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Buyer Perceptions of Supply Disruption Risk: A Behavioral View and Empirical Assessment

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Buyer perceptions of supply disruption risk: A behavioral view and empirical assessment

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1. Introduction

One of the primary goals of supply management is to secure uninterrupted flows of direct materials from the supply base (Kraljic, 1983). This goal is becoming more difficult to achieve as firms source important direct materials within supply chains of increasing complexity. This sourcing trend increases buying firms' exposure to risks stemming from supply disruption. The need to ensure continuity of supply has motivated several related streams of research that quantify the negative implications of supply disruptions (Hendricks and Singhal, 2005a,b), propose frameworks for analyzing and reducing supply disruption risk (Kleindorfer and Saad, 2005), and identify environmental and organizational factors that drive supply disruptions (Sheffi and Rice, 2005). While these research streams lend significant insights into the causes, effects, and management of supply disruption risk, little research has sought to understand how views of supply disruption risk are developed and how these views affect the decision-making process.

This paper addresses this gap in extant literature by incorporating behavioral risk theory into the study of supply disruption risk. Building on the initial developments of Zsidisin (2003), we adapt Yates and Stone's (1992b) model of risky decision-making as the conceptual framework for our study. In accordance with their model, we investigate the causal relationships amongst situation, representations of risk, and decision-making within the purchasing domain. To gain further understanding of the decision-making process, we examine the role of three representations of supply disruption risk: magnitude of supply disruption, probability of supply disruption, and overall supply disruption risk. Using survey data from buyers, we examine how the supply environment influences representations (i.e., buyers' perceptions) of risk, which in turn affect buyers' decisions to search for alternate suppliers. We draw from transaction cost economic (TCE) theory (Williamson, 1985) and resource dependence theory (RDT) (Pfeffer and Salancik,

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1978) to identify four salient attributes of the supply environment that affect representations of supply disruption risk: technological uncertainty, market thinness, item customization, and item importance. Previous supply management research suggests that these factors are particularly germane to the decision-making context of our study (Kraljic, 1983).

Our research contributes to the body of supply chain management literature in two important ways. First, this study lends insights into how buyers' perceptions of supply disruption risk are formed. Through our analysis, we validate that buyers' perceptions of magnitude of disruption, probability of disruption, and overall supply disruption risk facilitate the translation of situation to decision. While previous conceptualizations of the risky decision-making process offer alternate views (Yates and Stone, 1992b), our findings show that the omission of any of these representations of supply disruption risk leads to an incomplete and inaccurate view of the decision-making process. Second, we operationalize and validate perceptual measures of supply disruption risk using a multi-step approach to scale development and validation. We do not investigate disruption events per se; rather, we develop perceptual measures to better understand how buyers and purchasing managers internalize and process supply disruption risk. Understanding perceptions of risk is essential because appraisals of risk are subjective and actions regarding risks are based on perceptions (Yates and Stone, 1992b). Therefore, the perceptual measures of supply risk developed within this paper may serve as the basis for future research that simultaneously examines the environmental factors that drive supply risk, the behavioral factors that affect managers' perceptions of supply risk, and the multiple tactics that may be used to mitigate supply risk.

The remainder of this paper is organized as follows. In Section 2, we review the conceptual underpinnings of behavioral risk that inform our theoretical model. In Section 3, we develop our research model and hypotheses. Our hypotheses examine the relationships amongst representations of supply disruption risk, the situational factors that drive these representations, and buyers' decisions to search for alternate suppliers. In Sections 4 and 5, we discuss our methodology, statistical analyses, and findings. In Section 6, we highlight the academic and managerial implications of our study. We conclude by noting the limitations of our study and offering recommendations that may guide future studies of supply disruption risk.

2. Literature review

We define supply disruptions as unforeseen events that interfere with "the normal flow of goods and[/or] materials within a supply chain" (Craighead et al., 2007, p. 132). Supply disruptions can be characterized as glitches (Hendricks and Singhal, 2003) and may be attributable to many factors including supply market complexities and the importance of the purchased product (Kraljic, 1983). Supply disruptions may have immediate or delayed negative effects on buying firm performance over the short and/or long-term, pending the severity of the disruption and the buying firm's recovery capabilities (Sheffi and Rice, 2005). Whereas revenue loss from disruptions may stem from the inability to meet demand and inventory mark-downs, "expediting, premium freight, obsolete inventory, additional transactions, overtime, storage and moving, selling, and penalties paid to customer" drive operating costs higher (Hendricks and Singhal, 2003, pp. 503–504). Supply disruptions can also hamper productivity and capacity utilization for the buying firm, and may negatively affect a buying firm's ability to satisfy its customers. Empirical studies have found that supply disruptions negatively affect shareholder value and firms' operating and long-term stock price performance (Hendricks and Singhal, 2003, 2005a,b). Consequently, extant research has focused on the role of several supply management strategies, such as searching for and developing alternate sources of supply, to mitigate the risks associated with supply disruption (Kraljic, 1983).

Zsidisin (2003) incorporates the notion of supply disruption within his conceptualization of supply risk and suggests that behavioral theory may be leveraged to deepen understanding of the risk construct. Within the behavioral literature, risk has been studied in terms of "the amount at stake" (Cox and Rich, 1964, p. 33), loss potential (Yates and Stone, 1992b), and hazards (Slovic, 1987). Importantly, subjective judgments of risk are a significant determinant of managerial and consumer choice. Perceptions of risk influence adoption of business and supply strategy (Kraljic, 1983; Mintzberg, 1978), expected rates of return (McNamara and Bromiley, 1999), purchasing and executive decision-making (March and Shapira, 1987; Qualls and Puto, 1989), consumer purchase decisions (Kaplan et al., 1974), and consumer information search strategy (Dowling and Staelin, 1994).

Managers do not view risk as prescribed by classical decision theory; instead, behavioral research suggests that perceptual rather than objective assessments of risk guide decision-making behavior (March and Shapira, 1987). Similarly, Mitchell (1999, p. 164) asserts that "it is not objective risk which motivates behavior, but the consumer's impressions of it". Even when objective data is available to support decision-making, issues related to interpretation may interject bias into the risk assessment process (Yates et al., 1994). Therefore, we adopt the view that perceptions of risk, rather than objective measures, are the fundamental drivers of behavior.

The notion of loss is inherent in the concept of risk and outcome references play a formative role in individual's assessments of loss (Yates and Stone, 1992a). Sullivan and Kida (1995) note that individuals evaluate alternatives relative to an outcome reference to estimate gains and losses. Outcomes preferable to a reference outcome are gains; those less desirable than the reference outcome are losses (Yates and Stone, 1992a; Lopes, 1987). While there are several types of reference outcomes, target reference outcomes are particularly germane to our study of supply disruption risk. Yates and Stone (1992a, p. 8) describe a target reference outcome as "an outcome a person actively works to obtain" and acknowledge that target reference levels may be set by "individuals for themselves" or by "other people". Results from previous empirical studies of managerial behavior indicate that managers perceive risk relative to target reference outcomes set by an organization (Scott and Petty, 1984). For example, Mao (1970, p. 353) found that executives defined risk as "the prospect of not meeting the target rate of return." Similarly, Qualls and Puto (1989) find that organizational factors, rather than risk attitudes, affect industrial buyers' risk assessments.

Multiple factors are often used to measure and evaluate risk. Studies of consumer behavior suggest that overall perceived risk for a particular consumer product is a function of financial, social, psychological, physical, and performance risks (Kaplan et al., 1974). Interestingly, several measures of risk (e.g., financial and performance risk) were operationalized in terms of loss within these studies. Other researchers view perceived risk in terms of probability and magnitude of loss. Whereas the probability of loss refers to the likelihood that a particular loss may be realized, magnitude of loss captures the significance of a particular outcome (Yates and Stone, 1992a). Dash et al. (1976) adopt this view and measure perceived risk in terms of uncertainty of product satisfaction and consequence of unsatisfactory product performance. Similarly, Slovic (1987) characterizes the risks of 30 activities and technologies in terms dread risk (magnitude of loss) and unknown risk (probability of loss). In a review of the consumer perceived risk literature, Mitchell (1999) highlights numerous studies that conceptualize risk in terms magnitude and probability.

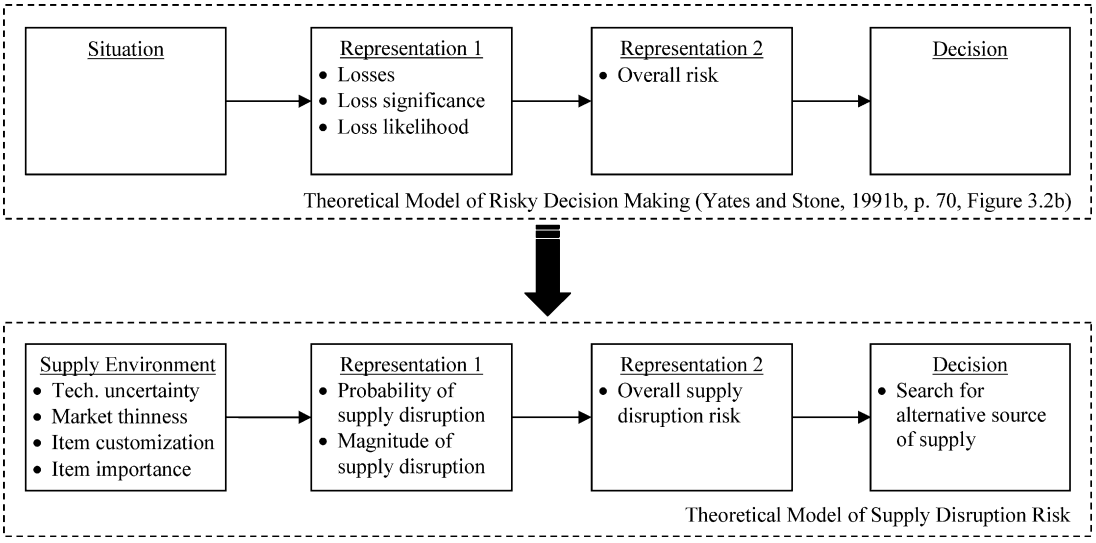


Fig. 1. Theoretical model.

Yates and Stone (1992b) incorporate magnitude and probability of loss within a four-stage behavioral model of risky decision-making. As shown in the top of Fig. 1, Yates and Stone posit that (1) situation, (2) representations of probability of loss and magnitude of loss, (3) overall risk assessment, and (4) decision form the essential stages of the decision-making process. In this model, loss significance, loss likelihood, and overall risk are positioned as related, but distinct representations of risk. In contrast with the traditional risk management literature, Yates and Stone distinguish between two successive stages of risk decision-making: judgment and evaluation. They argue that individuals first judge the probability of loss, magnitude of loss, and other relevant considerations before evaluating overall risk. Accordingly, individuals effectively synthesize their judgments of loss with judgments of other considerations to form an evaluation of overall risk. It is this appraisal of overall risk, not the probability or magnitude of loss that directly influences decision-making.

3. Theoretical model of supply disruption risk

We adapt Yates and Stone's (1992b) model of risky decision-making to the study of supply disruption risk. To facilitate our study, we adopt the purchase of a particular direct material from a specific supplier as the context and the buyer–supplier transaction as the unit of analysis of our study. The focal decision for our study is a buyer's decision to search for an alternate source of supply. As shown in the bottom of Fig. 1, we posit that representations of magnitude and probability of disruption are the primary determinants of overall supply disruption risk. Further, we assert that buyers' perceptions of overall supply disruption risk directly influence their decision to search for new sources of supply.

Situation is the salient factor that affects representations of risk. We draw on the work of Baird and Thomas (1985) and examine situation in terms of environmental factors. TCE and RDT suggest four salient supply environment factors that may affect representations of supply disruption risk for a given purchased material: technological uncertainty, market thinness, item customization, and item importance. We acknowledge that these supply environment attributes do not represent a comprehensive list of all the factors affecting representations of supply disruption risk; rather, our purpose is to illustrate how representations of supply disruption risk facilitate the translation of these salient situational factors into buyers' decisions. The following sections develop the theoretical support for each of the hypothesized relationships in our model.

3.1. Overall supply disruption risk

We define overall supply disruption risk as an individual's perception of the total potential loss associated with the disruption of supply of a particular purchased item from a particular supplier. Risk cannot exist in the absence of potential loss (Yates and Stone, 1992b); this central tenet is consistent with early conceptual and empirical studies of consumer behavior (Kaplan et al., 1974) and subsequent studies of perceived risk (March and Shapira, 1987; Slovic, 1987). Further, our definition is based on a perceptual rather than objective view of risk; prior research suggests that actual behavior often deviates from that predicted by expected utility theory (Fischhoff, 1992; Kahneman and Tversky, 1979). We limit the context of our supply disruption risk definition to a particular product purchased from a particular supplier. Several studies of industrial buyer behavior (Hahn et al., 1986; Treleven and Schweikhart, 1988) indicate that both the specific purchased product and particular supplier influence perceptions of risk. Finally, we note that our definition does not incorporate specific forms of loss, like financial, psychological, performance, physical, or social loss (Kaplan et al., 1974) or causes of loss, such as losses due to strikes, fires, natural disasters, or poor performance (Treleven and Schweikhart, 1988). Loss occurs when the target reference (i.e., expectation that supply occurs without failure) is not met; thus, our definition of overall supply disruption risk subsumes the different forms of loss attributable to unforeseen events that interfere with the normal flow of materials and/or goods (Craighead et al., 2007).

Our overall supply disruption risk definition differs substantively from classical definitions of perceived risk, which directly incorporate the probability and magnitude of loss. Conceptually, perceived risk has been defined in terms of chance and danger (Kogan and Wallach, 1964), the amount lost and feelings of certainty (Cunningham, 1967), and the potential occurrence of events having detrimental effect (Zsidisin and Smith, 2005). Perceived risk has also been measured as a multiplicative combination of probability and magnitude of loss (Cunningham, 1967; Peter and Ryan, 1976). However, this approach may be misguided. In particular, Kaplan and Garrick (1981) note the difficulty in equating the risk of a high probability-low magnitude

loss scenario with one characterized by low probability and high magnitude of loss. Further, March and Shapira (1987) find that magnitude of loss influences risk perception to a much greater extent than probability of loss; in extreme cases, executives completely discounted the notion of loss probability. In such cases, a multiplicative model of perceived risk does not capture the perceived risk attributable to magnitude of loss.

While many definitions of risk incorporate both probability and magnitude of loss, Yates and Stone (1992b) suggest that probability and magnitude of loss play a formative role in the development of risk perceptions. A key difference between these successive stages of assessment is the distinction between judgments and decisions (Yates, 1990). A judgment is "an opinion about what is or will be the state of some aspect of the world", whereas an overall risk appraisal is "a type of decision, specifically a partial evaluation" (Yates and Stone, 1992b, p. 68). As a type of decision, overall risk appraisals play an important role in determining behavior. Shapira (1995) supports this notion by suggesting that executives base decisions on a "feel" of overall risk. Similarly, Yates and Stone (1992b) indicate that managers describe projects in terms of "overall riskiness". Consistent with Yates and Stone's prescriptions (1992b), we argue that overall supply disruption risk assessments are driven by buyers' judgments of the magnitude and probability of supply disruption they are facing. We define probability of supply disruption as the perceived likelihood that a supply disruption will occur and the magnitude of supply disruption as the perception of the severity of losses that may result from a disruption.

H1a. Probability of supply disruption is positively associated with overall supply disruption risk.

H1b. Magnitude of supply disruption is positively associated with overall supply disruption risk.

3.2. Antecedents of supply disruption risk

We draw from TCE and RDT to identify product and supply market factors that we hypothesize will affect perceptions of supply disruption magnitude, supply disruption probability, or both. Both TCE and RDT describe exchange relationships between organizations and have been employed extensively in the study of buyer–supplier relationships. While the two theories are often contrasted against each other, there is significant overlap in their predictions (Ulrich and Barney, 1984). Both TCE and RDT explain how organizations choose governance structures in the face of uncertainty; so factors identified from these theories are of particular interest in understanding perceptions of supply disruption risk.

TCE focuses on the costs associated with exchange governance by identifying governance mechanisms (markets or hierarchies) that are most appropriate for a given set of exchange conditions (Williamson, 1991). The selection of an appropriate governance structure is driven by asset specificity and the degree of uncertainty. Actors will favor markets when transactions are characterized by a limited need for adaptation, coordination, and safeguarding. RDT argues that organizations are dependent on their environmental contexts to obtain resources (Pfeffer and Salancik, 1978). Differences in dependencies allow organizations to exert power and influence over other organizations. Because increased dependence increases exposure to risk, organizations try to limit dependence on other organizations whenever possible (Smeltzer and Siferd, 1998). Two factors are important in determining dependence: (1) the importance of the resource and (2) the concentration of resource control.

From these two theoretical perspectives, we identify important supply market and product characteristics that impact perceptions of the probability and magnitude of supply disruption. Specifically we examine technological uncertainty, market thinness, item customization, and item importance.

3.2.1. Technological uncertainty

Technological uncertainty represents *the rate of change in underlying technologies of a purchased product* (Stump et al., 2002). Technological uncertainty makes it more difficult to forecast future developments as unforeseen events unfold and new opportunities and threats arise (Bensaou and Anderson, 1999; Cannon and Perreault, 1999). Technological uncertainty also increases the difficulty of processing supply market information. Standards for product price and quality performance may be difficult to establish in uncertain environments, making it difficult to apply safeguarding tactics (Stump and Heide, 1996). By causing changes in the market and reducing buyers' ability to adjust to these changes, technological uncertainty increases the likelihood of a supply disruption.

H2. The level of technological uncertainty is positively associated with the probability of supply disruption.

The firm's desire to maintain levels of innovation is one of the key drivers of technological uncertainty (Auster, 1992). However, the pursuit of innovation imposes limitations on product development capacity because of the lack of perfect information (Petersen et al., 2003). Turbulence associated with high technological uncertainty requires increased interaction between buyer and supplier (Lazzarini et al., 2008). Firms often seek to reduce uncertainty by establishing tighter relationships with suppliers (Dyer and Singh, 1998). This requires organizations to make relationship specific investments (Stuart et al., 1998). Because of these investments, disruptions in supply cannot be easily managed by turning to another supplier; thus, the difficulty of switching suppliers increases the impact of those disruptions.

H3. The level of technological uncertainty is positively associated with the magnitude of supply disruption.

3.2.2. Market thinness

Market thinness is the "*the degree to which a buying firm has* [*a limited number of*] *alternative sources of supply to meet a need*" (Cannon and Perreault, 1999, p. 444). Thin markets reduce buyer alternatives because there are fewer suppliers. Consequently, direct materials sourcing in thin supply markets is subject to opportunistic supplier behavior (Bensaou and Anderson, 1999; Grover and Malhotra, 2003). Furthermore, there is reduced information because, in thin markets, few suppliers sell comparable goods (Cannon and Perreault, 1999, p. 444). This suggests two important mechanisms that support a positive relationship between market thinness and likelihood of supply disruption: (1) lock-in and (2) reduced information flow.

H4. The level of supply *market thinness* is positively associated with the *probability of supply disruption*.

When there are fewer available suppliers, sourcing organizations will be more dependent on those firms (Pfeffer and Salancik, 1978). In thin markets, suppliers have greater power because the resources they supply cannot be obtained from other sources. Having fewer alternatives increases the negative impact from a supply disruption because sourcing organizations are not in a position to easily switch suppliers (Gassenheimer and Monolis, 2001; Yeh, 2005). This inability to acquire needed resources from alternate suppliers means that sourcing organizations will bear the full brunt of the costs associated with the disruption.

H5. The level of supply *market thinness* is positively associated with the *magnitude of supply disruption*.

3.2.3. Item customization

We define item customization as the *extent to which purchased items are modified according to the specifications of a specific buyer* (Hegde et al., 2005; Perdue and Summers, 1991). Customer-specific product adaptations necessitate specialized investments in plants, manufacturing equipment and processes, and/or worker skills (Hallen et al., 1991). By developing transaction-specific assets, suppliers achieve efficiencies in the provision of goods that more closely match buyers' requirements (Stump et al., 2002). Importantly, these transaction-specific investments also raise buyers' switching costs (Hallen et al., 1991; Stump et al., 2002). Increased switching costs associated with the purchase of customized items reduce buyers' abilities to deter suppliers' opportunistic behavior and the production of non-standardized products introduces new processes which may be problematic (Hegde et al., 2005). Both of these increase the likelihood of supply disruption.

H6. The level of item customization is positively associated with the probability of supply disruption.

Buyer specific adaptations to form, features, and/or fit enable customized components to enhance the internal or external quality of the buyer's final product (Clark and Fujimoto, 1990). Relative to standardized, off-the-shelf components, customized inputs minimize the need for functional compromise. Therefore, the supply of customized items may significantly affect the success of a buying firm's low cost or differentiation strategy. Consequently, when outsourcing involves customized items, a supplier's failure to deliver will have significant negative consequences for the buying firm.

H7. The level of purchased item customization is positively associated with the magnitude of supply disruption.

3.2.4. Item importance

Item importance represents the *degree to which a purchased part is critical to the manufacture of an organization's other parts, components, or end-products* (Cannon and Perreault, 1999; Krause, 1999). An item may be important either because it represents a large proportion of the required inputs or is a particularly important element in a firm's end-product(s) (Kraljic, 1983). Several studies have found that the buying firm's perception of the financial and strategic significance of a particular purchased item has a significant effect on supply chain activities and behaviors (Cannon and Perreault, 1999; Krause, 1999). The fact that a component is important increases an organization's vulnerability if acquisition of the resource is no longer assured. From the risk-based perspective, a buying firm experiences more significant losses from a supply disruption for critical items.

H8. The level of purchased item importance is positively associated with the magnitude of supply disruption.

3.2.5. Search for alternative source of supply

The search for suppliers is one of the key activities in the organizational buying process (Johnston and Lewin, 1996). While contemporary sourcing approaches emphasize repeated purchases with an incumbent supplier (Kim et al., 2008), organizations must also mitigate the risks associated with the supply of purchased goods. High supplier performance will encourage the continuation of a relationship with a supplier (Kim et al., 2008; Anderson and Weitz, 1989). Conversely, as buyers perceive greater overall risk in the supply of a particular item from a specific supplier they will seek to reduce the risk by searching for alternative sources of supply. The decision to search for alternatives will be based on an assessment of overall supply disruption risk given the situation associated with the incumbent supplier.

H9. Overall supply disruption risk is positively associated with the search for alternative sources.

3.2.6. Exogenous correlations

While the product and market constructs included in the model are distinct, the underlying causal mechanisms at work for some of these factors overlap. This is particularly true for item customization. When purchase items are customized for a particular buyer, this serves to both restrict the choices of the buying firm and increase the importance of the customized item. Choice is limited because of specific investments made by the supplying organization in producing the customized item. This serves to create an artificially thin market because buyers cannot readily find another supplier with the same capability (Cannon and Perreault, 1999; Stump et al., 2002). Customized items take on an increased importance because of both their functional attributes (Ulrich and Ellison, 1999) and their value to the final product (Clark and Fujimoto, 1990). Accordingly, we include exogenous correlations in our model between item customization-market thinness and item customization-item importance to account for the shared mechanisms affecting perceptions of supply disruption probability and magnitude.

4. Methodology

4.1. Research instrument development

We used a multi-step process to initially develop and subsequently validate our instrument (Churchill, 1979). Initially, we conducted an extensive review of the operations, marketing, and supply chain management literature to identify relevant constructs, operational definitions, and survey measurement items. Whenever possible, validated measures from previous research were incorporated into this study. We adapted existing questions to measure market thinness (five-item scale developed by Cannon and Perreault, 1999), technological uncertainty (three-item scale developed by Stump et al., 2002), and product customization (four-item scale developed by Stump et al., 2002). Further, we developed a six-item scale for item importance that: (1) incorporates the notions of importance, essentiality, priority, and significance from Cannon and Perreault's (1999) four-item bipolar scale for supply importance; and (2) draws from Krause's (1999) operationalization of "importance of purchased inputs" as it relates to top management attention. Finally, we adapted a single item from Kim et al. (2008) to measure search for alternate source of supply.

Prior literature provides little guidance for operationalizing the magnitude of supply disruption, probability of supply disruption, and overall supply disruption risk constructs. Consequently, we drew from the behavioral risk literature to develop initial items that were consistent with our operational definitions. Specifically, we incorporated the conceptual works of Yates and Stone (1992a, 1992b) and Zsidisin (2003) into the initial development of item measures for the probability and magnitude of supply disruption constructs. Our measure of overall supply disruption risk is based upon Yates and Stone's (1992b), Shapira's (1995), and Slovic's (1987) conceptual development of overall risk. Consistent with Shapira's (1995) findings, we developed a single-item measure that captures buyers' overall "feel" of supply disruption risk.

In the subsequent stages of scale development, we conducted interviews and pre-tests with low-, mid-, and executive-level managers representing both buyers and suppliers from the automotive components, specialized fastener, plastic resin, and part/package labeling industries. Our findings yielded several insights that affected the methodology of our study. First, the

completion time for the entire questionnaire ranged from 24 to 43 min; consequently, many measurement items were eliminated from the questionnaire. Second, when given the choice, respondents tended to select their most important supplier relationship to serve as the basis for the questionnaire. As such, we modified our sampling methodology to ensure collection of survey response data that included supplier relationships of both major and minor importance. Third, our interviews indicated a potential disconnect between the desired behaviors sought by purchasing executives and the actual behaviors exhibited by purchasing managers and buyers. Therefore, we specifically targeted buyers and purchasing managers, rather than executives, to form the basis of our sample frame.

Next, we conducted a pilot study in which we administered print and web-based questionnaires to a cross-section of purchasing professionals affiliated with six chapters of the Institute for Supply Management (ISM) located in the Northeast United States. We assessed the response data using exploratory factor and reliability analyses. Our assessment suggested that several items loaded poorly onto their intended constructs; as indicated in Tables 2a and 2b, these measurement items were dropped from this study. The resulting multi-item constructs exhibited acceptable psychometric properties: (1) no substantive cross-loadings were evidenced, (2) all Cronbach's alpha values were greater than 0.7, (3) all composite reliability values were greater than 0.7, and (4) all average variance extracted values were greater than 0.5.

4.2. Sample frame and data collection

The sample frame of our primary study consisted of 3196 Title 2 and Title 3 purchasing professionals randomly selected from a list of ISM members. Generally, Title 2 and Title 3 ISM members are mid-level purchasing professionals with titles such as buyer, senior buyer, and purchasing/supply chain manager. This sample frame facilitated the study of the perceptions of buyers who manage supplier relationships on a day-to-day basis. Additionally, a stratified sample was randomly drawn across U.S. manufacturing industries having two-digit SIC's between 20 and 39, thereby targeting a cross-section of purchasing professionals that manage the procurement of direct materials across a wide range of U.S. manufacturing industries.

Data collection was completed in January 2007. In total, 223 direct material buyers and purchasing managers returned their completed questionnaires; this resulted in an effective response rate of 7.1% for our study. The relatively low response rate may be attributable to two key factors. First, our contact list excluded telephone and email contact information and, to a large extent, employer information. Prior to survey administration, it was not possible to verify that each member of our sample frame was an active purchasing professional employed by a manufacturing firm. Second, it was not possible, *a priori*, to identify potential respondents who actively purchased direct materials. Consequently, we sent questionnaires to buyers of both direct and indirect materials. We received 69 notifications via phone, email, or returned surveys from those that said they were retired, with a different company, in a new position, or otherwise not currently involved in the purchase of direct materials.

4.3. Survey instructions

Prior to survey administration, potential respondents were randomly separated into two groups. Pending group membership, respondents were asked to identify a direct material supplier of either major or minor importance that they "actively manage on a regular basis".[1] Throughout the questionnaire, this supplier was referred to as "Supplier Y". Respondents were also instructed to identify a direct material purchased from this supplier and an end-product into which the purchased item was incorporated. The direct material and end-product selections were referred to as "Item X" and "Product Z", respectively, throughout the questionnaire. Using this approach, the questionnaire was customized to each respondent's specific purchasing situation. We used 20 items to test our behavioral model of supply disruption risk. The final list of measurement items and associated constructs is presented in Tables 2a and 2b.

Table 1a
Annual sales of buying firms.

Total annual sales ($)	Frequency
<50 million	46
50–299.9 million	44
300 million–999.9 million	28
1–4.9 billion	30
≥5 billion	29
Missing	46
Total	223

Table 1b
Purchases from Supplier Y.

Total annual sales ($)	Annual purchases of Item X from Supplier Y (frequency)	Total annual purchases from Supplier Y (frequency)
<100 thousand	21	13
100–499.9 thousand	44	21
500–999.9 thousand	15	23
1–2.9 million	40	39
3–9.9 million	24	43
10–49.9 million	24	27
≥50 million	16	17
Missing	39	40
Total	223	223

4.4. Overview of statistical methods

We applied structural equation modeling techniques to validate our measures and test our hypotheses. For cross-validation purposes, the measurement and structural models were independently estimated using AMOS (v6) and EQS (v6). In all cases, results were consistent across software platforms; hence, we report only those estimated by AMOS.

5. Analysis and findings

5.1. Respondent profile and survey biases

The demographic profile of the respondents for this study is provided within Tables 1a–1d. Most respondents identified themselves as Purchasing Managers. Approximately 73% of the respondents were men and roughly 45% of respondents held at least one professional certification from ISM (i.e., C.P.M. or A.P.P.). Over 85% had more than eight years experience managing the supply of purchased materials, with none having fewer than three years of purchasing experience. 52.5% of the respondents answered their questionnaire with respect to a supplier of major importance; 40.4% of the responses are based on supplier

[1] This approach prevented potential losses in response variance and generalizability that may have occurred if all participants chose their most important supply relationship as the context for their survey response.

Table 1c
Supplier relationships of major versus minor importance.

Relationship importance	Contract (frequency)	Spot buy (frequency)	Buy type missing (frequency)	Total (frequency)	Average contract length (months)	Average relationship length (years)
Major	93	21	3	117	19.18	11.81
Minor	69	20	1	90	19.35	9.78
Missing	13	2	1	16	23.82	12.93
Total	175	43	5	223	19.54	11.04

Table 1d
Direct material purchases.

Direct material type	Frequency
Raw material	88
Component	88
Assembly	34
System	8
Missing	5
Total	223

relationships of minor importance. The average length of relationship between respondents' companies and their suppliers is 11.04 years and respondents managed a median of $1 M–2.9 M in annual purchases of "Item X" from "Supplier Y". 78.5% of the supply relationships reported in this study are contractual; 18.4% of the responses are based on spot buys. For those reporting contractual buys, the average length of contract is 19.5 months. The majority of the respondents (78.9%) answered the questionnaire with respect to a raw material or component purchase.

Non-response bias was assessed by comparing industry membership, geographic location, and annual sales revenue across (1) responders and non-responders and (2) early and late responders (Armstrong and Overton, 1977). ISM provided industry membership and address data for each member of our sample frame. We compared industry classification for both responders and non-responders ($\chi^2 = 16.80$, $p = 0.60$) and early and late responders ($\chi^2 = 15.84$, $p = 0.46$) and found no significant differences. Using address data, we classified respondents into one of the eight Bureau of Economic Analysis geographic regions that comprise the continental U.S. Chi-squared tests were used to assess differences across geographical regions for both responders versus non-responders ($\chi^2 = 3.78$, $p = 0.81$) and early versus late responders ($\chi^2 = 9.36$, $p = 0.23$); our results suggest no significant differences across geographic regions. To assess differences in firm sales across responders and non-responders, we randomly selected 100 non-responders from our mailing list and recorded annual sales revenues for each of the non-responders' firms using secondary data from Hoovers and Reference USA databases. We contrasted this frequency distribution with the annual sales data reported by 177 survey participants. We found no significant difference in annual sales revenue across responders and non-responders ($\chi^2 = 7.46$, $p = 0.11$). Self-report data was used to assess differences in annual sales revenue across early and late responders; similarly, no significant differences were found ($\chi^2 = 1.26$, $p = 0.87$). In aggregate, these results suggest that, despite the low rate of response for this study, respondents adequately represent the population of ISM Title 2 and Title 3 buyers and purchasing managers who are employed within manufacturing industries.

An additional concern with single-respondent, questionnaire-based measurement is the existence of common method variance (CMV). We assessed CMV using Harmon's one-factor test (Podsakoff and Organ, 1986). We conducted exploratory factor analysis with principal components extraction and no rotation for all variables in our model and found that six factors had Eigenvalues exceeding one with the first factor accounting for 26.24% of the variance. We also confirmed this finding in our confirmatory analysis (Byrne, 2006). While this does not rule out the presence of CMV, it is unlikely to be problematic.

5.2. Results of the confirmatory factor analysis

To assess the reliability and validity of the scales that were initially validated in the pilot study, we conducted confirmatory factor analysis (CFA) on our sample data ($n = 223$). Survey items, item descriptive statistics, factor loadings, t-values, and model fit statistics are listed in Tables 2a and 2b. Our results show acceptable model fit ($\chi^2 = 167.592$, d.f. = 120, $p = 0.003$; RMSEA = 0.042; CFI = 0.978; SRMR = 0.051) and that all item-to-factor loadings were significant ($p < 0.01$) and substantive ($\lambda > 0.5$). We examined items for loadings onto unintended factors and found no significant cross-loadings; these results provide evidence of scale unidimensionality.

We assessed the reliability of our scales using Cronbach's alpha, average variance extracted (AVE), and composite reliability (CR) scores. As reported in Table 3, all Cronbach's alpha and CR statistics exceed or are at the 0.7 cutoff established in the literature. In addition, all but one scale (probability of supply disruption) surpassed the accepted 0.50 cutoff for AVE. We re-assessed the AVE and CR for the probability of supply disruption construct by conducting exploratory factor analysis on our pilot and follow-up[2] datasets; our results indicate that the AVE exceeds 0.6 for both datasets (0.705 and 0.630, respectively) and CR exceeds 0.8 for both datasets (0.877 and 0.836, respectively). As such, we conclude that the convergent validity of our multi-item scales is adequate (Fornell and Larcker, 1981).

Two of our scales are based on single-item measures: overall supply disruption risk and search for alternate source of supply. We collected additional longitudinal data to validate our measure of overall supply disruption risk. In November 2008, we collected perceptual measures of supplier performance from 90 direct material buyers of a single manufacturing firm and culled objective supply disruption data from the same firm's archival database for the previous five-year period (measures shown in Table 4). Six months later, we asked the same respondents to rate overall supply disruption risk using our single-item measure. As presented in Table 5, the results of our analysis show that overall supply disruption risk is significantly and negatively correlated with each perceptual measure of supplier performance. Additionally, we find that the total number of supply disruption cases and the total costs recovered from suppliers (due to disruptions) for the previous five-year period are significantly and positively related to overall supply disruption risk for all respondents and for those with five or more years of experience working with their matched supplier. Based on

[2] To confirm the validity of our constructs, we administered our survey questionnaire to an additional random sample of Title 2 and Title 3 ISM purchasing professionals; we received 41 responses. Statistics derived from this "follow-up" sample provide additional support for the validity of the constructs used in this study.

Table 2a
Survey items, item means, standard deviations, item loadings, and *t*-values from CFA for exogenous variables[a].

Items (1, strongly disagree; 4, nuetral; 7, strongly agree)		Mean	S.D.	Loading[b]	*t*-Value
Item customization					
IC1	Item X is custom built for us	2.26	1.44	0.861	15.053
IC 2	We basically buy the same component that Supplier Y sells to other customers[b]	3.51	1.72	0.734	12.182
IC 3	Item X is pretty much an "off-the-shelf" item[c]	4.13	1.70	0.901	16.030
–	The specifications for Item X were substantially different from those of any other product that Supplier Y makes[d]	–	–	–	––
Technological uncertainty					
TU1	Rapid changes in Item X's industry necessitate frequent product modifications	2.83	1.57	0.638	9.389
TU2	Technology developments in Item X's industry are frequent	3.21	1.64	0.788	11.717
TU3	Technology changes in Item X's industry provide major opportunities	3.33	1.58	0.756	11.233
Item importance					
II1	If our company ranked all purchased items in order of importance, Item X would be near the top of the list	5.51	1.52	0.919	17.400
II2	Compared to other items our company purchases, Item X is a high priority with our company's purchasing managers	5.38	1.64	0.912	17.179
II3	Most other items that our company purchases are more important than Item X[c]	4.88	1.88	0.828	14.818
–	Item X represents one of our company's essential purchases[d]	–	–	–	–
–	Relative to other items that our company buys, Item X is of minor significance[c,d]	–	–	–	–
–	The purchase of Item X is critical to the success of our business[d]	–	–	–	–
Market thinness					
MT1	We could purchase Item X from several other vendors[c]	2.93	1.80	0.686	10.577
MT2	Supplier Y is really the only supplier we could use for Item X	2.44	1.63	0.884	14.140
MT3	Supplier Y almost has a monopoly for Item X	2.10	1.48	0.716	11.097
–	The supply market for Item X is very competitive[c,d]	–	–	–	–
–	No other vendor has Supplier Y's capabilities[d]	–	–	–	–

[a] Measurement model (includes all multi-item scales listed in Tables 2a and 2b) fit statistics: $\chi^2 = 167.592$, d.f. = 120, $p = 0.003$; χ^2/d.f. = 1.397; GFI = 0.925; CFI = 0.978; TLI (NNFI) = 0.972; NFI = 0.928; RMSEA = 0.042; SRMR = 0.051.
[b] Standardized coefficients; all loadings are significant at $p < 0.001$.
[c] Reverse-coded item; item measure reversed by subtracting response value from 8.
[d] Dropped after pilot study due to poor psychometric properties.

the results of our multi-method assessments, we conclude that our single-item measure of overall supply disruption risk is valid. We rely on the work of Kim et al. (2008) to demonstrate the validity of our single item measure of search for alternate source of supply. In their study of the Japanese electronics industry, Kim et al. (2008, p. 97) report that their item, "We are actively seeking an alternative supplier for this part", loads onto the search for alternative supplier construct at $\lambda = 0.94$. Given this near perfect loading, we adapted this single-item measure for our study.

Using the measurement model as a baseline, we tested the discriminant validity of our latent constructs by conducting a series of pair-wise tests; in these tests, the covariance between each pair of latent constructs was constrained to one. Then, using global χ^2 difference tests, we compared the fit of each constrained model to that of the baseline model (Bollen, 1989). Each constrained model resulted in a significant χ^2 increase ($p < 0.01$) when compared the baseline model; the results of this analysis support the discriminant validity of our latent constructs. Also, we note that the inter-construct correlations and standard errors reported in Table 3 similarly support the discriminant validity of our constructs.

5.3. Results of the structural model analysis

Fig. 2 reports the estimation results for the structural model. The model fit statistics reported ($\chi^2 = 231.602$, d.f. = 160, $p = 0.000$,

Table 2b
Survey items, item means, standard deviations, item loadings, and *t*-values from CFA for endogenous variables.

Items (1, strongly disagree; 4, nuetral; 7; strongly agree)		Mean	S.D.	Loading[a]	*t*-Value
Probability of supply disruption					
PSD1	It is highly unlikely that we will experience an interruption in the supply of Item X from Supplier Y[c]	2.90	1.38	0.735	9.786
PSD2	There is a high probability that Supplier Y will fail to supply Item X to us	2.44	1.28	0.570	7.788
PSD3	We worry that Supplier Y may not supply Item X as specified within our purchase agreement	2.63	1.42	0.708	9.476
–	We are confident in Supplier Y's ability to supply Item X to us[d]	–	–	–	–
Magnitude of supply disruption					
MSD1	An interruption in the supply of Item X from Supplier Y would have severe negative financial consequences for our business	4.92	1.76	0.905	17.349
MSD2	Supplier Y's inability to supply Item X would jeopardize our business performance	4.81	1.80	0.959	19.173
MSD3	We would incur significant costs and/or losses in revenue if Supplier Y failed to supply Item X	4.78	1.78	0.927	18.073
–	Without the supply of Item X from Supplier Y, we would be unable to meet our customer's demand[d]	–	–	–	–
–	Our relationships with our primary customers would be unaffected if Supplier Y failed to supply Item X[c,d]	–	–	–	–
Overall supply disruption risk[b]					
OSR1	Overall, the supply of Item X from Supplier Y is characterized by low levels of risk[c]	2.26	1.58	–	–
Search for alternate source of supply[b]					
SAS1	We are actively seeking alternate sources of Item X	4.25	1.79	–	–

[a] Standardized coefficients; all loadings are significant at $p < 0.001$.
[b] Single item scale.
[c] Reverse-coded item; item measure reversed by subtracting response value from 8.
[d] Dropped after pilot study due to poor psychometric properties.

Table 3
Inter-construct correlations (standard errors), average variance extracted, and scale reliabilities.

	Custom	TecUnc	ItmImp	MktThn	ProbSD	MagSD	OvrlRsk	Cron α	AVE	C.R.
Custom	–	–	–	–	–	–	–	0.869	0.697	0.869
TecUnc	0.085 (0.080)	–	–	–	–	–	–	0.769	0.533	0.769
ItmImp	0.178 (0.072)	0.267 (0.074)	–	–	–	–	–	0.911	0.787	0.911
MktThn	0.218 (0.074)	0.155 (0.081)	0.198 (0.073)	–	–	–	–	0.796	0.588	0.796
ProbSD	0.117 (0.082)	0.226 (0.086)	0.013 (0.082)	0.261 (0.081)	–	–	–	0.711	0.455	0.711
MagSD	0.327 (0.066)	0.313 (0.071)	0.415 (0.060)	0.335 (0.067)	0.187 (0.078)	–	–	0.950	0.866	0.950
OvrlRsk	0.252 (0.067)	0.224 (0.072)	0.157 (0.068)	0.258 (0.068)	0.468 (0.065)	0.270 (0.064)	–	–	–	–
AltSrc	0.052 (0.071)	0.042 (0.076)	0.254 (0.065)	0.102 (0.072)	0.129 (0.077)	0.116 (0.068)	0.194 (0.065)	–	–	–

Table 4
Measures of supplier performance and supply disruption.

Scales and associated indicators	
Supplier performance[a]	
Please indicate how Supplier Y's performance compares with your company's expectations for supplier performance for each of the following areas	
SP1	Price
SP2	Conformance quality
SP3	Delivery reliability
SP4	Product technology
SP5	Cost reduction/avoidance
SP6	Total value
Number of supply disruptions	
NSD1	Log of the total number of supply disruption cases that occurred over five-year period
Number of supply disruptions	
CSD1	Log of the total cost of supply disruptions that occurred over five-year period

[a] Response scale: 1, Falls Far Short; 4, Meets; 7, Far Exceeds.

RMSEA = 0.045, CFI = 0.968, SRMR = 0.081) generally satisfy the guidelines for fit established in the structural modeling literature (Hu and Bentler, 1998, 1999). Overall, our model explains a substantive amount of the variance of overall supply disruption risk (R^2 = 0.259), providing further evidence of the validity of our model of supply disruption risk.

The results of our statistical analyses provide support for eight of the nine hypothesized relationships in our proposed model. Our results indicate that both probability of supply disruption (β_{23} = 0.448, $p < 0.001$) and magnitude of supply disruption (β_{24} = 0.189, $p < 0.01$) have positive and statistically significant effects on overall supply disruption risk, providing support for H1a and H1b.

Two of the three proposed antecedents of probability of supply disruption drawn from transaction cost economics and resource dependence theories have significant positive relationships. As shown in Fig. 2, these antecedents explain 11.7% of the variance in the probability of supply disruption. Technological uncertainty (γ_{31} = 0.214, $p < 0.01$) and market thinness (γ_{32} = 0.238, $p < 0.01$) both show significant relationships providing support for H2 and H4. These findings indicate that managers purchasing direct materials in thin supply markets or markets characterized by high levels of technological uncertainty perceive a greater likelihood that a supply disruption will occur. No relationship is found between customization and the probability of supply disruption (γ_{33} = 0.085, $p > 0.1$), failing to support H6. Based on these results, it appears that the purchase of customized products does not directly increase managers' expectations of the probability of supply disruptions.

The results of our analysis provide support for all of the hypothesized antecedents of the magnitude of supply disruptions. Technological uncertainty (γ_{41} = 0.203, $p < 0.01$), market thinness (γ_{42} = 0.218, $p < 0.001$), item customization (γ_{43} = 0.224, $p < 0.001$), and item importance (γ_{44} = 0.311, $p < 0.001$) all have positive and significant effects on managers' views of the magnitude of supply disruptions. These findings provide support for H3, H5, H7 and H8. Together these findings suggest that both market and purchased item attributes affect the perceived impact of potential supply disruptions. The antecedents in the model explain 27.4% of the variance in the magnitude of supply disruption.

Our analysis finds a positive and significant relationship (β_{12} = 0.192, $p < 0.01$) between overall supply disruption risk and search for alternate source of supply (H9). Our results show that overall supply disruption risk accounts for 3.7% of the variance in search for alternate source of supply. While this represents a significant but relatively low percentage of the variation, we note that this decision provides a rich context that facilitates our study of the risky decision-making process. Further, we acknowledge that buyers may adopt several other supply management tactics to mitigate risks associated with supply disruption.

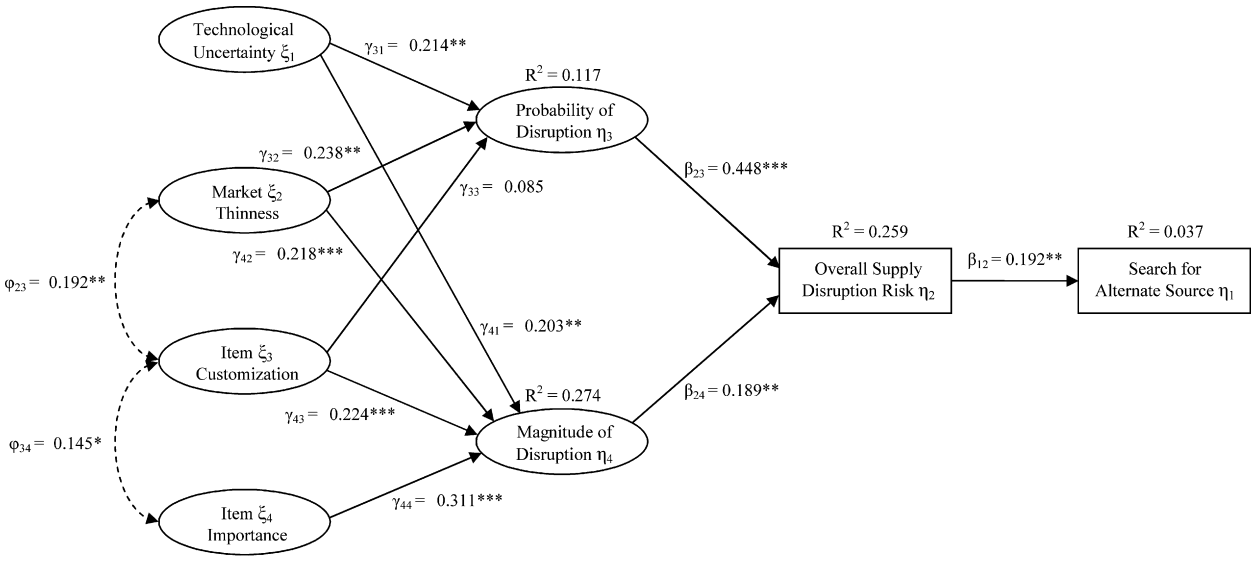
As shown in Fig. 2, we estimated two correlations that were exogenous to our causal model. The correlation between item customization and supply market thinness reflects the premise that customization is associated with artificially thin markets in which the buyer knowingly limits the number of suppliers that can immediately supply the customized materials (Cannon and Perreault, 1999); as expected, this correlation is positive and significant (φ_{23} = 0.192, $p < 0.01$). Similarly, the positive and significant correlation between item importance and item customization (φ_{34} = 0.145, $p < 0.05$) accounts for the notion that customization is associated with the perceived importance of the purchased item for the buying firm.

Finally, we controlled for size (annual sales revenue) and supplier relationship importance (minor versus major importance). The statistical significance of the paths in our model was

Table 5
Overall disruption supply risk item correlations[a].

Item	Statistic	Perceptual measures						Objective measures			
		All respondents						All respondents		Respondents with 5+ years experience	
		SP1	SP2	SP3	SP4	SP5	SP6	NSD1	CSD1	NSD1	CSD1
OSR1	Corr.	−0.37**	−0.18*	−0.29**	−0.20*	−0.24**	−0.16+	0.16+	0.18+	0.38*	0.27+
	n	90	90	90	89	89	89	82	63	33	26

[a] Correlation *p*-values: $^{+}p \leq 0.10$; $^{*}p \leq 0.05$; $^{**}p \leq 0.01$.



[a] Model fit statistics: χ^2 = 231.602, df = 160, p = .000; χ^2/df = 1.448; GFI = .907; CFI = .968; TLI (NNFI) = .962; NFI = .905; RMSEA = .045; SRMR = .081
[b] Regression weight p-values: * denotes p ≤ 0.05; ** denotes p ≤ 0.01; *** denotes p ≤ 0.001

Fig. 2. Structural model—standardized regression weights[a,b].
[a]Model fit statistics: χ^2 = 231.602, d.f. = 160, p = 0.000; χ^2/d.f. = 1.448; GFI = 0.907; CFI = 0.968; TLI (NNFI) = 0.962; NFI = 0.905; RMSEA = 0.045; SRMR = 0.081.
[b]Regression weight p-values: $^{*}p \leq 0.05$; $^{**}p \leq 0.01$; $^{***}p \leq 0.001$.

not affected by these additional control variables. Therefore, we conclude that our findings are robust across firm sizes and supplier relationship types.

6. Discussion and conclusions

Our research demonstrates the central role that representations of risk play in the risky decision-making process. Further insights into the role of risk representations may be gained by contrasting our theoretical model with alternate models in which the probability and magnitude of supply disruption constructs (Representation 1 in Fig. 1) and the overall supply disruption risk construct (Representation 2 in Fig. 1) are omitted. In our first post hoc analysis, we omit the probability and magnitude of supply disruption constructs and assess the direct effects of supply environment on overall supply disruption risk. As shown in Table 6, technological uncertainty, market thinness, item customization, and item importance directly account for just 12.2% of the variance in overall supply disruption risk, representing a 52.9% reduction in explained variance compared to the theoretical model. As such, the inclusion of probability and magnitude of supply disruption in our model enhances our ability to explain overall supply disruption risk. We find a similar result when we omit overall supply disruption risk and analyze the direct effect of magnitude and probability of supply disruption on buyers' decisions to search for alternate sources of supply. The results in Table 6 show that probability and magnitude of disruption explain substantively less variation in search for alternate source of supply as compared to overall supply disruption risk ($\Delta R^2 = -37.8\%$). When generalized, the results of our post hoc analyses provide strong empirical support for the inclusion of magnitude of loss, probability of loss, and overall risk within Yates and Stone's (1992b) model of risky decision-making.

Table 6
Alternate structural models—estimation results[a].

Independent variables	Dependent variables	
	Model 1: overall supply disruption risk	Model 2: search for alternative supplier
Technological uncertainty	0.175**	
Market thinness	0.188**	
Item customization	0.191**	
Item importance	0.055	
Probability of supply disruption		0.113+
Magnitude of supply disruption		0.100+
Overall supply disruption risk		
Coefficient of determination (R^2)	0.122	0.023
Percent decrease in R^2	52.9%	37.8%

[a] Regression weight p-values: $^{+}p \leq 0.10$; $^{*}p \leq 0.05$; $^{**}p \leq 0.01$.

The relative effect size of the standardized regression coefficients provides new insights as to how magnitude and probability affect perceptions of overall risk. In contrast to March and Shapira (1987) and Shapira (1995), we find that probability of supply disruption (β_{12} = 0.448) has more than twice the effect on overall supply disruption risk than magnitude of supply disruption (β_{13} = 0.189). Whereas banking executives studied by March and Shapira (1987) tended to focus on magnitude when assessing risk, buyers and purchasing managers appear to place greater emphasis on probability when forming their perceptions of overall supply disruption risk. We offer two possible explanations for these seemingly contrary findings. First, March and Shapira (1987) suggest that executives focus on upside opportunity (magnitude) because they believe that they can effectively manage probabilities in their favor. Conversely, buyers and purchasing managers are largely focused on minimizing supply disruptions because any disruption has negative cost implications for the buying firm. Second, the contrast in views of risk may be attributable to the level of position that respondents hold. Whereas executives tend to be well compensated for taking large risks and managing these risks successfully (March and Shapira, 1987), buyers hold much less authority and are primarily responsible for ensuring the smooth flow of direct materials from the supply base (Corey, 1978).

Our empirical findings also lend new insights into the definition of overall supply disruption risk. Zsidisin (2003, p. 222) defines supply risk as "the probability of an incident associated with inbound supply from individual supply failures or the supply

market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to consumer life and safety". Importantly, several recent supply chain management studies have adopted this definition (Choi and Krause, 2006; Cooper et al., 2006; Kull and Closs, 2008; Neiger et al., in press). However, our results suggest that this definition portrays an incomplete view of supply risk. While probability of supply disruption plays a primary role in the formation of overall supply risk perceptions, we also note that magnitude of supply disruption is a significant determinant. As such, results from our study serve to caution future researchers from adopting conceptualizations of supply disruption risk that include only the probability or the magnitude of a supply disruption.

Examination of the direct and indirect effects on representations of risk provides several interesting findings. First, we note that item customization and item importance affect the magnitude of supply disruption only. This finding provides further support for the inclusion of both the probability and magnitude of supply disruption constructs in future studies of supply disruption risk. For, if magnitude was omitted from this study, we would not capture the full effects of these purchased item attributes on overall supply disruption risk. Second, product and market factors have differing effects on the probability and magnitude of supply disruption. Contrary to classical risk literature, our results support the treatment of probability and magnitude as independent constructs. Third, we find that the total indirect effect of market thinness (0.148) and technological uncertainty (0.134) on overall supply disruption risk is much greater than that of item importance (0.059) and item customization (0.042). This finding indicates that buyers' perceptions of overall supply disruption risk increase substantially as their influence over specific attributes of the exchange decreases. For example, the level of customization is well within the control of the buying firm. However, aside from direct investment in productive resources, buyers have little immediate control over supply market thinness. Similar analogies can be drawn regarding technological uncertainty and item importance. This finding suggests that it may be particularly important for firms to invest in new supplier development and joint product development capabilities to mitigate external sources of supply disruption risk such as market thinness and technological uncertainty.

Contrary to our expectations, we find that the relationship between item customization and probability of loss is positive but not statistically significant. To explore this unexpected finding, we re-specified our theoretical model by (1) including a causal path between item customization and market thinness and (2) removing the corresponding exogenous correlation. Our exploratory findings indicate that market thinness fully mediates the relationship between item customization and probability of supply disruption. This finding suggests that transaction-specific investments which support sales of customized items impose higher switching costs to buyers, limiting the number of alternate sources of supply readily available to the buyer. As such, buyers create self-imposed thin supply markets by purchasing customized direct materials that require suppliers' specialized investment.

Results from this study inform managerial practice in several important ways. First, our process model of risky decision-making may inform organizational policy. Our research shows that direct material buyers' decisions are driven by their perception of overall supply disruption risk. Organizations may foster improved decision-making by implementing purchasing policies and procedures that facilitate buyers' translation of objective supplier performance data into accurate risk assessments. Second, our findings suggest the importance of associating attributes of exchange with specific representations of risk. Different exchange attributes may affect representations of probability and magnitude of supply disruption in different ways. Third, whereas previous conceptual research has focused on the role of disasters, terrorist attacks, and strikes, our study draws attention to the importance of considering exchange attributes as drivers of supply disruption risk. Finally, we provide validated measures to assess magnitude and probability of supply disruption; in addition to facilitating risk assessment, these measures may guide supplier segmentation (Kraljic, 1983) and portfolio approaches to supply base management (Wagner and Johnson, 2004).

While our study has important implications, it is subject to limitations. Due to the use of single respondents to capture our perceptual measures, the possibility of common method bias exists. However, our analysis suggests that the actual effect attributable to this potential bias is minimal. Second, the low response rate creates the possibility that our sample is not representative of a broader population of U.S. purchasing managers. While our tests did not indicate a significant difference between responders and non-responders, the generalizations made from our results must be viewed in light of this potential limitation.

Despite these limitations, findings from this study may provide a useful platform for future research. To establish the generalizability of Yates and Stone's model of risky decision-making, future research may consider the role of magnitude of loss, probability of loss, and overall risk in other contexts such as new product development and strategic investment settings. Such studies may be particularly important because, unlike supply disruption risk, these contexts offer the possibility to study decisions that involve potential gains as well as losses. Additionally, risk research that examines other types of decisions may study perceptions of respondents in other professions (e.g., engineers or accountants) and levels of the organization (e.g., executives).

At a more detailed level, our behavioral model of supply disruption risk may be refined by considering additional factors that may influence perceptions of magnitude of supply disruption, probability of supply disruption, and overall supply disruption risk. Further insights may be gained by studying how referent outcomes or aspiration levels (Lopes, 1987) interact with individuals' judgments of probability and magnitude of supply disruption to affect views of overall supply disruption risk. Additional psychological factors, such as age, education, expertise, experience, cognitive ability, mood, recency of disruption, risk preference, problem framing, and prior success, may affect buyers' assessments of risk (Sitkin and Pablo, 1992). Study of these behavioral factors may facilitate improved design of organizational structure and infrastructure that supports the risky decision-making process.

The supply chain management literature identifies several factors that may also impact perceptions of supply disruption risk. While the influence of product and supplier factors were empirically examined within the context of our study, several others warrant attention in future research. For example, Sheffi and Rice (2005) consider several external hazards such as strikes (e.g., US West Coast longshoremen strike), natural disasters, outbreak of disease, and terrorist attacks in their discussion of risk assessment and mitigation. Other research highlights the role of density of the supply network (Craighead et al., 2007), complexity of the supply network (Choi and Krause, 2006), supplier performance (Spekman and Davis, 2004), supplier shutdowns due to strikes, fires, financial distress, or sabotage (Sheffi and Rice, 2005), and shipping distance. Further, factors related to supply network complexity, such as geopolitical, natural, or socio-cultural factors may also contribute to supply disruption risk (e.g., Juttner, 2005). The simultaneous consideration of these drivers of supply disruption risk and their interactions (e.g., the interaction of natural disasters and density of supply network) may lend new insight into how particular disruption events affect perceptions.

Another rich avenue for future scientific investigation involves the examination of risk mitigation strategies. While our model of

overall supply disruption risk does not focus on risk mitigation strategies, it does advance a context in which the conditional effectiveness of risk reducing activities may be studied. Previous research suggests that the number of suppliers for a particular purchased product, the size and location of inventory within the supply chain (Kull and Closs, 2008), use of early supplier involvement practices (Petersen et al., 2005), the adoption of specific supplier selection criteria (Talluri et al., 2006), the development of existing or new suppliers (Krause, 1999), and integration of logistical transportation and information systems (Kaynak and Hartley, 2006) may attenuate supply disruption risk. Additional risk mitigation tactics include: (1) contingency planning (Sheffi and Rice, 2005), (2) suppliers' investments in flexible manufacturing, back-up systems, and spare capacity, (3) buyer's investments in in-house manufacturing capabilities, and (4) buyer's and supplier's joint investment in the development of relational norms. Future research should operationalize these mitigation strategies and examine their influence on buyers' perceptions of magnitude of supply disruption, probability of supply disruption, and overall supply disruption risk with respect to the relationships shown in our model.

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