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Doing Good across Organizational Boundaries: Sustainable Supply Chain Practices and Firms' Financial Risk

Abstract

Purpose – The purpose of this research is to theoretically hypothesize and empirically test the impact of sustainable supply chain practices (SSCPs) on firms' financial risk.

Design/methodology/approach – This research adopts signalling theory to explain the signalling role of SSCPs and the moderating role of the signalling environment in terms of supply chain characteristics. It collects and combines longitudinal secondary data from multiple sources to test the direct impact of SSCPs on firms' financial risk and the moderating role of supply chain complexity and efficiency. It conducts various additional tests to check the robustness of the findings and to account for alternative explanations.

Findings – This research shows that SSCPs help firms reduce financial risk but do not affect their returns. Moreover, the risk reduction of SSCPs is greater for firms with more complex and efficient supply chains. The findings are robust to alternative variable measurements and analysing strategies.

Research limitations/implications – This research reveals the role of SSCPs in reducing financial risk, urging researchers to pay more attention to the financial risk implications of supply chain practices in general and SSCPs in particular.

Practical implications – This research encourages firms to engage in SSCPs to reduce financial risk and enables them to assess the urgency of their SSCPs investments in view of the complexity and efficiency of their supply chains.

Originality/value – This is the first research examining the impact of SSCPs on financial risk, based on longitudinal secondary data and signalling theory. The empirical evidence documented and the theoretical perspective adopted offer important implications for future practice and research on SSCPs.

Keywords Sustainable supply chain practices, Financial risk, Signalling theory, Secondary data

Paper type Research paper

1. Introduction

Recent irresponsible events occurring in firms' supply chains have captured considerable public attention and affected the focal firms. For instance, Apple Inc. was blamed for poor working conditions and worker suicides at the manufacturing plants of Foxconn, one of Apple's major suppliers in China (Bloomberg News, 2010); a fire caused by serious safety issues at a Bangladeshi factory that supplied goods to Walmart stores killed at least 112 workers, which was "extremely troubling" to the retailer (Walmart, 2012); some textile manufacturers listed as Levi's suppliers were found to discharge hazardous chemicals into Mexican rivers, resulting in protests outside Levi's shop fronts in 80 cities around the world (Brown, 2012). Realizing the seriousness of such problems, some firms have begun to manage their supply chains in a more responsible way. For example, Apple investigated the working conditions at Foxconn's manufacturing plants after a series of worker suicides (Hille and Kwong, 2010); Walmart implemented new initiatives after the Bangladeshi factory fire, including enforcing stricter safety requirements, designing comprehensive inspection programs, and establishing a safety training academy, to improve the fire safety of its Bangladeshi suppliers' facilities (Walmart, 2013); Levi's required its major suppliers in Mexico and elsewhere to disclose pollution data after the Mexican water-pollution event, and committed to zero discharge of hazardous chemicals in its entire supply chain by 2020 (Levi Strauss & Co., 2012). These responsible practices adopted by firms to address the social and environmental issues along their supply chains are commonly known as sustainable supply chain practices (SSCPs) (Mariadoss *et al.*, 2016; Roehrich *et al.*, 2014; Wilhelm *et al.*, 2016).

This raises the question: does adopting SSCPs help a focal firm to reduce financial risk as assessed by markets? Some practitioners give a positive answer to this question (Antink *et al.*, 2014; Eurosif, 2012). For instance, Eurosif, an association for promoting sustainable investments across Europe, argues that "the social and environmental challenges of globalized supply chains are closely linked to financial risks for the companies involved" (Eurosif, 2012, p. 3) and urges investors to assess the companies on their capabilities to reduce such risks by implementing sustainable supply

chain standards and practices. On the other hand, the research community remains silent on this question. Little empirical evidence has been documented in the academic literature about whether SSCPs are related to firms' financial risk. Our research attempts to answer this important question.

However, even though SSCPs might help reduce financial risk as some practitioners have suggested (Antink *et al.*, 2014; Eurosif, 2012), the risk reduction due to SSCPs could be different for firms with different supply chains. For instance, firms with complex supply chains across different countries and industries might face higher uncertainty and thus rely more on SSCPs to reduce financial risk (Awaysheh and Klassen, 2010). On the other hand, firms with efficient supply chains that are highly utilized might be more vulnerable to supply chain disruptions (Hendricks *et al.*, 2009), making SSCPs more valuable to them. As a result, in addition to the direct impact of SSCPs on financial risk, we will further investigate the moderating role of supply chain characteristics such as supply chain complexity and efficiency. Taken together, our research will answer the following research questions:

RQ1. How do SSCPs impact firms' financial risk?

RQ2. How do supply chain characteristics such as supply chain complexity and efficiency moderate the SSCPs-financial risk relationship?

Viewing the SSCPs-financial risk relationship from a signalling perspective, we theorize that firms' SSCPs signal a lower likelihood of irresponsible events in their supply chains and a lower impact of such events, if any, on the focal firms, reducing investors' uncertainty about the firms' future cash flows and resulting in lower financial risk. Following the signalling logic, we further argue that the effectiveness of the SSCPs signals in reducing financial risk depends on the signalling environment such as the characteristics of firms' supply chains. In particular, we hypothesize that the SSCPs signals should be more effective in uncertain and vulnerable signalling environments such as complex and efficient supply chains.

We collect and combine longitudinal secondary data from multiple sources to test our hypotheses. Consistent with our arguments, we find that SSCPs reduce firms' financial risk but do not affect their returns. Moreover, the risk reduction due to SSCPs is greater for firms with more complex

and efficient supply chains. Our findings are robust to alternative variable measurements and analysing strategies.

Our research is important in several ways. First, although researchers have paid much attention to SSCPs in recent years (Mariadoss *et al.*, 2016; Roehrich *et al.*, 2014; Wilhelm *et al.*, 2016), little is known about the relationship between SSCPs and firms' financial risk. Our research represents one of the earliest studies examining the impact of SSCPs on firms' financial risk. By revealing the role of SSCPs in reducing financial risk, our research might inspire researchers to explore the financial risk implications of supply chain practices in general and SSCPs in particular.

Moreover, we adopt signalling theory in this research. Our signalling perspective considers not only the signalling role of SSCPs but also the moderating role of the signalling environment in terms of supply chain complexity and efficiency. As "the signaling environment on the whole is an underresearched aspect of signaling theory" (Connelly et al., 2011, p. 62), our research contributes to the signalling literature by highlighting the importance of the signalling environment in moderating the effectiveness of the signals concerned. This signalling perspective can also serve as a useful theoretical foundation for future research on SSCPs.

Finally, our research advances the understanding of the SSCPs-financial risk relationship as we investigate not only the direct impact of SSCPs on financial risk but also the moderating role of supply chain complexity and efficiency. The findings of our research thus not only encourage firms to engage in SSCPs to reduce financial risk but also enable them to assess the urgency of their SSCPs investments in view of the complexity and efficiency of their supply chains.

2. Literature review and hypothesis development

2.1. Sustainable supply chain practices (SSCPs)

"Sustainability" has become an important research topic in supply chain management (SCM). Early research on sustainable SCM has focused on the green or environmental aspect of SCM (Linton et al., 2007; Seuring and Müller, 2008). For instance, Wu and Pagell (2011) investigate how firms make supply chain decisions to balance short-term profitability with long-term environmental goals, but

"the social dimension and the social impact of environmental management were not the focus" (p. 589) of their research. A review conducted by Seuring and Müller (2008) published 10 years ago also suggests that the literature on sustainable SCM is "dominated by green/environmental issues" (p. 1699).

Nevertheless, recent research has expanded the scope of sustainable SCM to include the social dimension of SCM (e.g., Mariadoss *et al.*, 2016; Roehrich *et al.*, 2014; Wilhelm *et al.*, 2016). Consistent with those recent studies, we view SSCPs as the integration of both social and environmental dimensions into SCM. Specifically, we define SSCPs as the responsible practices or strategies adopted by firms to manage social issues, such as human rights, working conditions, child labour, discrimination, and health and safety, as well as environmental concerns, such as pollution, recycling, waste reduction, greenhouse gas emissions, and energy consumption, along their supply chains. SSCPs can be implemented at different levels and vary across firms. For example, while some firms implement SSCPs at the executive level by appointing board members to oversee the social and environmental issues in their supply chains, other firms implement SSCPs at the policy level by designing supplier codes to require their suppliers to comply with social and environmental standards (VBDO, 2012). Moreover, we should emphasize that SSCPs concern how firms manage their supply chains in a sustainable way rather than simply how their supply chain partners, such as suppliers and distributors, behave responsibly (Roehrich *et al.*, 2014). Such a distinction is important because the former concerns sustainability across organizational boundaries, while the latter focuses only on the social and environmental performance of individual firms.

Prior research has well documented various internal and external factors across different levels that influence firms' adoption of SSCPs (e.g., Awaysheh and Klassen, 2010; Hsu *et al.*, 2016a; Huq *et al.*, 2014; 2016; Mariadoss *et al.*, 2016; Roehrich *et al.*, 2014; Wilhelm *et al.*, 2016). For instance, Wilhelm *et al.* (2016) investigate how agency factors such as incentives and information transparency, as well as institutional factors such as regulatory pressure and lead firm pressure affect the adoption of sustainable practices in multi-tier supply chains, while Hsu *et al.* (2016a) examine the influence of both eco-innovation and eco-reputation strategic orientations on firms' deployment of sustainable

supply chain initiatives.

Although the literature is dominated by research on the antecedents of SSCPs, some researchers have begun to investigate the performance outcomes of adopting SSCPs (e.g., Gualandris and Kalchschmidt, 2016; Gualandris *et al.*, 2015; Klassen and Vereecke, 2012). Among these outcome studies, some are especially concerned with the risk implications of SSCPs (e.g., Gualandris *et al.*, 2015; Hajmohammad and Vachon, 2016; Klassen and Vereecke, 2012), although all of them focus on firms' operations and supply chain risks, rather than the financial risk as assessed by stock markets. For instance, Gualandris *et al.* (2015) examine how the development of sustainable evaluation and verification (SEV) systems in supply chains can help firms recognize potential risk in their supply chains, but not the potential financial risk perceived by investors. As a result, our research attempts to fill this important gap in the literature by investigating the impact of SSCPs on firms' financial risk.

2.2. Financial risk

Risk, as defined by Sitkin and Pablo (1992), is "the extent to which there is uncertainty about whether potentially significant and/or disappointing outcomes of decisions will be realized" (p. 10). From this perspective, risk is associated with outcome uncertainty and includes "a full range of outcomes, both positive and negative" (Sitkin and Pablo, 1992, p. 11). The financial risk as assessed by stock markets is in line with Sitkin and Pablo's (1992) conceptualization. This is because greater financial risk, as reflected in higher fluctuation or volatility of firms' stock prices, represents investors' higher uncertainty about the firms' cash flows in the future (Luo and Bhattacharya, 2009; Srinivasan and Hanssens, 2009).

The overall financial risk, or stock price volatility, can be further decomposed into two components: systematic financial risk and idiosyncratic financial risk (Luo and Bhattacharya, 2009). Systematic financial risk is sensitive to broad economic and market factors such as inflation and exchange rate that are common to all firms (Srinivasan and Hanssens, 2009). Idiosyncratic financial risk, on the other hand, is associated with firm-specific strategies and events such as firms' service transition strategies and demand-supply mismatching events (Hendricks and Singhal, 2014; Josephson

et al., 2016). Prior finance research has found that idiosyncratic financial risk accounts for over 80% of the total financial risk faced by firms, whereas systematic financial risk explains less than 20% (Goyal and Santa-Clara, 2003). As SSCPs are firm-specific strategies, we expect them to be more closely related to idiosyncratic than to systematic financial risk. Nevertheless, we conduct robustness tests in Section 4.1 to compare the impacts of SSCPs on different types of financial risk.

While financial risk has long been an important research topic in the finance literature (Ferreira and Laux, 2007; Fu, 2009; Goyal and Santa-Clara, 2003), researchers in other business disciplines such as marketing and information systems are paying increasing attention to the relationships between firms' nonfinancial strategies and their financial risk (e.g., Aggarwal *et al.*, 2011; Josephson *et al.*, 2016; Luo and Bhattacharya, 2009; Hsu *et al.*, 2016b). For instance, Hsu *et al.* (2016b) investigate the impact of different branding strategies such as endorsed branding and sub-branding on firms' financial risk, while Aggarwal *et al.* (2011) examine how collaboration with other firms to set IT standards can affect the focal firms' financial risk. However, the extant literature on financial risk pays little attention to firms' supply chain strategies or practices such as SSCPs. Although some recent SCM studies (e.g., Hendricks and Singhal, 2005; 2014) have documented the effects of supply chain events such as supply chain disruptions and demand-supply mismatches on firms' financial risk, they are not directly concerned with firms' supply chain practices. Therefore, our research broadens the horizon of the financial risk literature by providing a direct investigation on the financial risk impact of firms' supply chain practices, more specifically, SSCPs.

2.3. A signalling perspective on the SSCPs-financial risk relationship

Signalling theory applies to situations of asymmetric distribution of information between two parties in which certain underlying characteristics or capabilities of one party are unobservable to the other party (Connelly *et al.*, 2011). For instance, in our research context, firms' underlying characteristics or capabilities may be unobservable to external investors. In his seminal work on job market signalling, Spence (1973; 1974) suggests that despite information asymmetry, job applicants can use observable information such as college degrees to signal their unobservable capabilities to potential employers.

Inspired by Spence's work, researchers have applied the signalling logic to various contexts including SCM (e.g., Beer *et al.*, 2018; Hoetker *et al.*, 2007; Stevenson and Busby, 2015). For instance, Beer *et al.* (2018) investigate how suppliers use costly buyer-specific investments without long-term contracts to signal their underlying trustworthiness to buyers, while Hoetker *et al.* (2007) study how suppliers of low-modularity components use their existing customers' status to signal their unobservable ability to potential buyers. In line with these SCM studies, we see the merit of adopting the signalling perspective to explain how firms use SSCPs to signal their underlying characteristics or capabilities to investors, influencing investors' perception and thus affecting the firms' financial risk.

The signalling literature emphasizes that "signals must be costly to be credible" (Connelly *et al.*, 2011, p. 47) because costs reduce the probability of false signalling and receivers are more likely to attend to costly signals. SSCPs are costly investments. For instance, according to *The New York Times*, a Walmart director stated in a meeting that occurred before the Bangladeshi factory fire that a plan to improve the electrical and fire safety of Bangladeshi factories would require "very extensive and costly modification" and it was "not financially feasible for the brands to make such investments" (Greenhouse, 2012). Prior studies have also found that costs are among the major barriers preventing firms from engaging in SSCPs (McMurray *et al.*, 2014). Therefore, the high investment costs make SSCPs credible signals from the signalling perspective.

In line with recent SCM studies (e.g., Ellis *et al.*, 2010; Kull *et al.*, 2014), we argue that firms' SSCPs convey two interrelated messages to investors: a lower likelihood of irresponsible events in the firms' supply chains, and a lower impact of such events, if any, on the focal firms. First, SSCPs help firms control the irresponsible behaviour of their supply chain partners. For instance, some automotive manufacturers such as Ford and BMW require their suppliers to obtain third-party certifications of their management systems that are related to sustainability (e.g., ISO 14001; OHSAS 18001), ensuring their suppliers' compliance with international social and environmental standards (BMW, 2018; Industry Week, 2005). On the other hand, some fashion brands such as Puma and Levi's conduct regular assessments of their suppliers' social and environmental performance, and have established practices to reward good performers financially (Donnan, 2014; Longman, 2016). As a

result, although the specific SSCPs being adopted vary across firms, the probability of irresponsible events should be lower in supply chains with SSCPs rather than without SSCPs. Some anecdotal evidence supports this view. For instance, after Apple's intervention, the working conditions at Foxconn have improved, and the number of reported worker suicides has decreased since 2010 (Bradsher and Duhigg, 2012).

Despite their lower probability, irresponsible events can occur in supply chains even in the presence of SSCPs, but their impact on the focal firms should be lesser than that without SSCPs. This difference can be explained by the insurance protection argument (Godfrey, 2005; Shiu and Yang, 2017): SSCPs help firms build up positive moral capital, which provides them with insurance-like protection against the irresponsible events that occur in their supply chains. This argument is consistent with the findings of recent CSR studies (e.g., Flammer, 2013; Godfrey *et al.*, 2009) which have shown that negative events such as legal actions and eco-harmful accidents have a less severe impact on firms with better CSR performance.

As irresponsible events in supply chains could disrupt firms' operations, damage their reputations, and tarnish their brands, ultimately affecting their cash flows (Bloomberg News, 2010; Wieland and Handfield, 2013; Walmart, 2012), a signal of lower likelihood and impact of those events helps reduce investors' uncertainty about the firms' future cash flows, leading to reduced financial risk as reflected in lower stock price volatility. Therefore, we propose our first hypothesis:

H1. Firms' SSCPs reduce their financial risk.

2.4. The moderating role of supply chain complexity and efficiency

While we expect SSCPs to reduce firms' financial risk, the extent to which the financial risk can be reduced might vary across firms with different supply chains. From a signalling perspective, the effectiveness of the SSCPs signals might be dependent on the signalling environment. Prior studies have well documented how signals' effectiveness is contingent on their own characteristics such as signal strength, signal frequency, and signal consistency (Connelly *et al.*, 2011). For instance, if signals are more visible, sent more frequently, and tend to agree with one another, the effectiveness of

the signals will be enhanced (Basdeo *et al.*, 2006; Janney and Folta, 2003; Miller and Triana, 2009). However, the signalling literature has devoted limited attention to the role of signalling environment in moderating the effectiveness of the signals concerned (Connelly *et al.*, 2011). Nevertheless, signalling environment is an important factor in our research context because the need of investors to rely on firms' SSCPs signals depends on the characteristics of the firms' supply chains that might vary significantly across firms. As a result, we consider how the signalling environment in terms of supply chain characteristics (e.g., supply chain complexity and efficiency) might affect the effectiveness of the SSCPs signals in reducing financial risk.

Complex supply chains that are across countries and industries can be viewed as an uncertain signalling environment for several reasons. First, for firms with complex supply chains across different countries, they have a higher likelihood of sourcing from low-cost countries with different cultures, norms, and attitudes toward sustainable practices (Awaysheh and Klassen, 2010; Burkert *et al.*, 2012). These differences imply that supply chain partners' compliance with labour, safety, and environmental standards varies significantly across countries (UNCTAD, 2012). Moreover, geographical distances, linguistic differences, and other issues arising from these supply chains hamper information flows and increase information asymmetry between the focal firms and their supply chain partners, making it difficult for the former to monitor the behaviour of the latter (Burkert *et al.*, 2012). Even if the supply chains are across different industries rather than different countries, uncertainty remains a concern. For instance, Zhu and Sarkis (2006) find that even within a single country such as China, firms in different industries behave quite differently toward environmental issues, increasing the probability of irresponsible events in these supply chains.

Such an uncertain signalling environment can make firms' SSCPs signals more effective in reducing financial risk. This is because, as Sanders and Boivie (2004) point out, "signals should be most important when the uncertainty is greatest" (p. 182). Complex supply chains that are across countries and industries increase information asymmetry between firms and investors, making the investors more difficult to make sense of the firms' underlying supply chain activities and how they are related to the firms' cash flows. As a result, investors are more likely to attend to other observable

signals such as SSCPs, making the SSCPs signals more effective in reducing the investors' uncertainty about the firms' future cash flows, lowering stock price volatility and thus reducing financial risk. On the other hand, for firms with simple supply chains within the same countries and industries, investors are less uncertain about the firms' supply chain activities and thus do not have to rely on the SSCPs signals to make their judgement. As a result, the SSCPs signals are less effective in a more certain signalling environment. Therefore, we propose our second hypothesis:

H2. Supply chain complexity moderates the SSCPs-financial risk relationship such that the risk reduction of SSCPs is greater for firms with more complex supply chains.

Efficient supply chains, on the other hand, are less viewed as an uncertain signalling environment. Instead, efficient supply chains are usually regarded as a competitive advantage for firms in today's competitive, globalized environment (Hendricks *et al.*, 2009; Modi and Mabert, 2010). However, efficient supply chains can also make firms more vulnerable to irresponsible events once these events have occurred in the firms' supply chains. This is because these supply chains are highly utilized and bear fewer buffers to mitigate the resulting disruptions (Kleindorfer and Saad, 2005). Some anecdotal evidence confirms this view. For instance, General Motors, running an efficient supply chain[1], suffered considerable losses due to a labour strike at its supplier, American Axle, in 2008 (Associated Press, 2008). Therefore, efficient supply chains represent a more vulnerable signalling environment in our research context.

While investors are uncertain about the underlying supply chain activities in complex supply chains, efficient supply chains, on the other hand, make investors more uncertain about the resulting outcomes. On the one hand, efficient supply chains should lead to positive outcomes as they enable firms to gain an efficiency advantage over competitors (Hendricks *et al.*, 2009; Modi and Mabert, 2010). On the other hand, these supply chains could bring on negative outcomes as they are more vulnerable to irresponsible supply chain events (Kleindorfer and Saad, 2005). Such outcome

[1] General Motors has the most efficient supply chain in terms of the cash-to-cash cycle among the six automotive companies studied by Mayer (2013).

uncertainty can result in higher financial risk when investors hold diverse views on the possible outcomes. Nevertheless, Sitkin and Pablo (1992) suggest that risk can be reduced if "outcomes can be influenced, even modestly, by the decision maker" (p. 10). SSCPs help reduce risk by influencing the negative outcomes of efficient supply chains. In particular, SSCPs build up positive moral capital to lessen the negative impact of irresponsible events in supply chains (Godfrey, 2005). Therefore, the SSCPs signals should be more effective in a more vulnerable signalling environment as they reduce the outcome uncertainty as perceived by investors. On the other hand, as there is a lower variability of outcomes in less efficient supply chains, investors are less likely to attend to firms' SSCPs signals, making the SSCPs signals less effective in a more invulnerable signalling environment. Therefore, we propose our last hypothesis:

H3. Supply chain efficiency moderates the SSCPs-financial risk relationship such that the risk reduction of SSCPs is greater for firms with more efficient supply chains.

A conceptual model summarizing the three proposed hypotheses is shown in Figure 1.

--- Figure 1 about here ---

3. Methods

3.1. Data collection

We collect longitudinal secondary data from multiple sources to construct our variables. Specifically, we obtain the annual Responsible Supply Chain Benchmark (RSCB) reports published by the Dutch Association of Investors for Sustainable Development (VBDO) from 2006 to 2012 to measure firms' SSCPs. VBDO compiles the RSCB reports based on information collected from various public sources such as annual reports, sustainability reports, supplier codes, and company websites (VBDO, 2012). The RSCB reports are focused on firms publicly listed on the Euronext Amsterdam. VBDO sampled 32 firms in 2006 (VBDO, 2006), but since 2009, the number of sample firms has increased to 40 (VBDO, 2009). VBDO choose firms "whose procurement of goods and services constitutes a significant proportion of their total expenditure" (VBDO, 2012, p. 6) and thus exclude such firms as

financial institutions and recruitment companies. Nevertheless, the RSCB reports cover firms operating in very diverse sectors including chemicals, construction, electronics, food and agriculture, industry and manufacturing, media, metals and mining, oil and offshore, pharmaceuticals, and transport (VBDO, 2012). Moreover, VBDO includes firms with different sizes in the RSCB reports. For instance, among the 40 firms included in the 2012 RSCB report (VBDO, 2012), 20 (or 50%) are from the AEX index (a large-cap index), 19 (or 47.5%) are from either the AMX index (a mid-cap index) or the AScX index (a small-cap index), and one (or 2.5%) is a local firm that is not included in these three indices. Such a wide variety of the sample helps improve the generalizability of our results to firms in different sectors and with different sizes.

VBDO strives to assess the same firms across years unless they are delisted from the Euronext Amsterdam (VBDO, 2012). For instance, VBDO excluded Wavin N.V. from the sample in 2012 because this firm was delisted from the Euronext Amsterdam on July 12, 2012 (Euronext, 2012) and added TKH Group to the sample in the same year to "bring the total number of companies back to 40" (VBDO, 2012, p. 13). As a result, we are able to identify 57 unique firms from the RSCB reports published between 2006 and 2012. The total number of firm-year observations is 260 over this seven-year period (2006-2012), suggesting that on average there are about five-year observations for each sample firm.

For these 57 sample firms, we collect their daily stock data from Datastream, segment data from Thomson Reuters Knowledge, and accounting data from Compustat Global, to compute firms' financial risk, supply chain complexity, and supply chain efficiency, respectively. The detailed measurement procedures are discussed below and summarized in Table I.

--- Table I about here ---

3.2. Measurements

SSCPs. We rely on the RSCB reports published by VBDO to measure firms' SSCPs for several reasons. First, VBDO emphasizes that its RSCB report "focuses on environmental and social issues that arise during the production and operating processes in the entire supply chain of the company"

(VBDO, 2012, p. 14), which is consistent with our definition of SSCPs that is concerned with both the environmental and social dimensions of supply chain practices. Second, VBDO has published the RSCB reports annually since 2006, enabling us to conduct time series analyses to obtain more rigorous results. Third, all the firms assessed in the RSCB reports are listed on the Euronext Amsterdam, allowing us to obtain their publicly available data to construct other hypothesized variables. Finally, the RSCB reports are published by VBDO, an independent party, rather than by the sample firms concerned, thus reducing possible self-report and common method biases.

VBDO classifies the assessment items included in the RSCB reports into three broad categories: governance, policy, and management (VBDO, 2012). The governance category contains assessment items that are concerned with the environmental and social strategies adopted at the executive level. Some examples include whether a firm has assigned a formal member of the Executive Board or a high level commission to oversee the sustainability of its supply chain, and whether it has conducted a supply chain analysis and identified the sustainability themes on which its supply chain has a significant impact. The policy category, on the other hand, contains assessment items that pertain to the sustainability rules and guiding principles adopted at the policy level. It includes such assessment items as whether a firm has a supplier policy and a corresponding management system related to sustainability, whether it has a supplier code that requires its suppliers to comply with social and environmental standards, and whether it has a method to monitor its suppliers' compliance with the supplier code. Finally, the management category contains assessment items focused on the sustainable practices implemented at the daily operations and management level. The assessment items included in this category cover various practices along a firm's supply chain ranging from upstream practices such as the competence of the persons supervising suppliers and the transparency of supervising results to downstream activities such as product recycling and responsible marketing. For each assessment item included in the RSCB reports, VBDO employs a point-based system to assign a specific number of points to a sample firm, based on relevant public information concerned with this item. For instance, for the assessment item related to monitoring method in the policy category, VBDO assigns zero points to a firm if it has no method to monitor its suppliers' compliance with the

supplier code, one point if it has a method to monitor its suppliers' compliance with the supplier code but no independent verification of the application of the method has been conducted, and two points if it has a method to monitor its suppliers' compliance with the supplier code and the application of the method is verified independently.

While the three broad categories remain consistent across years, the specific assessment items under each category might change to "reflect [the] latest developments in the field" (VBDO, 2013, p. 20). Although such changes in assessment items across years also occur for other CSR databases such as KLD (Servaes and Tamayo, 2013), they make the absolute points a firm receives in different years incomparable with one another. To address this issue, we follow prior CSR studies (e.g., Servaes and Tamayo, 2013) by measuring a firm's SSCPs based on a normalized score rather than the absolute points it receives. Specifically, consistent with prior CSR studies that use databases with point-based systems such as KLD and Asset4 (e.g., Eccles *et al.*, 2014; Servaes and Tamayo, 2013), we first apply an equal-weighted approach to add up the points a firm receives across all assessment items in a particular year. For instance, Sligro Food Group received a total of 27 points across the 25 assessment items in 2012 (VBDO, 2012). We then obtain the maximum number of points a firm might receive across all assessment items in the same year. For instance, the maximum number of points a firm might receive across the 25 assessment items in 2012 is 52. Finally, we obtain the normalized score for this firm by dividing the number of points it receives by the maximum number of points in the same year. For instance, the normalized score for Sligro Food Group in 2012 is 27/52 = 0.52. Our sample firms' SSCPs thus are measured as these normalized scores, which range from 0 to 1 and make SSCPs comparable across firms and years.

Financial Risk. Consistent with prior studies that investigate the impact firms' strategies and practices on financial risk (e.g., Hsu *et al.*, 2016b; Josephson *et al.*, 2016), we expect that SSCPs should be more related to firm-specific, or idiosyncratic financial risk, rather than to market-specific, or systematic financial risk. As a result, our measure of financial risk is focused on idiosyncratic financial risk, but we also conduct additional robustness tests in Section 4.1 to analyse the impact of SSCPs on systematic financial risk. We measure idiosyncratic financial risk based on the Market

model that has accounted for stock market movements (Luo *et al.*, 2014). Specifically, we first regress the daily stock returns of firm i (R_{it}) on the daily market returns (RM_t; the returns of MSCI Netherlands index) in each year, as shown below.

$$R_{it} = \alpha_i + \beta_i RM_t + \varepsilon_{it} \,. \tag{1}$$

For each year, we obtain the annualized standard deviation of the residuals (ε_{it}) to represent the idiosyncratic financial risk of firm i (Luo *et al.*, 2014; Mishra *et al.*, 2013). To reduce infrequent trading bias, we only include firms whose daily stock data with non-zero trading volume are available for at least 180 trading days in the year when the idiosyncratic financial risk is calculated (Fu, 2009).

Supply Chain Complexity. Prior studies (e.g., Gilbert and Heinecke, 2014; Rugman and Verbeke, 2004) have suggested using sales and assets as proxies for downstream and upstream supply chain activities, respectively. Rugman *et al.* (2009) further check the robustness of these proxies. We thus merge the distributions of a firm's sales and assets to illustrate its supply chain complexity. In line with our hypothesis development, the measure of supply chain complexity should include both the geographical and industrial dimensions. Thus, using the geographical and industrial segment data for sales and assets obtained from Thomson Reuters Knowledge, we calculate the levels of supply chain complexity based on the Herfindahl index (Hendricks *et al.*, 2009):

$$Supply\ Chain\ Complexity_{it} = 1 - \frac{1}{4}\left\{\sum_{k=1}^{N}\left[\left(\frac{Sales_{ikt}}{Sales_{it}}\right)^2 + \left(\frac{Assets_{ikt}}{Assets_{it}}\right)^2\right] + \sum_{j=1}^{M}\left[\left(\frac{Sales_{ijt}}{Sales_{it}}\right)^2 + \left(\frac{Assets_{ijt}}{Assets_{it}}\right)^2\right]\right\}, \tag{2}$$

where N and M represent the total number of geographical and industrial segments[2], respectively, reported by firm i in year t.

An important concern about our measure of supply chain complexity is whether this measure based on data at the organizational level is able to capture the characteristics at the supply chain level. To address this concern, we obtain supply chain-level data from Bloomberg SPLC to verify our measure of supply chain complexity. Bloomberg SPLC maps the buyer-supplier relationships of about

[2] The formats of geographical and industrial segments vary across firms, as shown in Thomson Reuters Knowledge. To make the results comparable across firms, we standardize the geographical and industrial segments based on seven continents and six-digit NAICS codes, respectively.

35,000 firms around the world by monitoring the money flows among these firms on both a customer (revenue) and supplier (cost) basis (Kim and Davis, 2016; Steven *et al.*, 2014). Unfortunately, Bloomberg SPLC "only provides a cross-sectional dataset with the latest annual relationships" (Kim and Davis, 2016, p. 1905) and does not cover our sample years from 2006 to 2012. We thus focus on our sample firms in 2012 to reduce the time-lag concern. Specifically, for the 40 sample firms included in the 2012 RSCB report, we obtain their latest buyer-supplier relationship data from Bloomberg SPLC and follow Kim and Davis (2016) by measuring a firm's supply chain complexity as the natural logarithm of the total number of suppliers and customers of this firm. We then calculate the correlation between this alternative measure and our original measure. Despite a lag of several years and a relatively small sample size, we find a significant positive correlation between the two measures ($b = 0.530$, $p < 0.01$), providing strong support for our measure of supply chain complexity based on the segment data from Thomson Reuters Knowledge.

Supply Chain Efficiency. Consistent with prior SCM studies (e.g., Farris II and Hutchison, 2002; Lo *et al.*, 2009), we measure a firm's supply chain efficiency in terms of its cash-to-cash cycle due to its ability to capture a firm's efficiency in managing a supply chain "across inbound material activities with suppliers, through manufacturing operations, and the outbound logistics and sales activities with customers" (Farris II and Hutchison, 2002, p. 292). Practitioners have also relied on the cash-to-cash cycle to interpret the efficiency of a firm's supply chain (Mayer, 2013). For instance, the negative cash-to-cash cycle of Dell Inc. is often cited as an example of an efficient supply chain (Hughes, 2014). Mathematically, the cash-to-cash cycle of firm *i* in year *t* can be computed as follows.

$$Cash\text{–}to\text{–}cash\ cycle_{it} = Days\ of\ inventory_{it} + Days\ of\ accounts\ receivables_{it} - Days\ of\ accounts\ payables_{it}\ . \quad (3)$$

As cash-to-cash cycle varies across industries, we standardize a firm's cash-to-cash cycle within its industry to control for inter-industry differences. Moreover, due to the negative relationship between cash-to-cash cycle and supply chain efficiency (i.e., a short cash-to-cash cycle indicates an efficient supply chain), we apply reverse coding to ease the interpretation of our results. Therefore, we measure the supply chain efficiency of firm *i* in industry *j* (2-digit GICS code) in year *t* as follows.

$$Supply\ Chain\ Efficiency_{ijt} = -\frac{Cash\text{-}to\text{-}cash\ cycle_{ijt} - Mean\ of\ cash\text{-}to\text{-}cash\ cycle_{jt}}{Standard\ deviation\ of\ cash\text{-}to\text{-}cash\ cycle_{jt}}. \quad (4)$$

As we have argued in hypothesis development that an efficient supply chain is more utilized and has leaner inventory, a natural concern is whether our measure of supply chain efficiency is able to capture the level of inventory redundancy and slack at the supply chain level. To address this concern, we verify our measure with the supply chain-level data collected from Bloomberg SPLC. Specifically, for the 40 firms included in the 2012 RSCB report, we identify all the suppliers and customers of each firm based on the latest buyer-supplier relationship data collected from Bloomberg SPLC (Kim and Davis, 2016; Steven *et al.*, 2014). We then obtain an alternative measure of a firm's supply chain efficiency as the average inventory turnover (cost of goods sold divided by inventory) across all the suppliers and customers of this firm. Finally, we calculate the correlation between this alternative measure and our original measure. We find a significant positive correlation between the two measures (b = 0.278, p < 0.1), suggesting that our measure of supply chain efficiency based on cash-to-cash cycle is related to the level of inventory leanness at the supply chain level.

3.3. Regression analysis

We construct a regression model, shown below, to test our hypotheses.

$$\begin{aligned} Financial\ Risk_{i(t+1)} &= \beta_0 + \beta_1 Firm\ Size_{it} + \beta_2 Market\text{-}to\text{-}Book\ Ratio_{it} + \beta_3 Leverage\ Ratio_{it} + \beta_4 Liquidity\ Ratio_{it} \\ &+ \beta_5 Dividend\ Payout_{it} + \beta_6 Supply\ Chain\ Complexity_{it} + \beta_7 Supply\ Chain\ Efficiency_{it} \\ &+ \beta_8 SSCPs_{it} + \beta_9 SSCPs_{it} \times Supply\ Chain\ Complexity_{it} \\ &+ \beta_{10} SSCPs_{it} \times Supply\ Chain\ Efficiency_{it} + Year\ Dummies + Industry\ Dummies + \varepsilon_{it}. \quad (5) \end{aligned}$$

All independent variables are lagged by one year from the dependent variable. We control for firm size (natural logarithm of sales), market-to-book ratio (the market value of equity over the book value of equity), leverage ratio (long-term debt over total assets), liquidity ratio (current assets over current liabilities), and dividend payout (cash dividends over the market value of equity) in the model, as they may be related to financial risk. Specifically, based on prior studies on financial risk (e.g., Ferreira and Laux, 2007; Hendricks and Singhal, 2014; Luo and Bhattacharya, 2009; Tuli and

Bharadwaj, 2009), we expect firm size and market-to-book ratio to be negatively related to financial risk, while leverage ratio, liquidity ratio, and dividend payout to be positively related to financial risk. We include year and industry (2-digit GICS code) dummies to account for any unobserved time- and industry-specific effects, respectively. To reduce multicollinearity concerns, we centre the hypothesized variables when computing interaction terms. We use the random effect estimator to test our hypotheses and adopt Baltagi and Wu's (1999) approach to address possible autocorrelation of errors in our random effect estimation. We perform additional tests in Section 4.1 to check the robustness of our findings and to account for alternative explanations.

4. Results

The correlations among variables and the regression results are presented in Tables II and III, respectively. In Table III, Model 1 is the basic model, which includes all control variables, year dummies, and industry dummies. Models 2 to 4 add the direct impact of SSCPs and the moderating effects of supply chain complexity and supply chain efficiency, respectively, to Model 1. Model 5 is the full model, which includes all the variables presented in equation (5). All five models are significant (Wald Chi-square ≥ 215.04, $p < 0.01$), with R-squares ranging from 0.560 to 0.619. The number of firm-year observations is reduced to 187 due to the missing data for some variables.

--- Table II about here ---

--- Table III about here ---

All the five control variables exhibit the expected directionality, but only market-to-book ratio and dividend payout are significant ($p < 0.05$) across the five models. SSCPs remain negative and significant ($p < 0.1$) in Models 2 to 5, suggesting that managing supply chains in a sustainable way helps firms reduce financial risk. Therefore, H1 is supported. As shown in Models 3 and 5, the interaction between SSCPs and supply chain complexity is negative and significant ($p < 0.01$). It indicates that the risk reduction of SSCPs is greater for more complex supply chains, supporting H2. Finally, the interaction between SSCPs and supply chain efficiency shown in Models 4 and 5 is also negative and significant ($p < 0.05$), showing that the risk reduction of SSCPs is greater for more

efficient supply chains. Therefore, H3 is also supported.

4.1. Robustness tests

We conduct several additional tests to check the robustness of our findings and to account for alternative explanations. The results of these tests are summarized in Table IV, and the corresponding testing procedures are described below. Due to space constraints, we present only the results for the three hypothesized variables[3], i.e., SSCPs, supply chain complexity, and supply chain efficiency, in Table IV. Overall, these tests provide further support for our arguments and offer great insights into the underlying relationships among variables.

--- Table IV about here ---

Alternative measures of financial risk. We adopt several alternative measures of financial risk to check the sensitivity of our results. First, we compute the idiosyncratic financial risk from equation (1) with the returns of AEX All Share index as the market returns (RM_t) and re-estimate equation (5) using this new financial risk. The results are consistent, as shown in Model 1 of Table IV. Second, we measure financial risk as total risk (i.e., annualized standard deviation of daily returns; see, e.g., Hendricks and Singhal, 2014) and obtain qualitatively similar results in Model 2 of Table IV. Finally, we re-estimate equation (5) using systematic financial risk (i.e., β_i from equation (1); see, e.g., Hsu *et al.*, 2016b) as the dependent variable but do not find a significant impact of SSCPs on systematic financial risk ($p > 0.1$) in Model 3 of Table IV. These results confirm our expectation that SSCPs are firm-specific strategies, thus affecting firm-specific or idiosyncratic financial risk rather than market-specific or systematic financial risk.

Impact of SSCPs on firm returns. A natural question arising from our results about the ability of SSCPs to reduce financial risk is whether SSCPs also affect firm returns. To provide a more comprehensive view of the SSCPs-firm returns relationship, we examine the impact of SSCPs on both market- and accounting-based measures of firm returns. Our market-based measure is abnormal stock returns (i.e., α_i from equation (1); see, e.g., Hsu *et al.*, 2016b), while our accounting-based measure is

[3] The detailed results including all variables are available upon request.

return on assets (ROA) (i.e., operating income over total assets; see, e.g., Servaes and Tamayo, 2013). We re-estimate equation (5) using abnormal stock returns and ROA as the dependent variable, resulting in Models 4 and 5, respectively, in Table IV. The results show that SSCPs are not significantly ($p > 0.1$) related to both market- and accounting-based measures of firm returns. These findings suggest that while SSCPs reduce financial risk, they do not affect firm returns.

Alternative measures of supply chain complexity. In addition to the equally weighted measure of supply chain complexity shown in equation (2), we compute an alternative value-weighted measure presented below as a robustness check.

$$Supply\ Chain\ Complexity_{it} = 1 - \frac{Sales_{it}\sum_{k=1}^{N}(\frac{Sales_{ikt}}{Sales_{it}})^2 + Assets_{it}\sum_{k=1}^{N}(\frac{Assets_{ikt}}{Assets_{it}})^2 + Sales_{it}\sum_{j=1}^{M}(\frac{Sales_{ijt}}{Sales_{it}})^2 + Assets_{it}\sum_{j=1}^{M}(\frac{Assets_{ijt}}{Assets_{it}})^2}{2(Sales_{it} + Assets_{it})}, \quad (6)$$

where N and M represent the total number of geographical and industrial segments, respectively, reported by firm i in year t. The regression results with this value-weighted measure remain consistent, as shown in Model 6 of Table IV. Moreover, to gain a better understanding of the role of different dimensions of supply chain complexity, we re-estimate equation (5) with the separate geographical and industrial dimensions, respectively. The regression results shown in Models 7 and 8 of Table IV suggest that the impact of SSCPs on financial risk is stronger for complex supply chains across countries (b = -0.286, $p < 0.05$) rather than across industries (b = -0.035, $p > 0.1$). This finding is consistent with recent practitioner reports (e.g., UNCTAD, 2012; Wieland and Handfield, 2013) that have emphasized the importance of managing global supply chains in a sustainable way.

Alternative measure of supply chain efficiency. As our measure of supply chain efficiency based on cash-to-cash cycle focuses on the cash conversion dimension, we adopt a new proxy proposed by Johnson and Templar (2011) that has taken account of "cash generation and asset efficiency" (p. 100) as an alternative measure and obtain consistent results in Model 9 of Table IV.

Alternative estimator. To account for the possible heteroskedasticity of errors across firms, we re-estimate equation (5) using the Prais-Winsten estimator with panel-corrected standard errors (Mishra *et al.*, 2013) and obtain qualitatively similar results in Model 10 of Table IV.

Additional controls. Informed by prior CSR and marketing studies (e.g., Luo and Bhattacharya,

2009; McWilliams and Siegel, 2000), we include R&D and marketing intensities as additional controls in equation (5). We measure R&D and marketing intensities as R&D expenses and marketing expenses (selling, general, and administration expenses minus R&D expenses) over sales, respectively. We also control for firms' own CSR in equation (5). We measure the CSR of our sample firms as the equally weighted CSR index obtained from Asset4 (see Cheng *et al.*, 2014 for a detailed discussion on Asset4). The regression results remain consistent with these three additional controls, as shown in Model 11 of Table IV. Interestingly, we find that CSR is not significantly related to financial risk in Model 11 ($p > 0.1$; not tabulated), suggesting that the risk reduction effect of SSCPs is quite robust and well above that explained by CSR.

Impact of financial risk on SSCPs. Finally, although we have maintained a one-year lag between financial risk and SSCPs in equation (5), reverse causality remains possible. We thus test the impact of financial risk on SSCPs by interchanging financial risk and SSCPs in equation (5). The regression results shown in Model 12 of Table IV indicate that financial risk does not affect SSCPs significantly ($p > 0.1$), ruling out the reverse causality explanation.

5. Discussions and conclusions

No firm can be an island, especially from the SCM perspective. While the irresponsible events occurring in supply chains damage firms' reputations and tarnish their brands (Wieland and Handfield, 2013), managing supply chains in a sustainable way enables firms to reduce financial risk. We have made several points about SSCPs in this research. First, our research provides a signalling perspective on the SSCPs-financial risk relationship. Second, consistent with our arguments, we find that SSCPs help firms reduce financial risk, especially idiosyncratic financial risk, but they do not affect firm returns. Moreover, the risk reduction due to SSCPs is greater for firms with complex and efficient supply chains. Our findings are robust to alternative variable measurements and analysing strategies. We discuss the implications of our study for both practice and research below.

5.1. Implications for practice

Firms have long been asked to address the social and environmental issues along their supply chains responsibly, but it is not clear how firms can benefit from such an expensive move. Our research suggests that managing supply chains in a sustainable way can help firms reduce financial risk as assessed by markets. This finding is important because financial risk is related to firms' short-term stability as well as long-term survival (Luo and Bhattacharya, 2009; Srinivasan and Hanssens, 2009). Our finding also enables firms to convince their risk-averse shareholders to support their SSCPs investments to reduce financial risk. However, firms should realize that SSCPs are unable to reduce all types of financial risk, such as market-specific financial risk. This is because SSCPs are firm-specific strategies and should be more effective in reducing firm-specific (i.e., idiosyncratic) rather than market-specific (i.e., systematic) financial risk. Nevertheless, as idiosyncratic financial risk accounts for over 80% of the total financial risk faced by firms (Luo and Bhattacharya, 2009), our research suggests that firms can rely on SSCPs as a strategic move to reduce their idiosyncratic financial risk, which in turn leads to lower total financial risk.

While some practitioners have worried about the high investment costs associated with SSCPs (Greenhouse, 2012), our research shows that SSCPs do not affect firm returns. This may be due to the fact that consumers are willing to pay more to support firms that manage their supply chains in a sustainable way (Fliess *et al.*, 2007), compensating for the investment costs associated with SSCPs. As a result, SSCPs help firms reduce financial risk without damaging their returns.

Although SSCPs reduce financial risk, firms should realize that the extent to which the financial risk can be reduced might depend on the nature of their supply chains. Our research suggests that firms with complex and efficient supply chains benefit more from SSCPs in terms of risk reduction. Although supply chains across different countries enable firms to source globally with lower costs and better flexibility (Cohen and Mallik, 1997), they also imply a higher likelihood of irresponsible events due to cultural differences and monitoring difficulties along these complex supply chains (Burkert *et al.*, 2012; UNCTAD, 2012). However, many firms have "overlooked the social aspects of running a global supply chain" (Wieland and Handfield, 2013, p. 27). Indeed, some firms such as Walmart and Apple have learned hard lessons from neglecting the sustainability issues along their global supply

chains (Bloomberg News, 2010; Walmart, 2012). Therefore, firms running global, rather than local, supply chains have a higher need to adopt SSCPs to reduce financial risk.

On the other hand, firms improving supply chain efficiency to survive in today's competitive environment might ignore the possible "efficiency backlash" (Westbrook *et al.*, 2007, p. 1) arising from their efficient supply chains. In particular, the high utilization and low buffers of these supply chains make firms more vulnerable to the disruptions resulting from the occurrence of irresponsible events, as is the case with General Motors (Associated Press, 2008). Therefore, firms running efficient supply chains are also in an urgent need of adopting SSCPs to mitigate financial risk. Taken together, our research not only encourages firms to "do good" across organizational boundaries to reduce financial risk but also urges them to assess the urgency of their SSCPs investments in view of the complexity and efficiency of their supply chains.

5.2. Implications for research

Our research offers some important implications for future research on SCM in general and SSCPs in particular. First, while SSCPs have attracted much attention in the SCM community and researchers have begun to examine the impact of SSCPs (Gualandris *et al.*, 2015; Klassen and Vereecke, 2012), little is known about the financial risk implications of SSCPs. Although it seems more reasonable for SCM researchers to focus on the impact of SSCPs on operations and supply chain risks, studying financial risk can help broaden the horizon of SCM and enable SCM researchers to contribute to the financial risk literature. In fact, researchers in other non-finance disciplines have started to look at how various nonfinancial strategies are related to financial risk (Aggarwal *et al.*, 2011; Hsu *et al.*, 2016b). We thus hope our research on financial risk can inspire SCM researchers to investigate the financial risk implications of supply chain practices in general and SSCPs in particular. For example, how do various supply chain practices and strategies such as vertical integration, vendor-managed inventory, and new product co-development between buyers and suppliers relate to firms' financial risk? On the other hand, while our research has revealed the impact of overall SSCPs on financial risk, future research can further explore whether the financial risk impact will vary, for example, across

different types (e.g., SSCPs at the executive level vs. SSCPs at the policy level) or different dimensions (e.g., social dimension vs. environmental dimension) of SSCPs. As prior research has suggested that "environmental and social dimensions are indeed different" (Wilhelm *et al.*, 2016, p. 55), it could thus be interesting to investigate how they are different from each other in terms of reducing financial risk.

Our research contributes to the signalling literature by highlighting the important role that signalling environment plays in moderating the effectiveness of the signals concerned. Although prior signalling studies have shown how various signal characteristics such as signal strength, signal frequency, and signal consistency can affect the effectiveness of the signals concerned (Basdeo *et al.*, 2006; Janney and Folta, 2003; Miller and Triana, 2009), limited attention is paid to the role of the signalling environment. A recent review on signalling theory also suggests that "the signaling environment on the whole is an underresearched aspect of signaling theory" (Connelly *et al.*, 2011, p. 62). However, our research indicates that the underresearched signalling environment indeed is important in the signalling process because it influences the need of the receivers to rely on the signals being sent from the signallers, thus affecting the effectiveness of the signals concerned. In particular, our research suggests that investors rely more on the SSCPs signals in more uncertain and vulnerable signalling environments such as complex and efficient supply chains, thus making the SSCPs signals more effective in reducing investors' uncertainty and lowering financial risk. Our research thus encourages future signalling studies to further explore the role of the underresearched yet important signalling environment in other research contexts beyond SSCPs. On the other hand, the signalling perspective adopted in our research can serve as a useful theoretical foundation for future research on SSCPs. For instance, while our research focuses on how investors interpret firms' SSCPs signals, the SSCPs signals in fact could also be received by other stakeholders such as competitors and customers, which in turn might affect other performance outcomes beyond financial risk. For example, firms' SSCPs signals might influence customers' perception about the firms' products and images, affecting their buying behaviour as well as firm profits (Fliess *et al.*, 2007). On the other hand, although our research assumes that the SSCPs signals are honest signals due to the high investment costs involved

(Greenhouse, 2012), false signalling is still possible such that firms show mock compliance with SSCPs without real commitment. Such dishonest signals might have varying impacts on firms' financial risk depending on how they are perceived (and punished) by investors, which is worth further investigation.

Although the literature on sustainable SCM is still "dominated by qualitative research methods such as case study, interview and conceptual/theoretical model" (Ansari and Kant, 2017, p. 2536), our research demonstrates the possibility and advantages of conducting quantitative research on sustainable SCM based on longitudinal secondary data collected and combined from multiple sources. First, we measure different variables based on data from different sources, reducing common method bias. Second, we maintain time lags between dependent and independent variables, ensuring the direction of causality under test. Third, we verify our measures with additional data collected from other sources, improving the validity of our measures. Finally, we conduct various additional tests with alternative measures and analysing strategies, enhancing the robustness of our findings and ruling out alternative explanations. Given the advantages as mentioned, we encourage future research to make use of some recently available longitudinal secondary data (e.g., RSCB, Asset4, SPLC) that are related to sustainability and SCM to conduct more rigorous analyses and contribute to the literature on sustainable SCM.

5.3. Limitations and conclusions

Similar to other studies using secondary data, our research is not perfect in its measurements. In particular, although the use of sales and assets as proxies for downstream and upstream supply chain activities, respectively, is in line with prior SCM research (e.g., Gilbert and Heinecke, 2014, Rugman *et al.*, 2009), we acknowledge that these proxies might be too simplistic to account for the potential complexity of a firm's supply chain. Similarly, relying on the cash-to-cash cycle to illustrate supply chain efficiency, while widely used by researchers and practitioners (e.g., Farris II and Hutchison, 2002, Mayer, 2013), might overemphasize the cash conversion dimension without taking other possible dimensions into account. Nevertheless, by collecting additional supply chain-level data to

verify our measures and adopting alternative measures to check the robustness of our findings, we obtain consistent results and demonstrate the rigour of our research.

Although the RSCB reports are the best longitudinal data available for us to measure firms' SSCPs and cover a wide variety of firms in different sectors and with different sizes, all of these firms are publicly traded in the Euronext Amsterdam, which might limit the generalizability of our findings to private firms and firms listed in other countries. Further investigation in these contexts is thus warranted.

To conclude, our research highlights the role of SSCPs in reducing firms' financial risk without affecting their returns. We also reveal the moderating role of supply chain complexity and efficiency in the SSCPs-financial risk relationship, enabling firms to assess the urgency of their SSCPs investments. These findings are consistent with our signalling perspective on the SSCPs-financial risk relationship. We hope our research can inform practitioners about the importance of "doing good" across organizational boundaries and encourage researchers to engage in this emerging research area on SSCPs.

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Table I.

Variable descriptions

Variables	Measurements	Data Sources	References
SSCPs	Normalized Responsible Supply Chain Benchmark (RSCB) scores.	VBDO.	Servaes and Tamayo (2013), VBDO (2012).
Financial Risk	Annualized standard deviation of the residuals in the Market model.	Datastream.	Luo *et al.* (2014), Mishra *et al.* (2013).
Supply Chain Complexity	$1-\frac{1}{4}\left\{\sum_{k=1}^{N}[(\frac{Sales_{ikt}}{Sales_{it}})^2+(\frac{Assets_{ikt}}{Assets_{it}})^2] + \sum_{j=1}^{M}[(\frac{Sales_{ijt}}{Sales_{it}})^2+(\frac{Assets_{ijt}}{Assets_{it}})^2]\right\}$, where N and M represent the total number of geographical and industrial segments, respectively.	Thomson Reuters Knowledge.	Hendricks *et al.* (2009), Rugman *et al.* (2009).
Supply Chain Efficiency	Standardized cash-to-cash cycle within the same industry (2-digit GICS code) (reverse coded).	Compustat Global.	Farris II and Hutchison (2002), Hendricks *et al.* (2009).
Firm Size	Natural logarithm of sales.	Compustat Global.	Hendricks and Singhal (2014), .Hendricks *et al.* (2009).
Market-to-Book Ratio	Ratio of the market value of equity to the book value of equity.	Datastream, Compustat Global.	Hendricks and Singhal (2014), Luo and Bhattacharya (2009).
Leverage Ratio	Ratio of long-term debt to total assets.	Compustat Global.	Ferreira and Laux (2007), Luo and Bhattacharya (2009).
Liquidity Ratio	Ratio of current assets to current liabilities.	Compustat Global.	Luo *et al.* (2014), Tuli and Bharadwaj (2009).
Dividend Payout	Ratio of cash dividends to the market value of equity.	Datastream, Compustat Global.	Luo *et al.* (2014), Tuli and Bharadwaj (2009).

Table II.

Correlation matrix

Variables	Mean	Std. dev.	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Financial Risk	0.273	0.127	1								
2. Firm Size	8.521	1.449	-0.221***	1							
3. Market-to-Book Ratio	1.973	1.171	-0.205***	-0.032	1						
4. Leverage Ratio	0.201	0.099	0.048	-0.066	0.280***	1					
5. Liquidity Ratio	1.345	0.555	0.144**	-0.217***	-0.197***	-0.263***	1				
6. Dividend Payout	0.040	0.052	0.246***	0.166**	-0.058	0.164**	-0.122*	1			
7. Supply Chain Complexity	0.439	0.157	-0.221***	0.406***	0.065	0.052	-0.204***	0.049	1		
8. Supply Chain Efficiency	0.046	0.606	-0.110	0.212***	-0.070	-0.009	-0.319***	0.119	0.205***	1	
9. SSCPs	0.436	0.296	-0.333***	0.599***	0.046	-0.097	-0.118	0.157**	0.425***	0.249***	1

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ (two-tailed tests).

Table III.

Results of regression models

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	0.521*** (4.122)	0.466*** (3.614)	0.448*** (3.637)	0.471*** (3.708)	0.451*** (3.660)
Firm Size	-0.022*** (-2.632)	-0.015* (-1.661)	-0.010 (-1.107)	-0.016* (-1.740)	-0.011 (-1.204)
Market-to-Book Ratio	-0.024*** (-2.850)	-0.024*** (-2.794)	-0.026*** (-3.095)	-0.020** (-2.402)	-0.022*** (-2.699)
Leverage Ratio	0.109 (1.159)	0.099 (1.060)	0.088 (0.965)	0.110 (1.191)	0.100 (1.113)
Liquidity Ratio	0.010 (0.510)	0.008 (0.429)	0.010 (0.551)	0.014 (0.756)	0.014 (0.790)
Dividend Payout	0.600*** (4.353)	0.636*** (4.593)	0.623*** (4.594)	0.668*** (4.903)	0.651*** (4.849)
Supply Chain Complexity	0.024 (0.359)	0.039 (0.592)	0.048 (0.754)	0.052 (0.805)	0.060 (0.942)
Supply Chain Efficiency	0.023 (1.420)	0.023 (1.426)	0.030* (1.880)	0.038** (2.250)	0.041** (2.472)
SSCPs		-0.070** (-1.791)	-0.056* (-1.478)	-0.213*** (-3.250)	-0.178*** (-2.725)
SSCPs × Supply Chain Complexity			-0.599*** -(3.106)		-0.528*** (-2.728)
SSCPs × Supply Chain Efficiency				-0.123*** (-2.701)	-0.102** (-2.272)
Year Dummies	Included	Included	Included	Included	Included
Industry Dummies	Included	Included	Included	Included	Included
Number of Observations (*N*)	187	187	187	187	187
R-square	0.560	0.574	0.612	0.596	0.619
Wald Chi-square	215.04***	221.08***	240.27***	237.90***	251.90***

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ (two-tailed tests for control variables and one-tailed tests for hypothesized variables). *z*-statistics are in parentheses. All independent variables are lagged by one year from the dependent variable.

Table IV.

Results of robustness tests

Models	SSCPs	SSCPs × Supply Chain Complexity	SSCPs × Supply Chain Efficiency	*N*	R-square	Wald Chi-square
1. Measure financial risk based on AEX All Share index	-0.155*** (-2.407)	-0.495*** (-2.591)	-0.099** (-2.234)	187	0.612	250.37***
2. Impact of SSCPs on total financial risk	-0.183*** (-2.699)	-0.408** (-2.027)	-0.103** (-2.222)	187	0.665	365.86***
3. Impact of SSCPs on systematic financial risk	-0.242 (-1.200)	0.534 (0.875)	-0.143 (-1.022)	187	0.419	65.44***
4. Impact of SSCPs on abnormal stock returns	0.000 (-0.128)	-0.002 (-0.987)	0.000 (0.420)	187	0.227	42.19**
5. Impact of SSCPs on return on assets	0.023 (0.550)	-0.081 (-0.618)	0.019 (0.667)	187	0.188	45.79***
6. Value-weighted measure of supply chain complexity	-0.183*** (-2.805)	-0.468*** (-2.639)	-0.106*** (-2.346)	187	0.614	254.42***
7. Geographical dimension of supply chain complexity	-0.152*** (-2.598)	-0.286** (-2.314)	-0.088** (-2.163)	181	0.648	278.46***
8. Industrial dimension of supply chain complexity	-0.222*** (-3.469)	-0.035 (-0.297)	-0.122*** (-2.797)	174	0.652	250.81***
9. Alternative measure of supply chain efficiency	-0.054* (-1.397)	-0.470*** (-2.437)	-0.391* (-1.337)	191	0.584	241.63***
10. Alternative estimator	-0.146*** (-2.785)	-0.536*** (-2.612)	-0.083*** (-2.353)	187	0.668	320.13***
11. Additional controls	-0.219*** (-3.222)	-0.282* (-1.310)	-0.155*** (-3.207)	129	0.631	242.21***
	Financial Risk	Financial Risk × Supply Chain Complexity	Financial Risk × Supply Chain Efficiency	*N*	R-square	Wald Chi-square
12. Impact of financial risk on SSCPs	-0.085 (-0.273)	-0.764 (-1.182)	0.108 (0.760)	188	0.582	159.02***

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ (one-tailed tests). *z*-statistics are in parentheses. All independent variables are lagged by one year from the dependent variable.

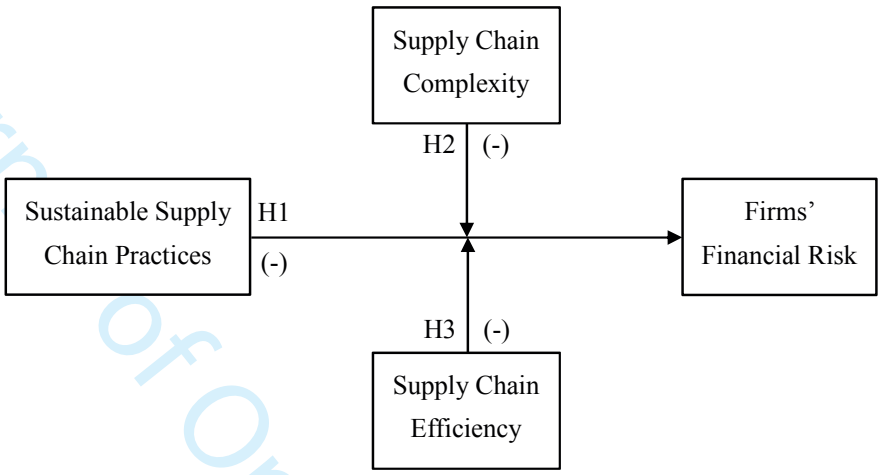

Figure 1.
Conceptual model