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Articles

Inter-relationship among risk taking propensity, supply chain security practices, and supply chain disruption occurrence

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ABSTRACT

Supply chain disruptions often led to declining sales, cost increases, and service failures for the company. Considering the profound impact of supply chain disruptions on business survivals, there is a need for formulating business initiatives that will make the company's supply chain network more resilient in the presence of risk and uncertainty. This paper sheds light on the inter-relationships among risk propensity, supply chain security practices, and disruption occurrence so that it can help the company figure out what it takes to overcome the company's vulnerability to supply chain risks and then gain competitive advantages over its rivals by better preparing for potential supply chain disruptions. This paper attempts to identify factors affecting the firm's risk behaviors and supply chain security practices based on the questionnaire survey of supply chain professionals. The finding indicates that firms which take the risk of supply chain disruption seriously are more likely to comply with security initiatives and build safety stocks and subsequently reduce the frequency of supply chain disruption occurrence.

1. Introduction

As the globalization of business activities accelerated, today's supply chains span the globe with unprecedented complexities and uncertainties. These complexities and uncertainties not only increase risk, but also reduce visibility that, in turn, makes supply chain operations more vulnerable to unforeseen disruptions. Reflecting growing concerns over supply chain disruptions, supply chain risk management (SCRM) has become an emerging research topic (Altay and Ramirez, 2010; Ellis et al., 2011; Manuj and Mentzer, 2008a, 2008b; Revilla and Sáenz, 2014; Schoenherr et al., 2012; Son and Orchard, 2013; Tang, 2006a; Whitney et al., 2014; Zsidisin and Wagner, 2010). One of the central themes of past SCRM research includes the definition and categorization of supply chain risks and identification of their sources. For instance, borrowing from investment portfolio concepts, Rao and Goldsby (2009) defined supply chain risk in two ways: First, risk is considered the manifestation of uncontrollability that may result in either positive or negative outcome. Second, risk refers to a form of negative outcomes that adversely affect organizational performance. Altay and Ramirez (2010) investigated how natural disaster such as earthquake, windstorms, floods, and fires affected firms in different business sectors. They observed that firms did not take disaster disruption management seriously due to their perceived low probability of disaster occurrence, despite the fact that natural disaster actually affected firm performances.

Considering the potential connection between the firm's perceived risk and risk mitigation actions, Ellis et al. (2011) identified individual, organizational, and environmental factors that affected the formation of risk perception and mitigation actions. Despite a variety of risk factors (sources) and their level of importance to mitigation actions, Revilla and Sáenz (2014) found the level of disruption management implementation to be universal all across the world. More recently, Ambulkar et al. (2015) identified three antecedents for enhancing the firm's resilience to supply chain disruptions: (1) supply chain disruption orientation; (2) resource reconfiguration capabilities and (3) firm's risk management infrastructure. They found that supply chain disruption affected the firm's resilience level differently depending upon the firm's resource configuration and risk management infrastructure. Focusing on the effectiveness of risk mitigation actions rather than the identification of risk sources, Whitney et al. (2014) noticed that multiple sourcing was often used as a temporary hedge to reduce supply chain disruption risks. However, they found that temporary multiple sourcing turned out to be ineffective in dealing with supply chain disruption, if product design and manufacturing methods for the disrupted items were complex. Supporting this

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finding, Bode and Wagner (2015) showed that horizontal, vertical, and spatial supply chain complexities increased the frequency of supply chain disruption and thus made a temporary hedge less efficient.

In the presence of various supply chain risks illustrated above, this paper aims to develop risk mitigation action plans that help firms better control such risks, while assessing the impact of supply chain security and safety stock practices on supply chain disruption occurrence based on the empirical study. In particular, drawing upon the contingency theory, this paper introduces firm's risk taking propensity as an antecedent, which may reflect the firm's risk management behavior, proposes security compliance and safety stock plans, and identifies various types of supply chain disruption occurrence.

2. Relevant literature

Reflecting the growing awareness of supply chain risk and a need for contingency planning, there exists abundant literature dealing with supply chain risk (e.g., Tang, 2006a, 2006b; Khan and Burnes, 2007; Manuj and Mentzer, 2008a, 2008b; Vanany et al., 2009; Tang and Nurmaya Musa, 2011; Chaudhuri et al., 2013, Zhao et al., 2013). Given the plethora of articles reviewing and synthesizing the past supply chain risk literature, our focus in this section is to examine what has been studied up to this point to identify various forms of supply chain disruption, and assess their impact of supply chain security practices on reduction of such disruption occurrence.

2.1. Risk taking propensity

Since the firm's corporate culture in dealing with risk may influence the way the risk is managed, we take into account the degree of risk taking propensity for formulating SCRM strategy. Generally, risk taking propensity refers to a company's willingness to commit their resources to risk management (Miller and Friesen, 1978). Sitkin and Pablo (1992) defined risk taking propensity as a general tendency for a person to either take or avoid risks. Risk taking propensity ranges from risk-aversion tendencies to actively avoiding risk to risk-seeking tendencies to actively exploit uncertainty (Weber et al., 2002). Kocabasoglu et al. (2007) is one of the first to study risk taking propensity at an organizational level to understand SCRM behavior and then define risk taking propensity as a likelihood of a firm's acceptance of less or more risky behavior over time. Also, Gilley et al. (2002) and Das and Joshi (2007) observed that the more the firm was willing to take risk by engaging in risky business activities, the more likely it was to take bold actions that can lead to innovative product and service development.

2.2. Supply chain security practices

Wagner and Bode (2009) proposed a cause-oriented focus and an effect-oriented focus when managing supply chain risk. A cause-oriented focus refers to a reduction in the likelihood of disruption occurrence and the avoidance of possible risk through switching and relocating existing facilities and launching preventive safety and security initiatives. An effect-oriented focus refers to the adoption of redundancy principles, such as the establishment of organizational slacks, use of buffering strategy, capacity expansion, and multiple sourcing. Zsidisin and Wagner (2010) postulated that the development of supply chain resilience involved increased flexibility and redundancy to weaken the adverse effect of supply chain disruption. Their statistical result indicated that redundancy had a moderating role between perceived supply risks and disruption occurrence. Bode et al. (2011) introduced the concept of motivation to act as supply chain disruption orientation to explain the firm's responses to supply chain disruption. Also, they explained how the firm's supply chain disruption orientation influenced its choice of disruption responses such as bridging and buffering actions. In particular, they found that the buffering action worked as safeguards which enhanced firm's stability by protecting them from supply chain disruption. Speier et al. (2011) developed a supply chain security practice which can mitigate product safety and security risks. Their proposed security practice includes information sharing, process management, and supply chain partnership management. They also recognized the importance of top management mindfulness and commitment to security, since it could help lower the detrimental effect of supply chain disruption and foster a security culture. Hoffmann et al. (2013) introduced buffering and insurance as a reactive risk mitigation action. They discovered that buffering was unable to prevent disruption but it could absorb the detrimental effect of supply chain risk. They also found that risk mitigation actions such as buffering moderated the relationship between environmental uncertainty and supply risk management performance. Based on the aforementioned studies, since security compliance and safety stock plans can be considered risk mitigating security measures, we regard security compliance and safety stock plans as supply chain security practices.

2.2.1. Security compliance

In the aftermath of 9/11 incident, a growing number of firms began to realize how significantly a lack of contingency planning or disaster preparedness can disrupt supply chain operations and subsequently damage business performances. To develop “safe-harbor” plans of action against supply chain risks, many firms took supply chain security more seriously and then considered developing more effective security measures. For instance, the U.S. firms invested in approximately $65 billion to enhance supply chain security in the wake of 9/11 incidents (Williams et al., 2009). Notable examples of these security measures include compliances with the Customer-Trade Partnership against Terrorism (C-TPAT), the Container Security Initiative (CSI), Fast and Security Trade (FAST), the Emergency Planning and Community Right to Know Act (EPCRA), the Advanced Manifest Rule (AMR), Antitamper Seals, X-ray and/or Gamma-ray scanning of containers, Safe and Secure Tradelanes (SST), and ISO/PAS 28000:2005 (Williams et al., 2008, 2009; Willis and Ortiz, 2004). Generally, a supply chain security system refers to the application of policies, procedures, and technology to protect supply chain assets (e.g., product, equipment, facilities, information, and personnel) from the theft, damage, sabotage, terrorist attack or unauthorized contraband (Closs and McGarrell, 2004; Whipple et al., 2009).

2.2.2. Safety stock

In this paper safety stock refers to the extent to which a company maintains redundant inventory (i.e., added finished goods and extra components/parts) to absorb or cushion the detrimental effect of supply chain disruption. Creating redundancy enables firms to reduce the likelihood of disruption and increase resilience. Safety stocks, multiple sourcing, expanded capacity, and backup sites are examples of redundancy. Sheffi and Rice (2005) claimed that redundancy could incur sheer cost with limited benefit. Thus, redundancy was needed only in the case of disruption, because it might lead to underutilized capacity, idle inventory, and increased waste. That is to say, redundancy can disguise inefficiencies by inhibiting the advantages of a lean supply chain (Tang, 2006a). Tomlin (2006) viewed redundancy as a mitigation action. Examples of such an action included multiple sourcing, added inventory, and increased production capacity. Similarly, Tang

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(2006a) introduced several types of potential redundancy such as extra back-up production capacity, extra inventory, and extra back-up suppliers. Simchi-Levi et al. (2014) developed a model to help firms identify areas of hidden risk. To deal with those risks, they proposed two action plans: (1) redundancy which included excessive inventory, multiple production sites, and dual-sourcing strategies; (2) flexibility which included system, product-design, and process flexibility as a mitigation action plan. They illustrated that, when automaker's supply disruption occurred, availability of alternative sourcing was critical for preventing production-line stoppage.

2.3. Supply chain disruption occurrence

In an effort to identify sources of supply chain risk, Christopher and Lee (2004) and Trkman and McCormack (2009) developed a theoretical framework that categorized different sources of supply chain risk: (1) internal risk, (2) supplier risk, (3) customer risk, and (4) external risks. These sources are affected by three key factors: environmental, network, and organizational. An environmental factor is considered external, because it originates from external uncertainties created by natural, political, and social events. A network factor pertains to any uncertainty created by demand fluctuations, product life cycle patterns, and logistics flows (Johnson, 2001). An organizational factor pertains to any disruptions inside the organization including credit crunch, legal liability, and operating uncertainty (Ritchie and Marshall, 1993; Rao and Goldsby, 2009). An organizational factor is a subset of a network factor which encompasses a number of organizational factors. A network factor, in turn, is considered part of an environmental factor. Bode and Wagner (2015) defined supply chain disruption as the combination of an unintended and unexpected triggering event that occurred somewhere in the upstream supply chain (the supply network), the inbound logistics network, or the purchasing (sourcing) environment, and a consequential situation which presented a serious threat to the normal course of business operations of the focal company. They explained that supply chain disruption could stem from quality problems with suppliers, delivery outages, supplier defaults, labor strikes, or plant fires.

In general, internal disruption emanates from any disruptions and failures of resources (i.e., equipment, labor, technology, and system) to maintain a normal level of operation within a company (Kiser and Cantrell, 2006). Internal disruption tends to have an adverse impact on the firm's performances due to production/distribution stoppage in a form of labor strikes, machine downtime, and information system breakdown (Chopra and Sodhi, 2004). Supplier disruption is caused by disruptive production and service flows from suppliers. This risk includes: (1) business disruption caused by the supplier's inability to meet orders, (2) delivery delays from suppliers and their next-tier suppliers, (3) unexpected bankruptcy of core suppliers, (4) conflicts with suppliers due to confusion regarding inventory ownership and intellectual property, and (5) opportunistic behaviors of suppliers due to information asymmetry (Manju and Menzter, 2008b). In addition, the supplier's lax quality standards, material shortages, and spare parts restrictions represent supplier risk (Rao and Goldsby, 2009). Similarly, (Zsidisin and Wagner, 2010) posited that supply disruption could be caused by late deliveries and quality failures. Customer disruption would be caused by the unpredictability of customer demand or the instability of customer loyalty. It often results from demand forecasting error, changes in customer needs and preferences, seasonal fluctuations, and customer defection. External disruption arises from any disruptions and failures outside the supply chain such as natural disasters, political instability, terrorism, and global financial crisis (Tapiero and Grando, 2008).

As discussed above, much of the prior research on SCRM tended to focus on the identification of supply chain risks and assessment of their impacts on firm performance. However, research on the antecedents of supply chain security practices or studies considering the antecedent level of security compliance and safety stock which can capture the importance of SCRM has been rare up to this point. In particular, existing studies have mainly discussed about how perceived risk affected firm performance negatively and how the firm deployed risk mitigation actions. There have been only a handful of studies explaining what motivates firms to take an action to cope with supply chain disruption. To fill this research gap, we introduced risk taking propensity as a firm's motive to develop risk mitigation action plans. Also, motivated by SCRM research opportunities presented by Schoenherr et al. (2012), this paper investigated the inter-relationship between risk taking propensity and supply chain security practices. These supply chain security practices include the implementation of security compliance procedures, safety stock build-up, and the prevention of disruption occurrence (e.g., inaccurate demand forecasting, terrorist attacks, capacity instability, and poor delivery performance). With these in mind, this paper develops the following constructs for the model described in Table 1.

Table 1
Definition of constructs of risk taking propensity, supply chain security practices, and supply chain disruption occurrence.

Construct	Definition	Relevant References
Risk Taking Propensity	Company's willingness to make resource commitments to deal with risks	Ho (1996), Gilley et al. (2002), Cho and Lee (2006), Das and Joshi (2007) and Kocabasoglu et al. (2007)
Security Compliance	The application of policies, procedures, and technology to protect the destruction of supply chain assets from theft, damage, or terrorism	Bernasek (2002), Lee and Wolfe (2003), Closs and McGarrell (2004), Ritter et al. (2007), Williams et al. (2008), Whipple et al. (2009) and Williams et al. (2009)
Safety Stock	Extent to which a company is maintaining redundant stock to absorb or cushion the detrimental effect of supply chain disruptions.	Sheffi and Rice (2005), Tomlin (2006),Tang (2008), Zsidisin and Wagner (2010) and Bode et al. (2011)
Internal Disruption	Supply chain disruption occurrence related to any disruptions and failures of resources to maintain a normal level of operation within an individual company	Chopra and Sodhi (2004) and Kiser and Cantrell (2006)
Supplier Disruption	Supply chain disruption occurrence related to any disruptions and failures of product and/or service flow from suppliers	Choi and Krause (2006), Manuj and Menzter (2008b), Rao and Goldsby (2009), Wagner and Neshat (2010) and Zsidisin and Wagner (2010)
Customer Disruption	Supply chain disruption occurrence related to unpredictable or misunderstood customer demand	Chopra and Sodhi (2004), Trkman and McCormack (2009) and Wagner and Neshat (2010)
External Disruption	Supply chain disruption occurrence that arise from any disruptions and failures outside the supply chain	Manju and Menzter (2008b), Tapiero and Grando (2008), Rao and Goldsby (2009), Altay and Ramirez (2010) and Zsidisin and Wagner (2010)

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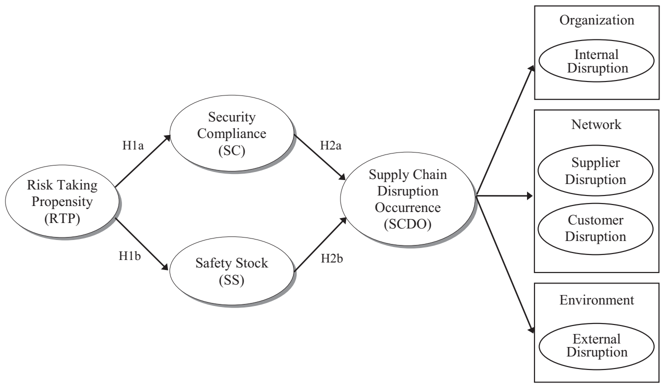

Fig. 1. Research model.

3. Theory and hypotheses development

3.1. Contingency theory

To examine how risk taking propensity motivates the firm to take supply chain security initiatives, we adopted contingency theory in the strategic literature. In general, contingency theory aims to investigate how environmental variables influence the behavior of organizations (Lawrence and Lorsch, 1967). Contingency theory suggests that optimal decisions and actions are dependent on internal and external factors. To elaborate, Burns and Stalker (1961) introduced the contingency approach by making a distinction between mechanistic and organic forms of management and organization. The mechanistic form is related to routine technology and stable environments, whereas the organic form is related to changing technology and turbulent and uncertain environments. Different types of technical systems and the size of firms explain many of organizational characteristics (Woodward, 1965; Pugh, 1968). For example, Thompson (1967) introduced the contingency theory indicating that uncertainty played a crucial role in shaping and determining organizational structure under the assumption that organizations acted rationally. Similar to Davis and Powell (1992), he surmised that organizations attempted to achieve rationality and the desired outcome given different levels of uncertainty in technologies and environments. Such rationality can be broken down into three levels: (1) technical level; (2) managerial level; and (3) institutional level. Technical rationality includes long-linked, mediated, and intensive technology to carry out procession tasks. Managerial rationality mediates technical rationality and environments. Institutional rationality pertains to environments outside the organization. He believed that an organization should take into account contingent factors to resolve the tension between uncertainty and organizational rationality, regardless of its size and environments in which it operated. To sum up, contingency theory posits that the more organizational structures and processes can adapt to uncertain environments, the more successful the firms will be (Miller, 1992).

In addition, Sousa and Voss (2008) observed that the contributions of contingency theory were achieved by (1) identifying important contingency variables that distinguish between contexts, (2) grouping different contexts based on these contingency variables, and (3) determining the most effective internal organization designs or responses in each major group. The internal and external contingency factors that helped establish these groupings have been identified in many contingency studies (Gupta, 1994; Homburg, 1999; Mintzberg, 1979; Sousa and Voss, 2008). These factors are organizational size, age, environment, and technology. Contingency studies also identified three different types of variables: (1) contextual variables, which represent situational characteristics exogenous to the focal firm and its managers; (2) response variables, which are the organizational or managerial actions taken in response to current or anticipated contingency factors; and (3) performance variables, which are dependent measures and represent specific aspects of effectiveness that are appropriate in evaluating the fit between the above two variables (Sousa and Voss, 2008). Gupta (1994) identified common dimensions among these variables, such as task difficulty, task variability, and task interdependence. Mintzberg (1979) identified stability, complexity, diversity, environment, and hostility as contingency variables and the design of the superstructure, positions, decision making, and lateral linkage as structural design parameters. Ho (1996) used the contingency theory to explain the relationship between environmental uncertainty and managerial choice, while assessing the impact of uncertainty and risk taking behavior on manufacturing strategy and firm performance. Later, Homburg (1999) found that market-related uncertainty, technological turbulence, and market growth could be external contingency factors.

In view of SCRM, Wagner and Bode (2009) applied contingency theory and strategic choice theory to develop a conceptual framework which explains the relationship between supply chain risk and firm performance. Trkman and McCormack (2009) examined how contingent factors affected supplier risk and supply chain disruption. From a theoretical lens of contingency theory, they believed that risk mitigation actions should be firm-specific based on supplier characteristics and environments. They also discovered that the fit between supplier portfolio and risk mitigation actions could dictate supply chain success. More recently, Grötsch et al. (2013) introduced the antecedents of proactive SCRM that included mechanistic control system, rational cognitive style, and relational buyer-supplier relationships from the contingency perspective.

Built upon the aforementioned prior studies, this paper applies contingency theory to examine how heavily the firm's risk mitigation actions are dependent on internal and external business environments and uncertainties. Drawing from contingency theory, Fig. 1 displays a conceptual framework and research model proposed by this study. This study identifies risk taking propensity as an antecedent that allows firms to initiate and implement supply chain security practices. Herein, supply chain disruption is classified into three different levels: (1) an organization level; (2) a network level; and (3) an environment level. At the organizational level, the firm encounters disruption that hampers its ongoing internal operations. At the network level, disruption originates from a network of suppliers and customers. Environmental-level disruption occurs outside a firm's supply chain network, which supply chain participants have no or little control over. In line with Christopher and Lee (2004), and Trkman and McCormack (2009), supply chain disruption occurrence is conceptualized as a second order construct which has three sub-dimensions of different types of disruption. Firm size using the number of employees is used as a control variable in the proposed model to see if larger firms are more likely to implement a higher level of supply chain security practices than its smaller counterparts.

3.2. Risk taking propensity and supply chain security practices

A firm's willingness to deal with risks impacts its strategic decision on SCRM (MacCrimmon and Wehrung, 1986). Firms that are exposed to constant uncertain situations tend to develop skills to make decisions under uncertainty (Makhija and Stewart, 2002). Organizational risk-taking propensity is characterized by a tendency to engage in risky behavior, a preference for taking bold actions when coping with risk, and a willingness to commit to resource investment (Miller and Friesen, 1983; Miller, 1983). Many researchers examined a relationship between risk taking

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propensity and decision making processes. For instance, Miller (1983) contended that the more risk firms took, the more likely they would engage in risky behavior and exhibited bold acts to accomplish their goals. If firms face a wide range of changing environments and requirements, they are more likely to regard changes as opportunities and deal with disruption by making resource commitment. Keil et al. (2000) found that there was a significant positive relationship between the firm's risk taking propensity and its decision-making behavior and subsequent business practices. In fact, Gilley et al. (2002) found that risk-seeking firms tended to exhibit behaviors that led to new product and service offerings, and frequently exploited innovative technology. As such, Tabak and Barr (1999) and Forlani et al. (2002) noted that risk taking propensity affected the firm's intention to adopt technological innovation. They also indicated that the firm's willingness to deal with risks would lead to its greater resource commitments to risk-mitigating practices including its compliance with supply chain security initiatives.

Likewise, Gilley et al. (2002) discovered that the more risk-averse a management team was, the less likely it was to commit resources to new products and technologies. According to them, risk-taking firms tended to exhibit behaviors that launched new products, provided new services, and used innovative technology. By connecting risk perception to risk taking propensity, Petrakis (2005) illustrated that entrepreneurs' risk taking propensity played a key role in transforming environmental impacts and business cycles. He found that risk taking propensity affected venture investments and firm performance. To reduce uncertainty and deal with risk, firms frequently collected information about the external environment in dynamic business climates, while establishing trust and collaboration with dependable partners as a way to facilitate information sharing (Daft and Lengel, 1986; Das and Joshi, 2007; Kocabasoglu et al., 2007). In light of the above discussions, it is hypothesized that the higher the level of risk taking propensity a firm exhibits, the higher the level of supply chain security and safety stock control actions it will take.

H1a. : The higher the level of risk taking propensity a firm exhibits, the higher the level of security compliance it will follow.

H1b. : The higher the level of risk taking propensity a firm exhibits, the higher the level of safety stock it will build.

3.3. Supply chain security practices and supply chain disruption occurrence

Sheu et al. (2006) found that Customer-Trade Partnership against Terrorism (C-TPAT) certification impacted international supply chain collaboration. Firms that implement C-TPAT are expected to benefit from lower costs, secure customs inspections, and customer satisfaction. Thibault (2006) suggested that security initiatives fostered cooperative relationships between the industry and the government. Sarathy (2006) observed that supply chain security efforts tended to raise visibility, reduce total cost, and enhance shipment tracking. Peleg-Gillai et al. (2006) found that security efforts led to improved relationships and profitability. Rice and Spayd (2005) showed that efforts to maintain and increase security led to collateral benefits, such as reduced theft, infrequent shipping delays, reduced equipment damage, and lower inspection costs. Rice and Caniato (2003) discovered that security-related activities led to a greater supply chain security and resilience. Hendricks et al. (2009) noticed that the more operational slack that existed in the supply chain, the less likely a negative stock market reaction would occur. By the same token, many researchers pointed out that safety stock and excessive capacity could mitigate the adverse impact of supply chain disruption (Tomlin, 2006; Tang, 2006a; Zsidisin and Wagner, 2010). Especially, Zsidisin and Wagner (2010) found that if a firm perceived a high level of supply market risks, extensive redundant practices would make disruptions occur less frequently. Similar to the findings of the aforementioned studies, Voss and Williams (2013) discovered that firms which were compliant with security initiatives such as C-TPAT tended to outperform firms which were not in terms of their supply chain resilience and firm performance. Based on these earlier study results, we hypothesize that the higher level of supply chain security practices a firm implement, the less frequently supply chain disruption occurs.

H2a. The higher the level of security compliance a firm follows, the less frequently supply chain disruptions occur.

H2b. The higher the level of safety stock a firm keeps, the less frequently supply chain disruptions occur.

4. Research methodology

4.1. Measures

To test the aforementioned hypotheses, we conducted an online questionnaire survey for multinational Korean firms. Through a broad literature review, the measurement items of five constructs for risk taking propensity and supply chain disruption as well as items for security compliance and safety stock are adopted and modified from the prior studies summarized in Table 1. The item generation and the selection of respondents and their respective industries were made by a series of structured interviews and a pilot test to suit the needs and purposes of this study. After the initial items were generated, the questionnaire was sent to content experts, including six professors and four supply chain professionals to assess whether each item measures the domain of the corresponding construct and to check the clarity and consistency of each item in terms of wording, length, and concept. These professors and practitioners were asked to review the questionnaire and then pinpoint any items they believed needed to be changed. After receiving their feedback and comments, the items were modified accordingly and included in the pilot study. Four professionals who were not involved in the previous test were chosen and asked to participate in the pilot test using the Q-sort method. Two rounds of the pilot test were conducted, and each round was completed by two professionals. After the test, the measurement items were refined and finalized to be included in the large-scale survey.

4.2. Data collection

Before collecting large-scale data, respondents were chosen among supply chain managers, plant managers, manufacturing managers, purchasing managers, vice presidents, and presidents/CEOs of companies from the industries within six Standard Industrial Classification (SIC) codes: 28 (Chemicals and Allied Products), 33 (Primary Metal Products), 34 (Fabricated Metal Products), 35 (Industrial and Commercial Machinery and Computer Equipment), 36 (Electronic, Electric Equipment and Components), and 37 (Transportation Equipment). As an initial target sample, we selected the top 500 firms from the Korea Composite Stock Price Index (KOSPI). Data collection lasted four months (during the period of mid-January and mid-May of 2011). After making phone calls to see if they were willing to participate in this survey, a link to the online survey questionnaires was sent to those willing participants. Reminder e-mails were sent to those who did not complete the survey questionnaire within two weeks after initial

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Table 2
Sample profiles.

Variables (*n*=156)	Frequency	In percentage
Industry (SIC)		
Primary Metal Products/Fabricated Metal Products (33/34)	8	5.1%
Industrial and Commercial Machinery/ Computer Equipment (35)	16	10.3
Electronic, Electric Equipment and Components (36)	46	29.5
Transportation Equipment (37)	42	26.9
Chemicals and Allied Products (28)	6	3.8
Others (Automotive)	35	22.4
Unidentified	3	1.9
Number of employees		
1–100	26	16.7%
100–249	28	17.9
250–499	22	14.1
500–999	33	21.2
1000 and over	39	25.0
Unidentified	8	5.1
Sales volume		
Less than 10	2	1.0%
10–49.9	16	8.1
50–99.9	46	23.2
100–499.9 millions	39	19.7
Unidentified	53	26.8
Job title		
CEO/Present	2	1.0%
Vice President	1	0.5
Director	80	60.4
Manager	66	33.3
Others	6	3.0
Years of job experiences		
Under 2 years	25	16.0%
2–5	47	30.1
5–10	62	39.7
11–20	14	9.0
Over 20 years	0	0.0
Unidentified	8	5.1

e-mailing. Follow-up phone calls were made as another reminder. A total of 174 respondents from the Korean firms completed the survey. Out of 174 responses, 18 responses were eliminated from the analysis due to incomplete or missing values, which resulted in a response rate of 34.8%.

Table 2 shows the sample characteristics of these respondents with their respective profiles. These profiles show that the sample data is well dispersed and that coverage is good for each category. A majority of respondents were comprised of directors and middle managers, who tended to be more willing to complete the questionnaire than high-level executives. Armstrong and Overton (1977) suggested that the late return of surveys from slow respondents represented the opinions of non-respondents, also referred to as non-response bias. Non-response bias reduces the validity of a measurement. To avoid non-response bias, we checked any statistically significant differences between early and late responses (Krause, 1999; Prahinski and Benton, 2004). After dividing 156 survey responses into two groups (106 for the early response and 50 for the delayed response), half of the total items were randomly selected and a *t*-test between the two groups was conducted. The results indicate that there is no statistically significant difference between these two groups. Harman's single factor test in SPSS and common latent factor test in AMOS were undertaken to assess the common method bias. First, when the number of factors is fixed to 1, the common variance explained by a single factor is 19.5% (Harman, 1976). Next, a common latent factor was loaded to every item in the original measurement model to check the common method bias. The common variance explained by the latent factor is 16.8%. The model fit indices between the original model (χ^2/df=1.432, CFI=0.945, IFI=0.946 and RMSEA=0.053) and the measurement model with the latent factor (χ^2/df=1.382, CFI=0.952, IFI=0.953 and RMSEA=0.05) are similar (Podsakoff et al., 2003). These results verified that non-response and common method bias are not a concern.

5. Structural modeling results

This study performs two-step statistical analyses: (1) measurement model development with the assessment of reliability and validity; (2) path coefficient analysis with structural modeling (Anderson and Gerbing, 1988).

5.1. Measurement and SEM

The results of the measurement model and the Structural Equation Model (SEM), which include seven constructs with 24 items, are shown in Appendix I. SEM results were tested to assess the measurement reliability and validity. Multiple fit indices (χ^2, CFI, IFI, and RMSEA) are reported to assess the model fit. Both Appendix I and II show mean, standard deviation, cross-loadings, average variance extracted (AVE), Cronbach's alpha, and composite reliability for all constructs and items. Alpha and composite reliability values for all seven constructs are greater than 0.7, a minimum threshold except for RTP (0.681). Alpha value of 0.681 is considered acceptable in using an international data set (Bagozzi, 1998; Cagliano et al., 2006). All the AVE values are greater than 0.5 with the exception of RTP (0.427) and ID (0.480). However, the convergent validity of RTP and ID is still verified because their composite reliability values are 0.688 and 0.727 each, greater than 0.6 (Fornell and Larcker, 1981). The results indicate that the instrument items are reliable measures. Standardized factor loadings for seven constructs are statistically significant at α=0.01 and their factor loadings on the respective constructs indicate evidence of convergent validity.

Table 3 shows inter-construct correlations and discriminant validity. The square root of average variances extracted (AVEs) is on the diagonal in brackets. The square root of AVEs of each construct is greater than the correlations of the construct with all other constructs (Fornell and Larcker, 1981). The results show that the discriminant validity for seven constructs is assessed, which means each construct is measuring a distinct concept among each other. Fig. 2 illustrates the standardized structural coefficients

Table 3
Inter-construct correlation and discriminant validity (*n*=156).

	RTP	SC	SS	ID	SD	CD	ED
RTP	**[0.688]**[a]						
SC	0.25	**[0.817]**					
SS	0.227	0.047	**[0.9]**				
ID	0.126	−0.158	0.094	**[0.727]**			
SD	0.015	−0.055	−0.209	0.363	**[0.810]**		
CD	−0.039	−0.237	−0.012	0.492	0.617	**[0.780]**	
ED	0.076	0.117	0.219	0.226	0.295	0.468	**[0.771]**

Note: RTP (Risk Taking Propensity), SC (Security Compliance), Safety Stock (SS), ID (Internal Disruption), SD (Supplier Disruption), CD (Customer Disruption), ED (External Disruption).
All correlation coefficients are significant at $p<0.01$.

[a] Square root of average variances extracted (AVEs) are on the diagonal in brackets.

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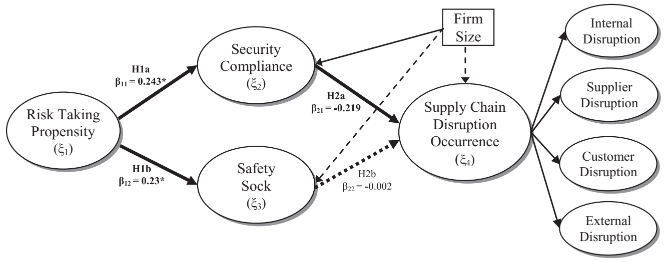

Fig. 2. Structural model results.

(1) between RTP as an independent variable and SC and SS as dependent variables; (2) between SC and SS and SCDO. As shown in Fig. 2, fit indices for validating the structural model reflect an acceptable model fit: χ^2/df=1.508, CFI=0.914, IFI=0.917 and RMSEA=0.057. CFI and IFI are higher than the recommended minimum value of 0.8; RMSEA is lower than the recommended minimum value of 0.08 for a fairly good model fit (Hu and Bentler, 1998; Modi and Mabert, 2007).

5.2. Path analysis and hypotheses testing results

Table 4 shows that three (H1a, H1b, and H2a) out of four hypotheses are supported and one hypothesis (H2b) is not supported. For H1a and H1b, standardized coefficients are statistically significant at α=0.05: H1a (β_{11}=0.243, $p<0.05$) and H1b (β_{12}=0.23, $p<0.05$). The path coefficient from security compliance to supply chain disruption occurrence is statistically significant ($\beta_{21}=-0.219$, $p<0.05$), whereas the relationship between safety stock and supply chain disruption occurrence is not supported ($\beta_{22}=-0.002$, $p>0.1$).

The acceptance of H1 indicates that risk taking propensity has a positive impact on both the levels of security compliance and safety stock. That is to say, with a high level of willingness to take risk a firm tends to develop action plans to cope with supply chain risk and better prepare for managing this risk. If the firm is more willing to take risk, it tends to take supply chin security practices more seriously and thus is highly likely to follow government or industry security guidelines and keep safety stock to cushion the negative effect of supply chain disruption. This result is congruent with the finding of other studies indicating that the more willing a firm is to take risk, the more likely they are to make resource commitment to deal with it (Petrakis, 2005; Das and Joshi, 2007; Kocabasoglu et al., 2007). The path coefficients from risk taking propensity to security compliance and safety stock are 0.243 and 0.23 each. The degree of impact of risk taking propensity on both supply chain security practices are about the same, which means each action carries a similar weight. In addition, H2a is supported. The result indicates that there is a negative direct effect of security compliance on supply chain disruption occurrence. Greater security compliance is expected to reduce the frequency of supply chain disruption occurrence including risk regarding regulatory barriers for supply chain operations (e.g., containerized cargo inspections) and legislation impacting supply chain operations (e.g., transportation safety regulations). It is interesting to note that although H2b is not statistically significant, its coefficient is still negative, which means the higher level of safety stock a firm maintains, the less frequently supply chain disruption occurs. That is to say, maintaining redundant stock makes the firm absorb or cushion the detrimental effect of supply chain disruptions. Firm size (number of employees) was included in the SEM as a control variable. The result shows that firm size affects SC positively at the significance level of 5%. In other words, larger firms are more likely to comply with security rules and international safety standards and then respond to them more sensitively due in part to their greater affordability for needed resource commitments to compliance and safety stocks.

6. Key study findings

This section summarizes important implications of the study findings so that this study can help firms coping with supply chain risks develop effective action plans for mitigating such risks. Several noteworthy implications are discussed below.

6.1. Managerial implications

First, given a variety of potential SC risks, the firm's reactions will vary depending on their tendencies to manage risk-related crisis. Within the framework of contingency theory, we attempted to identify key driving forces that may enable the firm to adopt and implement supply chain security practices. In our paper, risk taking propensity plays an important role in forming the firm's response and adaptation process to supply chain risks (Ho, 1996; Kocabasoglu et al., 2007). Ho (1996) argued that when confronted with uncertainty, a firm tended to prioritize risk taking propensity as a risk managerial choice over other strategic alternatives and make a substantial investment in establishing manufacturing flexibility to exploit risk. Our result indicates that the firm's ability to adopt and implement SCRM practices that reduce the detrimental effects of harmful events may depend on the extent to which the firm is willing to take on and deal with those events. Such extent depends on a firm's risk attitude, industrial requirement, and resource availability and commitment. In particular, we found that a firm which was willing to take risks tended to exploit those risks and thus tended to commit more resources and exert greater efforts in engaging supply chain security practices.

Second, we learned from the test result that the more a firm adopted and implemented security compliance measures, the less frequently supply chain disruption occurrence took place. In other words, supply chain security initiatives such as Customer-Trade Partnership against Terrorism (C-TPAT), Container Security Initiative (CSI), and Fast and Security Trade (FAST) can prevent or lower a likelihood that supply chain disruption occurs. It is consistent with the finding of Whipple et al. (2009) indicating that although the pay-off of security initiatives was not immediate, a

Table 4
Path analysis and hypotheses testing results.

Hypotheses	Relationship	Path coefficient	Critical ratio	Significance
H1a	**Risk Taking Propensity→Security Compliance**	**0.243**	**2.323**	$\boldsymbol{p<0.05}$
H1b	**Risk Taking Propensity→Safety Stock**	**0.23**	**2.255**	$\boldsymbol{p<0.05}$
H2a	**Security Compliance→Supply Chain Disruption Occurrence**	**−0.219**	**−2.027**	$\boldsymbol{p<0.05}$
H2b	Safety Stock→Supply Chain Disruption Occurrence	−0.002	−0.018	$p>0.1$
Control variable	**Firm Size→Security Compliance**	**0.221**	**2.584**	$\boldsymbol{p<0.01}$
	Firm Size→Safety Stock	−0.003	−0.034	$p>0.1$
	Firm Size→Supply Chain Disruption Occurrence	0.034	0.392	$p>0.1$

higher level of security practices led to improved firm performance such as increased product quality, higher customer satisfaction, greater resilience, and reduced incidents. Similarly, Quinn (2011) found security initiatives including C-TPAT played a safeguard role in protecting the firm from unexpected dangers and risks, while improving the firm's logistical and financial performance. As such, the firm's conscious effort to comply with supply chain security initiatives will actually increase its payoff despite the need for a greater resource and time commitments to security compliance. In particular, given that small firms are less likely to commit themselves to security compliance due to their limited resources, their large-sized supply chain partners should help and encourage those small firms to make a greater investment in security measures through financial aids and resource sharing. The rationale being that if the small firm becomes the source of the weakest link in the supply chain, other supply chain partners including the large firm will eventually suffer from the disruption caused by the small firm's unpreparedness for supply chain disruption. From a policy standpoint, the government should also consider offering incentives (e.g., preferred contractor status, tax incentives) to the firm with a good security compliance record to encourage the firm to comply with security initiatives.

Third, though statistically insignificant, safety stock has a negative impact on firm's supply chain disruption occurrence. This result is somewhat consistent with the finding of Zsidisin and Wagner (2010) indicating that redundancy partially supports the mitigation of extended supply chain risk. On the other hand, they pointed out that keeping a higher level of safety stock could hide potential sourcing problems with suppliers. In other words, keeping safety stock in the form of extra raw materials, parts, and finished goods may not necessarily eliminate or prevent supply chain disruption occurrence completely but can lower its frequency. From a practical standpoint, this study result indicates that the safety stock is justified as an extra buffer for potential supply chain disruptions, but the safety stock alone cannot reduce the supply chain disruption occurrence. As a better alternative, we proposed the combined use of safety stocks and other contingency plans such as multi-skilled worker training, hedging, and multiple sourcing. For example, recognizing the vulnerability of just-in-time (JIT) systems to unexpected production disruptions, Toyota once placed cross-trained employees who could handle multiple tasks at any work station on its assembly lines. By doing so, Toyota rarely missed its daily production goals even when minor disruptions (e.g., employee absenteeism) occurred on their assembly lines (Mishina, 1993; Chopra and Sodhi, 2004). Higher level of supplier disruption may lead a firm to switch to alternative sources of supply in the case that a firm's supplier is unreliable with respect to its quality assurance, delivery performance, and production capacity.

6.2. Theoretical contributions

First, drawing upon contingency theory, this paper investigated how risk taking propensity served as a motivation for the firm's decision to mitigate and lessen the detrimental effect of supply chain disruptions. Based on the empirical study, this paper confirmed contingency theory in that risk taking propensity indeed shaped risk-mitigating decisions and subsequently reduced the frequency of supply chain disruptions.

Second, in managing supply chain risks, there exist two different strategies: (1) *reactive strategy* which aims to take actions (e.g., damage control, disaster relief, inventory replenishment with safety stock, expedited shipment) after risk (i.e., supply chain disruption) has happened; (2) *proactive strategy* which is intended to prevent or prepare for potential risk before it occurs (e.g., Kleindorfer et al., 2003). Unlike the other existing SCRM literature which focused on either reactive or proactive SCRM strategies (e.g., Sheffi and Rice, 2005; Mitroff and Alpaslan, 2003; Tang, 2006b; Tang and Tomlin, 2008; Knemeyer et al., 2009), this paper attempted to examine the key success factors of SCRM practices from both reactive (e.g., safety stock) and proactive (e.g., security compliance) angles.

Also, although some of the existing SCRM literature (e.g., Svensson, 2000; Svensson, 2004; Zsidisin et al., 2004) attempted to identify and/or analyze the relationship between supply chain vulnerability (e.g., supply chain disruption) and supply chain risk drivers (e.g., customer dependence, supplier dependence, single sourcing), most neglected the analysis of relationship between risk taking propensity and supply chain vulnerability (e.g., supply chain disruption occurrence) using the empirical study. In particular, since risk taking propensity reflects the organizational culture, this study attempted to theorize that social factors such as organizational culture could determine how the organization employs its supply chain security practices and how significantly such practices influence its risk vulnerability using the contingency theory.

7. Concluding remarks

We conducted large-scale empirical studies that examined the inter-relationship of risk taking propensity, supply chain security practices, and supply chain disruption occurrence. Especially, it attempted to identify the antecedent that can motivate a firm to follow supply chain security initiatives, while investigating how the firm's risk management behavior influences risk management practices and its outcome from a holistic viewpoint. Also, it is noted that this study theorized the causal relationships among the firm's risk taking propensity, supply chain security practices, and frequency of supply chain disruption occurrence based on the development of reliable and valid measurement scales through a questionnaire survey. This is in contrast to a majority of the prior literature on SCRM that relied on conceptual frameworks, anecdotal evidences, case studies, and secondary data analysis. Thus, this study expands knowledge bases on SCRM given the paucity of empirical studies dealing with SCRM (Wagner and Bode, 2009).

7.1. Research limitations

Despite the aforementioned merits, this study is far from being perfect. For instance, since approximately half of the survey respondents represent the practices of small and medium-sized firms with fewer than 500 employees, the survey results could be biased toward those firms' practices (e.g., lack of security certifications, low priority of security compliance relative to large firms' risk-mitigating actions). Also, these respondents were asked to respond to the survey items on supply chain disruption that occurred during two years prior to the survey date. For that short span, some of the respondents might have never experienced any significant supply chain disruptions such as natural disasters and thus their responses could be misrepresented in the survey. Another limitation of the current study is the reliance on the opinion/feedback of a single respondent of each firm. As such, our survey did not examine whether or not risk taking propensity and risk-mitigating actions were influenced by the respondent's managerial role (e.g., principal purchasing agent, production manager, logistics manager).

Given the data at hand, we were only able to conduct wave analysis to test for unit non-response and acknowledge that more elaborate tests are recommended for survey-based research (Wagner and Kemmerling, 2014). Also, our data sample is limited to the Korean firms which represent Korean business practices. For example, the Korean firm's security compliance practices can be different from other country settings, since they can be affected by its government strict security guidelines and rules such as the X-ray inspection of most of incoming and outgoing container cargoes at the port. Likewise, the Korean firm's safety stock policy can be influenced by the growing popularity of JIT inventory practices among the Korean manufacturing firms.

7.2. Future research directions

The current study can be extended to include longitudinal data to confirm and re-examine the same research model. The longitudinal study would allow us to trace changes in inter-relationships among the risk-related variables over time. In addition, the proposed SEM can be tested in different business contexts using different contextual variables (e.g., different country, industry characteristics, and market and product characteristics). Going further, future research may explore the causal relationship between lean principles and supply chain security practices by testing the premise that the leaner the supply chain network, the more likely it is to become vulnerable to supply chain disruptions. Such relationship should be tested empirically, while analyzing the tradeoff between security compliance (or risk-mitigating actions) and supply chain disruption from a cost perspective. Lastly, other lines of future research which may be worth exploring include:

- Examination of the causal relationship between the firm's communication structure or information technology infrastructure and supply chain vulnerability;
- Assessment of the influence of organizational dependence, interaction, funding flows, and collaborative information sharing on supply chain vulnerability;
- Empirical investigation of cross-national differences in security compliance practices between two or more countries and their impact on supply chain vulnerability.

Appendix

See Table A and B

Appendix A
The questionnaire summary and construct validity

Label	Items	Mean	S.D.	Standardized loading	AVE	Alpha	Composite Reliability
Please indicate the extent to which following statement describes your company (1=not at all; 2=to little extent; 3=moderate extent; 4=great extent; 5=very great extent).							
	Risk Taking Propensity (RTP)						
	Our company:						
RTP1	provides rewards for innovative suggestions (e.g., bonuses, time off)	**3.226**	**1.118**	0.68	**0.427**	**0.681**	**0.688**
RTP2	has a tendency to take the first mover's advantage by leading the competition			0.724			
RTP3	makes quick decisions if we believe high-risk projects will provide a new competitive advantage			0.543			
	Security Compliance (SC)						
	Our company:						
SC1	has a function that specializes in supply chain security and compliance	**3.045**	**1.200**	0.735	**0.598**	**0.854**	**0.817**
SC2	follows government or industry initiated security guidelines (e.g., C-PAT, CSI, FAST, and AMR)			0.76			
SC3	verifies that supply chain partners follow government or industry security guidelines (e.g., C-PAT, CSI, FAST, AMR, etc)			0.823			
SC4	has defined consequences for supply chain partners who fail to comply with supply chain security procedures			0.772			
	Safety Stock (SS)						
	Our company:						
SS1	maintains safety stock in case of supply chain disruptions	**3.394**	**1.035**	0.903	**0.731**	**0.794**	**0.900**
SS2	keeps extra inventory of strategic items (e.g., raw materials, parts, and finished goods)			0.861			
SS3	uses safety stock to have time to prepare response and recovery in case of disruption			0.832			
SS4	maintains safety stock to reduce the likelihood of supply chain disruptions (e.g., supplier failure, machine breakdown)			0.822			
Please indicate the extent to which your company has experienced these problems in your supply chain for the last two years (1=not yet; 2=annually; 3=quarterly; 4=monthly; 5=weekly).							
	Internal Disruption (ID)						
	Our business is adversely affected by our internal:						
ID1	machine breakdowns	**2.38**	**1.219**	0.809	**0.480**	**706**	**0.727**
ID2	utility outages			0.48			
ID3	equipment operating out of specifications			0.746			
	Supplier Disruption (SD)						
	Our business is adversely affected by our suppliers':						
SD1	abrupt capacity fluctuations	**2.368**	**1.055**	0.586	**0.594**	**0.795**	**0.810**
SD2	inconsistent product quality			0.856			
SD3	poor delivery performance (e.g., inconsistent delivery)			0.84			
	Customer Disruption (CD)						
	Our business is adversely affected by our customers':						
CD1	inaccurate information about order quantities	**2.224**	**1.070**	0.805	**0.501**	**0.797**	**0.780**
CD2	sudden demand increases which often go beyond our capacity			0.737			
CD3	unpredictable requirements for product features			0.663			
CD4	orders for different product combinations			0.612			
	External Disruption (ED)						
	Our business is adversely affected by problems outside our company that resulted from:						
ED1	macroeconomic uncertainties (e.g., currency fluctuation, inflation)	**1.735**	**0.788**	0.571	**0.535**	**0.737**	**0.771**
ED2	regulatory barriers for supply chain operations (e.g., customs, tariffs)			0.86			
ED3	legislation or international standards changes for supply chain operations (e.g., ISO9000, transportation laws)			0.735			

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Appendix B

Factor and cross loadings for risk taking propensity, supply chain security practices, and supply chain disruption occurrence

	RTP	SC	SS	ID	SD	CD	ED
RTP1	**0.747**	0.135	.186	0.009	−0.066	0.028	0.117
RTP2	**0.823**	0.042	0.091	0.047	0.095	−0.068	−0.047
RTP3	**0.733**	0.098	−0.059	0.042	−0.007	0.012	0.003
SC1	0.168	**0.806**	−0.037	−0.102	0.006	0.025	0.008
SC2	0.209	**0.795**	0.047	−0.031	0.040	−0.085	−0.009
SC3	−0.044	**0.870**	0.013	0.059	−0.036	−0.059	0.081
SC4	0.004	**0.827**	0.043	−0.074	−0.031	−0.131	0.024
SS1	0.092	0.022	**0.907**	0.035	−0.063	0.031	0.043
SS2	0.067	−0.031	**0.897**	−0.027	−0.059	0.024	0.033
SS3	0.044	0.028	**0.866**	0.046	−0.073	−0.023	0.100
SS4	0.019	0.049	**0.854**	0.076	−0.106	−0.074	0.138
ID1	0.065	−0.074	0.034	**0.833**	−0.035	0.291	0.052
ID2	−0.006	−0.018	0.045	**0.765**	0.205	−0.159	0.147
ID3	0.082	−0.087	0.066	**0.656**	0.219	0.368	−0.049
SD1	0.030	0.138	−0.214	0.216	**0.567**	0.233	0.232
SD2	−0.020	−0.047	−0.107	0.070	**0.871**	0.168	0.132
SD3	0.037	−0.024	−0.079	0.114	**0.852**	0.232	−0.001
CD1	−0.039	−0.213	0.071	0.107	0.381	**0.640**	0.165
CD2	−0.007	−0.083	0.037	0.167	0.302	**0.693**	0.107
CD3	−0.021	−0.059	−0.141	−0.018	0.320	**0.721**	0.090
CD4	0.004	−0.015	−0.005	0.145	−0.098	**0.778**	0.314
ED1	0.103	−0.004	0.178	0.103	0.054	0.084	**0.709**
ED2	0.027	0.132	0.160	0.015	0.093	0.245	**0.783**
ED3	−0.063	−0.010	−0.023	0.027	0.133	0.160	**0.848**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

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