terminology adopted by Craighead et al. (2007), the supply chain complexity increases as the number of nodes and the amount of forward, backward and within-tier material flows increases. Craighead et al. (2007) go on to suggest that complexity is associated with vulnerability to disruptive events. Because of interdependencies among nodes, a disruption at any node can potentially propagate it to other nodes within the network. Caridi et al. (2010) notes that a supply chain that is optimal for a given set of product lines may not stay optimal when new lines are added. Rungtusanatham and Forza (2005) observed that the need for alignment between supply chain design and product design has not captured the attention of top management within firms. The net result is that manufacturing and logistics operations of firms are unprepared for a world of rapid product changes. This unpreparedness is associated with poor visibility into customer demand, errors in demand forecasts, long supplier lead times, and the need for higher levels of inventory. When these are combined with organizational strategy to move and outsource supply chain functions, a higher level of risk exists that undesirable outcomes are more likely to occur. Further, because of focus on different product lines and globalization, there is an increased likelihood that companies will face more number and variety of adverse events, such as natural disasters, economic volatility and supply chain problems, all increasing the frequency and impact of supply chain disruptions for the firm.

The innovation model used by firms has changed significantly in recent decades. The conventional practice was to grow from within, implying that most innovations originated within the firm. In a complex competitive world, innovation generation today spans multiple organizations, including one's supply chain partners (Roy, Sivakumar, and Wilkinson 2004). One reason for this change is that innovation involves high development costs that can eat into the benefits derived from it. To reduce the burden of these costs, firms may cooperate with their supply chain partners on the innovation process. The decision to co-innovate also has other benefits as it allows the focal firm to complement its R&D assets with its partners' R&D assets. However, any firm that collaborates with other firms runs the risk that disruptions can impact its performance and sometimes even its survival (Chopra and Sodhi, 2012). Using resource dependence arguments, Bode et al. (2011) suggest that a firm's need for scarce resources creates a dependence on its exchange partners which could act as a potential source of adversity for the firm (from a disruption perspective). Supply chain partners may have difficulty adapting to technological or product design changes which may result in either product launch delays or product quality problems (Zsidisin and Ellram, 2003). Also while partners may agree with some innovations, they may not agree with others. The problem is compounded by the fact that the firm may have little control over its supply chain partners' operations or choices and may have little safeguards against such uncertainty (Bode et al., 2011), contributing to disruptions and their impact. This can cause conflict with supply chain partners and bring about confusion about resource sharing. The flux generated by high focus on innovation can also affect the employees of the firm. Employees within the firm may find it difficult to adjust to constant changing work demands and may be stressed out (Lukas et al., 2002). This can lead to high employee turnover plus glitches in work thereby affecting the efficiency of the firm.

Further, firms with a strategic focus on innovation can lose sight of how increasing complexity can cause disruptions that they have not anticipated or are not prepared for. They may become too focused on commercializing their new ideas that they may not fully account for the uncertainties arising from unpredictable demand and erosion of competitive advantage through imitation efforts by competitors (Fisher, 1997). This could hurt the efficiency of the firm thereby limiting their overall performance. A high focus on innovation and getting out more products can also entice firms to develop products out of their core-competence area. Prior research has shown that innovation outside the competence area of the firm usually has a negative effect on firm's performance (Cooper, 1994; Manu and Sriram, 1996; Olson et al., 2005; Simpson, Siguaw, and Enz, 2006).

Supply chain disruptions can put companies at a disadvantage compared to their competitors. Managing supply chain disruptions comes at a cost (Sheffi and Rice, 2005; Hendricks and Singhal, 2005). Firms tend to increase their inventory or have vendor managed inventories; they may also resort to multiple sourcing and multiple distribution channels (Sheffi and Rice, 2005; Bode et al., 2011; Ambulkar et al., 2015) to become resilient to supply chain disruptions. These actions add significantly to the cost and adversely affect the efficiency of the firm (Craighead et al., 2007). There is also an opportunity cost as managers have to deal with the disruption and minimize its impact (defensive actions) instead of dealing with the market and customers to improve sales and market share (offensive actions). Overall, more of existing resources of the firm is spent on fighting fires and not on creating real value. The higher the frequency of disruptions and the greater the incidence of high-impact disruptions, the lower will be the efficiency of operations (which will be reflected in a lower ROA and lower AT). Because

firms may not be fully ready to handle disruptions (since they are more frequent and firms have limited resources), the impact of disruptions may also be high.

The above arguments lead us to our second hypothesis.

H2: Strategic focus on innovation has a negative effect on firm's efficiency by increasing supply chain disruption risk.

The innovation process is inherently uncertain and complex (Atuahene-Gima and Ko, 2001; Sorescu and Spanjol, 2008; Baker, Grinstein, and Harmancioglu, 2015).Summarizing the uncertainty implications on new product projects, Cooper (2003) noted that "the more difficult the project in terms of scope, new technology, and complexity, the more susceptible it is to perturbations and mismatches in the team, organization, and external environment." These perturbations, as noted in H2, could result in greater incidence of unanticipated supply chain disruptions. Under ideal conditions, firms will need to identify all unknowns and implement a risk management program to systematically address them (Cooper, 2003). Interestingly, research has noted that although firms are aware of supply chain risks, not many have implemented risk management systems. One possible reason for this is that firms may be underestimating the occurrence and impact of events that can disrupt operations. Further, even when such systems are in place, they may not always be effective at minimizing the impact of disruptive events. In a survey of executives, 45 percent of the sample indicated that the risk management program used in their firms is only somewhat effective or not effective at all in handling disruptions (Global risk management survey, Deloitte, 2015).

We propose that organizations can better handle disruptions that arise from a focus on innovation if they have a well-designed risk management structure (Blackhurst et al., 2011). The structure should include a clear policy to handle risks, systems to create and disseminate

information of relevance to reduce impact of those risks, and a dedicated team that is given a clear assignment of responsibility for handling response to the risks (Blackhurst et al., 2011; Ambulkar et al., 2015).

First, organizations need a clear risk management policy to strengthen management of risks associated with innovations through proactive risk identification, risk acceptance and risk management. The policy will ensure that the organization identifies and focuses on all risk events along the supply chain that affect its pursuit of performance objectives. The firm will need to identify uncertainties associated with development of detailed project tasks, task sequence, task interdependencies and task times (Tatikonda and Rosenthal, 2000) for each innovation project. It also will need to focus attention on managing each innovation project during its execution to identify and adapt to uncertainties as they arise. Once potential risks are identified, the policy should have clarity on which risks are reported to top management and which ones can be handled at lower levels. The idea is that major risks are reported to the top managers of the firm for review and acceptance. Finally, the policy will provide a consistent and proactive risk management framework. The presence of a policy will insist on embedding risk management practices into all key disruption points along the innovation chain. Top managers' attention and proactive planning for handling different types of eventualities are likely to reduce the impact of those eventualities.

Second, as mentioned above, organizations should have the capacity to quickly identify sources of risk in the management of the innovation process. This capacity will be more salient for firms that focus on innovation. In today's environment, firms have to rely more on the extended enterprise comprising of a network of companies for their innovation. The companies in the network are likely to be separated geographically and culturally. Hence, firms cannot

simply rely on established organizational and managerial mechanisms that support innovation at the firm level (Chapman and Corso 2005). They need new information and communication technologies that can bridge the distance between the partners and provide a virtual space for collaboration efforts. Prior research suggests that although the participation of supply chain constituents is recognized, many of the processes associated with integrating them into the innovation process are lacking (Petersen, Handfield, and Ragatz, 2005). Further, there are risks associated with evaluation of collaboration benefits. Examining whether the potentials of collaboration are being realized is difficult as companies need data on its outcomes which are often difficult to estimate (Dodgson, 1993). Moreover, reliance on external partners comes with associated hazards such as lack of trust, relinquishment of control, and differential ability to learn new skills and knowledge (Powell, Koput, and Smith-Doerr 1996). It is hard to manage risk without monitoring risks that arise from these hazards. Sodhi and Tang (2012) stipulate that companies need to develop mechanisms to discover such risks quickly so they will have the time for effective response. Tang and Tomlin (2008) suggest that firms that invest in risk management technology for monitoring and providing an advance warning system are able to develop effective contingent recovery plans for different types of innovation risks and disruptions. The implication is clear—in firms that are innovation-focused, having more mature information technology tools is going to facilitate managing disruptions arising from such focus; while there will be less need for technology tools in firms that are less focused on innovation.

Third, another component of risk management is the governance structure firms use for managing risk. Some firms may not have a dedicated risk management group as they believe that management of risk is a direct responsibility of line management (Pergler, 2012). Other firms may have a dedicated risk team as they appreciate the increasing level of complexity in their

global supply chains. A dedicated team has a better chance of educating itself about the risks in the supply chain, planning for worst-case scenarios and developing contingency plans (Handfield and McCormack, 2007; Trkman and McCormack, 2009). The team can work with suppliers and retailers to mitigate the risks inherent in the supply chain.

Overall, we argue that firms that have one or more of the above elements in place for managing risk will be able to mitigate the negative effect of innovation focus on the frequency and impact of supply chain disruptions.

H3: Risk management infrastructure mitigates the negative relationship between focus on innovation and supply chain disruption risk.

3.4 Research Data

In this section, we first describe the sample selection and data collection strategy. We then discuss the definition and operationalization of the dependent, independent, and control variables used in the study.

3.4.1 Sample selection and data collection

Data for the study was collected from manufacturing firms in India in the early part of 2013. Three major factors guided our choice of the sampling frame. First, the manufacturing industry in India is large and gaining major importance within the Indian economy. A recent report from McKinsey and Company estimates that the Indian manufacturing industry is expected to touch US $1 trillion by 2025. Indian manufacturing industry is not only becoming increasingly global (from 2003 to 2012, Indian annual outbound investment more than tripled, from US $10 billion to US $37 billion, Accenture report, 2013), it is also attracting international companies to establish their manufacturing operations in India. The national program - ‘Make in

India' includes major new initiatives that are geared towards making India a global manufacturing hub. Second, manufacturing companies in India are increasing their research and development expenses and focusing heavily on innovations and new product introductions (PWC report, 2015). Third, there has been an increase in the number of supply chain disruptions faced by Indian manufacturing firms (Ketkar and Vaidya, 2012). Issues such as delayed and unreliable supply, unwarranted escalation in prices of raw materials, and demand fluctuations are adversely affecting the growth of Indian manufacturing firms.

Two types of data sources were utilized for the study using a two-step process. In the first step, the disruption data—frequency and impact—as well as data for one of the control variables that is latent in nature (market turbulence) were collected using a survey instrument. In the second step, data for the most important model variables such as focus on innovation, firm innovativeness, risk management structure and efficiency and effectiveness metrics were all collected using secondary sources of data only for the firms responding to the survey. These secondary sources include annual reports of firms, financial data from the firm's balance sheet and profit and loss statement, and online sources of financial data. Because most data used in model testing are objective in nature, the common method bias (CMB) issue most common in survey studies is not a concern in this study.

For the survey study, the purchasing manager of the firm was chosen as the key informant. Content validity of the survey-instrument was established by initially testing the survey with nine purchasing managers of manufacturing firms. Feedback from the nine purchasing managers was taken to ensure the salience of the survey instrument and validate each scale item's relevance to its construct.

The services of an independent, professional Indian field survey firm were utilized to administer the survey to a random sample of purchasing managers drawn from public sector manufacturing firms in India. The data was collected from public sector manufacturing firms located in Bengaluru, Chennai, Delhi, Hyderabad, Kolkata, Mumbai and Pune. These cities were chosen for data collection purposes as they have the highest GDP contribution in the country (Yahoo Finance, 2011). A list of public sector manufacturing companies located in these cities was obtained through PAN India database. Initial calls were made to the front office of 744 firms to get contact details of the purchasing manager. Out of the 744 firms contacted, 247 firms refused to provide contact details due to company policy on restrictions in participating in surveys and 51 firms stated that the purchasing department was located at a different location and that they did not have their details. Contact details of purchasing managers at the remaining 446 firms were obtained out of which face to face interview appointments were set up with the purchasing managers in 339 firms. Of these, 166 respondents decided not to respond when the research topic was explained in person. They cited a lack of interest in the topic and felt that the study was not relevant to the industry they operated in. Purchasing managers at 173 firms agreed for the interview and responded to the survey questionnaire. Face to face interviews were conducted by interviewers trained and experienced in conducting corporate interviews. This provided us an overall response rate of 51.03%. The demographic characteristics of the companies from whom the purchasing managers responded are provided in table 9.

Once data collection was completed, to test for non-response bias, we used the method of comparing respondents and non-respondents on two key demographic characteristics (Filion, 1976; Ary, Jacobs and Razavieh, 1996)—annual revenue and age of the firm. Table 10a and 10b show the absence of non-response bias based on these two characteristics.

3.4.2 Variable description

3.4.2.1 Firm Performance

We measure firm performance using four different variables. These variables are revenue, net-income, return on assets (ROA) and asset turnover. ROA and asset turnover are efficiency based performance measures and indicate the level of profit and revenue generated for a given level of assets. They are complemented by net-income and revenue, which are effectiveness based performance measures that indicate the overall profit (after taxes, interest and depreciation) and sales of the firm. Firm performance was measured as a domain of separate variables because the above mentioned measures look at two different aspects of firm performance: efficiency and effectiveness. Having a domain of separate variables helps us overcome the limitation inherent in selecting a single measure (Barnett and Salomon, 2012) or an aggregate measure (Murphy et al., 1996). Prior research has noted that it is more informative to discuss the relationship between the predictor variables and a particular performance dimension (Murphy et al., 1996; Miller, Washburn, and Glick, 2013). In this study we believe that supply chain disruption risk has an effect on efficiency based performance measures and product innovativeness has an impact on effectiveness based performance measures. The data on these measures were obtained from the participating firms' 2013 annual reports.

3.4.2.2 Strategic focus on innovation

We use the vision/mission statements, values and corporate profiles provided in firms' annual reports and websites to measure the extent of their strategic focus on innovation. These sources are used because they enable firms to express a formal representation of their identity (Abratt, 1989; Dowling, 1993; Hatch and Schultz 1997) and because they play a role in

influencing firms' purpose and direction (Simons, 1994). A mission statement, for example, is a formal document of the firm's vision of what it wants to be. It serves as a tool that guides strategy formulation and implementation and brings about uniformity of thought and action among its employees (Germain and Cooper 1990). Following the guidelines of computer based text analysis and previous attention based studies (Weitzman 2000; Yadav, Prabhu and Chandy, 2007) we assess strategic focus on innovation by using average count of the word –"innovation" – or its different forms (innovative, innovating, innovational) in the vision/mission and value statements and corporate profiles of the firm. The reason we use average count of word – "innovation/innovative" is because not all firms had formal vision/mission statement, values and corporate profiles. Hence strategic focus of innovation was measured as the ratio of the count of word – "innovation" and its forms to number of formal representations of firm's identity. Examples of representation of focus on innovation or its forms in vision/mission statements, values, and corporate profiles are given below.

Vision/Mission statement – "Innovation and quality in processes, products and service."

Values – "Profitability, Quality, Innovation, Speed and Sustainability"

Statements used in the Corporate Profile – "Over 40 years, the company has scripted a trail blazing path in its field with farsighted vision, innovation and sheer dynamism."

3.4.2.3 Risk management infrastructure

Risk management infrastructure represents the resources the firm has in place to manage risks and disruptions that a company may face (Ambulkar et al., 2015). It is measured as a dichotomous categorical variable which is assigned a value 1 if a company has a team/department in place to manage risks/disruptions or a risk management framework/policy or information systems in place to risks/disruptions. The data on risk management infrastructure is

obtained from company annual reports by examining the Director's report and the Management Discussion and Analysis sections. Few examples of risk management infrastructures are provided below.

Example 1: "Your Directors have put in place critical risk management framework across the Company. Your Company is continuously evolving and improving systems and measures to take care of all the risk exigencies involved in the business."

Example 2: "We have an active risk management strategy in place and a Risk Committee, whose role is to identify potential risks and create mitigation strategies."

Example 3: "Your Company has an established Enterprise Risk Management function that engages with all the functions for risk assessment, ensures that the risk mitigation plans are in place and validates the risk mitigation status regularly."

3.4.2.4 Firm innovativeness

Innovativeness of the firm is captured based on whether it developed and placed new products into the market in the survey time period. New products could be completely new to the firm or major modifications of existing products. This construct was measured as an ordinal variable measured on a scale from 0 to 2 with 0 being no innovation activity, 1 being either created new products or added value to existing products and 2 being both, added value to existing products and created new products. This information was captured from the R&D benefits section in the firm's annual report.

3.4.2.5 Supply chain disruption risk

Supply chain disruption risk is defined as the expected loss faced by firm due to events that disrupt the normal flow of goods in its supply chain. To measure supply chain disruption risk two latent constructs were created (i) supply chain disruption frequency and (ii) supply chain disruption impact. Supply chain disruption frequency was measured on a five point Likert scale (1, "not at all"; 5, "very frequent"). It assessed how often a firm faced supplier related, manufacturing related and distribution related disruptions. Supply chain disruption impact was also measured on a five point Likert scale (1, "not at all"; 5, "to a very large extent) and it assessed the impact of supply related, manufacturing related and distribution related disruptions. Supply chain disruption risk was then measured by multiplying supply chain disruption frequency and supply chain disruption impact. The items used to measure supply chain disruption frequency and supply chain disruption impact are provided in appendix B.

3.4.2.6 Control variables

Firm age, firm size and market turbulence were the three control variables used in this study. Prior research reports a positive relationship between firm performance and firm size and firm age by showing that larger firms and firms with more experience tend to be more innovative (Hansen, 1992). Hence we control for these factors. Firm size was measured as number of employees of the firm. This information was coded onto an interval scale. Firm age was measured as the numbers of years since the firm was founded. We controlled for market turbulence, as it is shown that in highly turbulent markets, firms face increased uncertainty that affects their prospects of growth and survival (Anderson and Tushman, 2001) Market turbulence was measured as a latent construct and an existing scale was used to measure it (Murat, Huang and Roth, 2010; Ward and Duray 2000). It was measured on a five point Likert scale (1, "very

slow"; 5, "very rapid") and it assessed the degree of turbulence in product life, technologies and customer demand in the markets in which the firm operated.

3.4.3 Intercoder reliability

All the variables were coded by one of the authors in this study. To ensure reliability of this author's coding, a second coder naïve to the topic and issues of measurement coded the variables for 33 randomly selected firms (Miller, Washburn, and Glick, 2012). The initial level of agreement between the two coders was 87.88% for strategic focus on innovation, 93.34% for firm innovativeness and 96.97% for risk management infrastructure. The intercoder reliability was then calculated using the method suggested by Perreault and Leigh (1989). The reliabilities calculated for the three different variables were 0.916 for strategic focus on innovation, 0.953 for firm innovativeness and 0.962 for risk management infrastructure. All of these reliabilities were strong.

3.5 Analysis and Results

Factor analysis was used to assess the dimensionality of the supply chain disruption index in the theorized model. All the multiplicative items loaded onto a single factor, suggesting uni-dimensionality of the construct. The factor-loadings along with the descriptive statistics for the construct supply chain disruption index are provided in the appendix B. Factor loadings, average variance extracted (AVE) value and Cronbach alpha value were used to assess convergent validity of the supply chain disruption index construct. All the factor loadings were greater than 0.50 and significant at $p < 0.001$ suggesting high convergence (Hair et al., 2010). The Cronbach alpha value for the construct was 0.85, which is greater than the recommended value of 0.7 (Hair et al., 2010). The AVE value for the construct was 0.70 which is greater than the recommended value of 0.5 (Hair et al., 2010).

To test the proposed theoretical model, we used a manifest variable design of constructs in AMOS within a structural equation framework (SEM). SEM was used by us for the primary reason that we had a moderated-mediation model (Little et al., 2007). A manifest variable design was employed as strategic focus on innovation, risk management infrastructure and firm performance constructs were measured as objective variables.

The structural analysis of the model yielded good fit statistics, Chi-square = 69.80 ($p<0.001$), df = 34, Chi-square/df = 2.05, CFI = 0.98, TLI = 0.96, RMSEA = 0.078. Table 11 shows the structural model and path estimates.

3.5.1 Mediation analysis

The results from the structural analysis imply mediation by firm innovativeness and supply chain disruption risk. To test for mediation we use the bootstrapping method suggested by Preacher and Hayes (2004, 2008). In the bootstrapping method, indirect effects are calculated by repeatedly sampling the dataset. The confidence intervals and significance of indirect effects in then noted. The significance of indirect effects infers mediation in the model. In this study we measured the significance of indirect effects by sampling the dataset 5000 times and checking the significance using percentile based confidence intervals (95%). Fritz, Taylor and MacKinnon (2012) notes that Type 1 error can be a concern in bias corrected confidence intervals. In light of this, we use percentile based confidence intervals. We find that the indirect effects between strategic focus on innovation and the four firm performance variables to significant suggesting mediation in the model. Table 12 presents the mediation results.

3.5.2 Results

The results show that strategic focus on innovation has a positive impact on effectiveness based firm performance measures and a negative effect on efficiency based firm performance

measures. Firm's strategic focus on innovation has a positive impact on its revenue and net-income ($\beta3 = 0.273$, $p<0.001$, $\beta4 = 0.258$, $p<0.001$, respectively) by increasing its innovativeness ($\beta1 = 0.164$, $p = 0.029$). This provides support for hypothesis H1. It has a negative impact on its ROA and asset turnover ($\beta5 = -0.151$, $p=0.060$, $\beta6 = -0.142$, $p=0.045$, respectively) by increasing the supply chain disruption risk ($\beta2 = 0.268$, $p = 0.005$). This provides support for hypothesis H2. Results also show that risk management infrastructure of the firm moderates the negative impact of strategic focus on innovation by reducing the overall impact of supply chain disruptions, thus providing us the support for hypothesis H3 ($\beta7 = -0.232$, $p=0.015$).

3.6 Discussion and Summary

There is a general exhortation to companies to become more innovation-focused to deal with rapid changes in the external environment. The expectation is that directing organizational attention to exogenous changes can affect financial success by adjusting firms' responses to such changes. However, increasing the variety of products handled by a firm can result in increased complexity of the firm's operations. We focus on one negative consequence of that complexity in this study, namely, supply chain disruptions. Disruptions can increase the cost of operations and not only reduce financial success enjoyed by firms, but also result in inefficient utilization of the firm's assets. We call these as the bright side and dark side of innovation focus of firms.

On the bright side, the study results show that a firm's strategic focus on innovation leads to greater innovativeness which, in turn, increases the firm's revenues and net profits. We capture a firm's focus on innovation based on formal representations of the innovation concept in the firm's mission/vision statement, values statement and company profile description. These formal representations summarize the firm's strategic identity and have the capacity to drive the belief systems of the firm's employees and partners (Simons, 1994). Emphasizing innovation in

these representations, firms convey and bolster the importance of innovation to its employees to generate greater commitment from them towards innovation-related activities (Kohli and Jaworski, 1990). One of the important stages in the innovation process is initiation and having a focus on innovation is critical to initiation (Zaltman, Duncan, and Holbek, 1973). Van de Ven (1986) posits that organizational attention to innovation is critical for generating new ideas. Firms with a strategic focus on innovation manipulate their existing resources in such a way that innovation related activities are allocated the time and effort they require to run smoothly. To be continually innovative, firms need to gauge the competition, understand market needs better and become more aware of latest technological trends and opportunities (Frambach, Prabhu, and Verhallen 2003; Gatignon and Xuereb 1997). By drawing greater attention to innovation, firms ensure that these activities get attention and time from employees of the firm (Yadav, Prabhu and Chandy, 2007), thereby enabling generation of more number of innovations (Tushman and O'Reilly, 1996) at a faster rate (Kessler and Chakrabarti, 1996; Vázquez et al., 2001).

On the flip side, the results of the study show that focus on innovation also has a dark side. An important feature of innovation today is the use of inputs from a diverse set of suppliers to solve product and process problems. Although they may be committed to innovation, firms may differ in the degree to which they actively support the innovation efforts taking place across the network on its behalf. If suppliers are not well integrated or if there is alignment issues with the firm's strategy, innovation focus can lead to less coordinated actions within the supplier network and thereby greater disruptions in fulfilling market demand. Further, innovation focus implies increase in the number and diversity of product lines the firm will be engaged in. This increase will enhance the complexity of the supply chain operations that need to be managed. Anything going wrong in any part of the chain will result in disruptions for the firm's operations

or downstream commitments. We show in this study that a focus on innovation increases the risk of supply chain disruptions and hurts a firm's efficiency. A focus on innovation may also mean that firms enter arenas which are removed from their current markets and hence outside of their core-competence area. Prior research has shown that innovation outside the competence area of the firm usually have a negative effect on firm's performance (Cooper, 1994; Manu and Sriram, 1996; Olson et al., 2005; Simpson, Siguaw, and Enz, 2006).

Further, innovation focus implies reorganization of the firm's resources to squeeze more value from them. This reorganization may include taking resources away from existing products and allocating them for the new innovations. This reallocation process may impact the supply-demand equation for existing products and result in delays in meeting demand from customers for existing products. The end result may be lost orders or decision to keep excess stock in inventory so as to avoid such situations.

We proposed that one way firms may be able to mitigate the disruption impact arising from a greater focus on innovation is to develop a risk management infrastructure (RMI). We show empirically the efficacy of designing a RMI in innovation-focused firms. We consider RMI to include a risk policy, information technology that can provide timely information to decision makers, and a governance team that has responsibility for addressing risks in the firm's operations. The policy will clarify the extent of risk-taking that is permissible in the innovation operation. The information technology component will develop guidelines for gathering diagnostic information pertaining to innovation risk and communicating them to relevant decision makers. Finally, the governance team, because of assignment of responsibility, will have the authority and the resources to address risks that arise during the innovation process. The presence of these elements, it appears, enables firms to address potential disruption risks and

reduce their impact if not completely eliminate them. Lower levels of disruptions, in turn, contribute to more effective utilization of the firm's assets, as seen by the higher return on assets and higher asset turnover in firms with a RMI. Overall, it appears that firms are better able to monitor risks and have greater situational awareness through a risk management infrastructure. This helps them respond to supply chain disruptions quicker and also communicate information faster with their partners in times of distress. Innovation outcomes are uncertain and become liabilities if firms do not have a structure to manage the uncertainty (Stinchcombe, 1965; David and Han, 2003; Garud et al., 2011). A risk management infrastructure enables firms to adopt and use a systematic approach to manage supply chain disruptions arising out of innovation.

One feature of the study that needs special mention is the use of objective secondary data for most of the model variables. The metric for innovation focus is based on firm's representation of its position in sources that are readily available to key stakeholders of the firm. The metric for innovativeness is based on firm pronouncements with respect to introduction of new products and major modifications of existing products. The metric for risk management is designed based on the presence or absence of key risk elements within the firm. Finally, all the outcome variables are based on performance data reported in sources similar to Compustat data. Using such data not only eliminates problems associated with data collected using surveys, it also gives greater insights to managers into how directed focus on one element of strategy gets translated into bottom line metrics.

Overall, the results of the study open a new avenue that links the area of innovation with the area of supply chain management. It examined one facet of innovation, namely, top management focus and one facet of the supply chain, namely, disruptions. It was able to link these to objective financial metrics of the firm and show the positive and negative sides of

innovation for financial well-being of firms. This direction of enquiry can be extended in several ways to not only cover other facets of innovation and the supply chain, but also investigate conditions that modify or mediate their impact. First, the impact of innovation focus could be attenuated by the presence or absence of an innovation-oriented structure as well as by the degree to which the focus diffuses throughout the firm and is assimilated by the firm's employees. Second, future research can evaluate heterogeneity in model effects for different types of innovations, depending on those that are developed in-house versus those that are developed outside the firm. For products that are more dependent on external sources, the in-house focus may clash with the innovation culture in outside firms and may weaken the firm's innovativeness. Beyond differences in culture, a firm's position in the network, complementarity of technologies within the network, and governance mechanisms used with supply chain partners will all impact the effects observed for its innovation focus. Third, focus on innovation could impact other supply chain metrics such as supply chain uncertainty, coordination costs, and requirements for slack resources and conflict, all of which can be studied in the context of not just financial performance but also human performance. Finally, organizations need a comprehensive measurement system to appropriately direct resources for innovation. The impact of quality of such a system on commercialization success of a firm's innovations is another fertile area for future research. We believe that a better understanding of what the organization believes in and a better way of assimilating those beliefs within the organizational cadre will enhance chances for success of organizational strategies and actions.

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Table 9: Demographic Characteristics of the Responding Firms

Sector	Number of Respondents
Construction	4
Cement	3
Chemicals	13
Plastics	8
Machinery	45
Beverages	7
Automobile/Automobile components	10
Metals	10
Aircraft components	1
Food and Agriculture	9
Telecommunications - equipment	5
Pumps	2
Consumer Durables	4
Packaging	3
Glass	3
Electrical/Electronic components	11
Leather products	2
Textiles	5
Computer-hardware	9
Power generation	8
Miscellaneous	3
Oil	2
Paper	3
Pharmaceutical	3
Job Title	Number of Respondents
VP – Purchasing	3
Purchasing Manager	73
Purchasing Supervisor	6
Assistant Manager - Purchasing	36
Buyers and others	55
Revenue (in millions, in Indian Rupees)	Number of Respondents
Less than 10 million	0
Between 10 and 50 million	0
Between 50 and 100 million	2
Between 100 and 200 million	1
Between 200 and 500 million	0
Between 500 and 1000 million	1
Greater than 1000 million	169

Table 10a: Test for Non-Response Bias: Demographic Characteristic – Firm Revenue

Firm_Revenue (in millions, in Indian Rupees)									
		Chisquare value = 5.93, df=5, p value = 0.313							Total
		Less than 10	10 - 50	50 - 100	100 - 200	200 - 500	500 - 1000	Greater than 1000	
Responding Firms	Count	0	0	2	1	0	1	169	173
Non Responding Firms	Count	0	1	0	0	1	0	164	166
Total	Count	0	1	2	1	1	1	333	339

Table 10b: Test for Non-Response Bias: Demographic Characteristic – Firm Age

Firm_Age (in years)								
		Chisquare value = 6.07, df=5, p value = 0.299						Total
		Less than 10	10 - 25	25 - 50	50 - 75	75-100	Greater than 100	
Responding Firms	Count	1	31	85	38	10	8	173
Non-Responding Firms	Count	5	35	69	43	10	4	166
Total	Count	6	66	154	81	20	12	339

Table 11: Structural Model Results

Paths			Estimate	P value
Strategic Focus on Innovation	-	Firm Innovativeness	0.164	**(0.029)
Strategic Focus on Innovation	-	Supply Chain Disruption Risk	0.268	**(0.005)
Risk Management Infrastructure	-	Supply Chain Disruption Risk	0.099	0.180
Strategic Focus on Innovation* Risk Management Infrastructure	-	Supply Chain Disruption Risk	-0.232	**(0.015)
Firm Innovativeness	-	Revenue	0.273	***
Firm Innovativeness	-	Net Income	0.258	***
Firm Innovativeness	-	Asset Turnover	0.044	0.589
Firm Innovativeness	-	Return on Assets	0.038	0.636
Supply Chain Disruption Risk	-	Revenue	-0.016	0.825
Supply Chain Disruption Risk	-	Net Income	-0.021	0.768
Supply Chain Disruption Risk	-	Asset Turnover	-0.142	*(0.060)
Supply Chain Disruption Risk	-	Return on Assets	-0.151	**(0.045)
Control Variables				
Firm Age	-	Revenue	0.167	**(0.020)
Firm Age	-	Net Income	0.165	**(0.022)
Firm Age	-	Asset Turnover	0.023	0.807
Firm Age	-	Return on Assets	0.009	0.948
Firm Size	-	Revenue	0.159	**(0.027)
Firm Size	-	Net Income	0.173	**(0.016)
Firm Size	-	Asset Turnover	-0.010	0.899
Firm Size	-	Return on Assets	0.005	0.952
Market Turbulence	-	Revenue	-0.006	0.928
Market Turbulence	-	Net Income	-0.009	0.894
Market Turbulence	-	Asset Turnover	-0.012	0.869
Market Turbulence	-	Return on Assets	-0.023	0.759

Table 12: Mediation Analysis

Path	Indirect Effect
Strategic Focus on Innovation – Firm Innovativeness - Revenue	0.049** (0.002, 0.106)
Strategic Focus on Innovation – Firm Innovativeness – Net Income	0.046**(0.001, 0.101)
Strategic Focus on Innovation – Supply Chain Disruption Risk – Asset Turnover	-0.037**(-0.083, -0.001)
Strategic Focus on Innovation – Supply Chain Disruption Risk – Return on Assets	-0.040** (-0.086, -0.003)

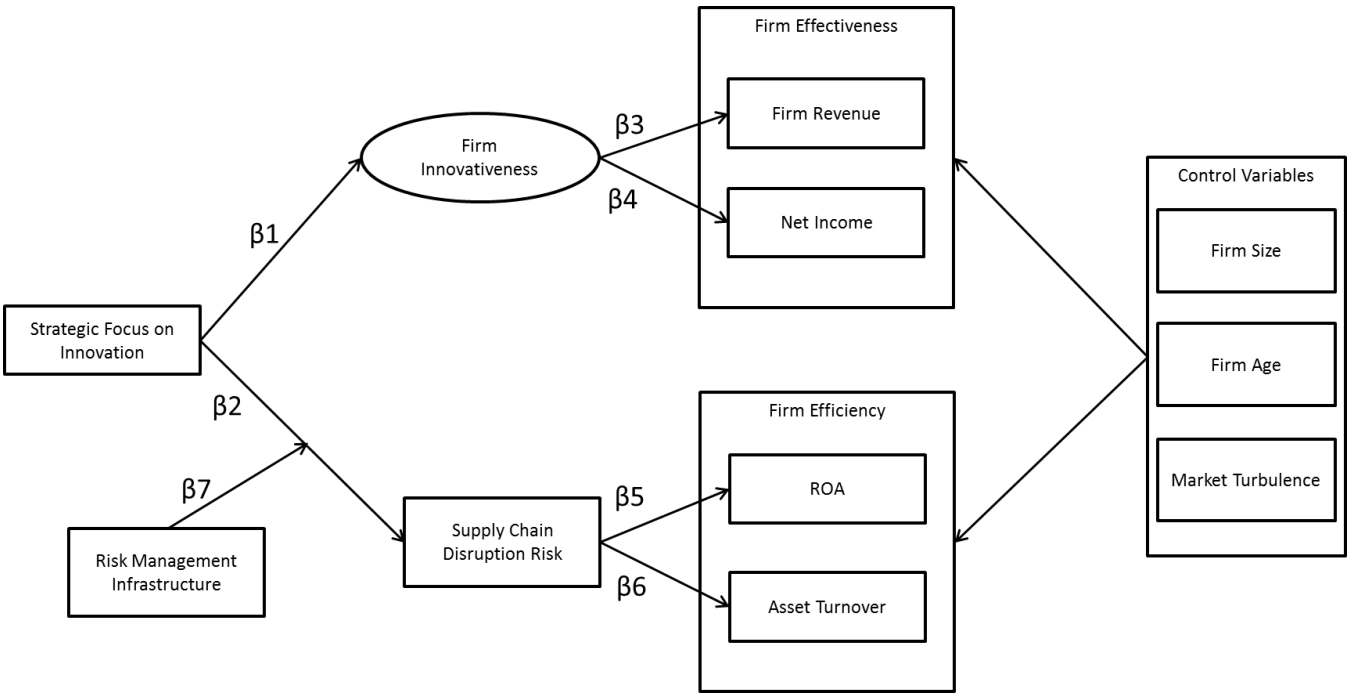

Figure 5: Theoretical Model

Appendix B: Construct Items (Descriptive Statistics, Factor Loadings and Reliability) [a]

Construct		**Mean**	**Standard Deviation**	**λ**	**α**
SC Disruption Frequency (DF) - how often does your firm face the following operational problems?					0.76
DF1	Delays in delivery by the suppliers.	2.43	.756	0.63	
DF2	Defective materials supplied by the suppliers (Quality issues).	2.08	.792	0.81	
DF3	Bottlenecks in the manufacturing/production process.	2.04	.852	0.84	
DF4	Delivery delays to your customers.	2.24	.777	0.76	
SC Disruption Impact (DI) - To what extent have these problems negatively affected your firm's performance					0.81
DI1	Delays in delivery by the suppliers.	2.29	.820	0.88	
DI2	Defective materials supplied by the suppliers (Quality issues).	2.01	.905	0.83	
DI3	Bottlenecks in the manufacturing/production process.	1.93	.811	0.78	
DI4	Delivery delays to your customers.	2.15	.843	0.72	
SC Disruption Risk (DR)					0.85
DR1	DF1*DI1	5.73	3.03	0.84	
DR2	DF2*DI2	4.56	3.53	0.88	
DR3	DF3*DI3	4.27	3.08	0.85	
DR4	DF4*DI4	5.16	3.38	0.76	
Market Turbulence(MT)					0.74
MT1	The rate at which products and services become outdated.	3.16	0.93	0.75	
MT2	The rate of innovation of new products and services.	3.69	0.85	0.85	
MT3	The rate of change of tastes and preferences of customers in your industry.	3.69	0.78	0.85	

Chapter 4: General Conclusions and Future Research

4.1 General Conclusions

Supply chain disruption management has become increasingly important topic to both academic researchers and while great deal of research has focused on it, very little has focused on how firms can become resilient to supply chain disruptions and the relationship between innovation and supply chain disruptions. In this dissertation, I first discussed how firms can become resilient to supply chain disruptions and then move the focus to supply chain disruptions that arise out of firm's strategic focus on innovation. Chapter 2 conceptualized firm resilience and showed how firms can become resilient to high and low impacts of supply chain disruptions. Firm resilience was conceptualized as the ability of the firm to be alert, adaptive and responsive to supply chain disruptions. I showed that it was very important for firms to be supply chain disruption oriented to become resilient. Supply chain disruption oriented firms had the ability to reconfigure resources (i.e., the ability to acquire new resources, shed existing resources or restructure existing resource base in wake of supply chain disruptions). This ability helped the firms to manage supply chain disruptions; however it was effective only when firms faced high impact disruptions. In case of low impact disruptions, firms used the risk management infrastructure that they had in place to counter them.

Chapter 3 focused on the relationship between supply chain disruptions arising out of firm's focus on innovation. In this chapter, I show both the bright side and dark side of innovation. In the bright side, strategic focus on innovation increased firm's innovativeness leading to greater effectiveness. Conversely, in the dark side, we find that the same strategic focus on innovation increases the risk of supply chain disruptions which reduces firm's efficiency. The risk of supply chain disruptions is mitigated by firms having a risk

management infrastructure. In order to develop a risk management infrastructure, firms focused on developing a team or department in place to manage supply chain disruptions or a risk management framework or information system in place to manage supply chain disruptions.

4.2 Future Research

In my future research, I intend to continue to contribute to the knowledge on supply chain risk/disruption management. In doing so, I wish to examine the supply chain risk/disruption management phenomenon drawing on different theoretical contexts, both within and outside the area of supply chain management and under different empirical contexts – technological, financial and cultural.

This dissertation has laid foundation for my future research work. Moving forward I would like to study disruption management in a business-to-business (B2B). I am interested in developing projects that examine the impact of buyer-supplier interdependence on buyer firm's resilience and also look at the impact of relationship investments in a buyer-supplier relationship on knowledge created based on interdependence in the relationship. I feel it is also important to understand and study how managers make decisions when their firms face supply chain disruptions. I would like to work on projects that will examine what behavioral characteristics of the supply chain manager make him/her competent at managing supply chain risk.