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The impact of information integration on supply chain finance and product
innovation performance: A case study

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Abstract

Purpose This study focuses on the implementation of an innovative supply chain finance (SCF) solution (i.e., purchase order finance) by an innovative SCF lender (i.e., supply chain service provider). It empirically investigates the impact of information integration between an SCF lender and borrowers on the lender's SCF decisions and the borrowers' product innovation performance.

Design/methodology/approach We conduct a case study in the Chinese smartphone industry. A mixed method design is used, and data are collected from both the SCF lender and borrowers. We first use an exploratory case study approach and collect qualitative data. Hypotheses are developed about the relationships between information integration, SCF and product innovation performance. We then conduct a confirmatory case study and collect quantitative data. As data are obtained from the firm and project levels, a multilevel structural equation modelling method is used to test the hypotheses.

Findings We find that the SCF lender and borrowers integrate information through both social interaction and information system integration. Information system integration is positively associated with SCF but does not significantly affect product innovation performance. Social interaction is negatively associated with SCF but positively associated with product innovation performance. SCF is positively associated with product innovation performance.

Originality/value This study contributes to the SCF literature by providing empirical evidence on the implementation of SCF from both the lender's and borrower's perspectives. We find that information system integration and social interaction have different effects on SCF and product innovation performance. The results thus provide insights into how a lender makes SCF decisions and into the benefits of SCF for borrowers.

Keywords: information integration, supply chain finance, product innovation performance, mixed method research

Article Classification: Research paper

1. Introduction

Late payment is a headache for businesses all over the world. Supply chain finance (SCF) aims to ensure that companies in the supply chain receive early payment and can obtain loans to finance growth and innovation (Wuttke et al., 2019). It uses supply chains to fund internal operations (Wuttke et al., 2013b). SCF has become an important tool for facilitating trade and optimising the planning, managing and control of working capital (Extra et al., 2019). The global volume of SCF in 2017 was \$574 billion and funds in use was \$212 billion, increasing 28% and 26% over 2016, respectively (Bickers, 2019). It is estimated that the size of the global working capital finance market is about \$56.3 trillion and that around half the companies in the S&P 500 (e.g., Procter & Gamble, Rolls-Royce, Coca-Cola and Vodafone) use some form of working capital finance (Greensill, 2019).

A number of innovative SCF models have been introduced, and new SCF lenders have entered the market (Caniato et al., 2019, Jia et al., 2020a), especially in emerging markets (10000link, 2019). Recent surveys show that the SCF industry in China has special characteristics compared with that in Europe (Liu et al., 2015, Bals, 2019). For example, reverse factoring is the most common SCF solution in Europe, whereas purchase order finance is preferred in Asia (Extra et al., 2019). Although new entrants such as platform and logistics service providers play important roles in the SCF industry, banks and factors remain the most important financial actors in Europe (Extra et al., 2019). Around one third of SCF lenders in China are supply chain service providers (SCSPs) (10000link, 2019). Aside from SCF solutions, Chinese SCSPs offer value-added services for borrowing companies, which are usually small and medium-sized enterprises (SMEs) that need funds to function and expand their business. These services include customs clearance, inventory management, logistics, import/export commodity inspection and international settlement (Liu et al., 2015). SCSPs can thus monitor and control the information and physical flows in supply chains and play an important role in providing SCF solutions (10000link, 2019). However, the majority of existing studies of SCF solutions are from the buyer's perspective (Caniato et al., 2019, Zhao and Huchzermeier, 2019) or focus on the manufacturer-centred financial network (Jia et al., 2020a). Empirical evidence of how SCSPs implement SCF solutions remains scarce (Liu et al., 2015, Xu et al., 2018).

This study aims to investigate the impact of information integration between SCSPs (i.e., SCF lenders) and SCF borrowers (SCFBs) on the SCSPs' SCF decisions and the SCFBs' product innovation performance. We focus on purchase order finance, an important pre-shipment finance instrument for mitigating SCFBs' capital constraints (Zhao and

Huchzermeier, 2019). Purchase order finance is a loan provided by a finance provider to a seller of goods for the sourcing or conversion of raw materials or semi-finished goods into finished goods that are delivered to a buyer (Global Supply Chain Finance Forum, 2016). It is based on a purchase order guaranteed by the buyer (Zhao and Huchzermeier, 2019) and covers the working capital needs of the seller, including the procurement of raw materials and other pre-shipment expenses, to allow the seller to fulfil delivery to the buyer (Global Supply Chain Finance Forum, 2016). An SCSP (i.e., SCF lender) and seller (i.e., SCFB) have different information on the uncertainties and risks of a transaction with a buyer. In addition, because of the inadequate credit guarantee system in China and the low credit ratings and high default frequency of Chinese SMEs, SCSPs face the issues of moral hazard and adverse selection, leading to credit risks (Stiglitz and Weiss, 1981, Liu et al., 2015). Therefore, an SCSP must use a variety of screening devices and mechanisms to control SCFBs' opportunistic behaviours (Pfohl and Gomm, 2009). Information integration can improve connectivity and transparency in supply chains, and thus reduce information asymmetry between an SCSP and SCFBs (Bals, 2019, Chen and Cai, 2011). Such integration allows SCSPs to evaluate SCFBs' ability or willingness to repay SCF. Researchers have argued that information integration allows an SCF lender to identify valuable projects, determine the probability of default, and monitor and control financial risks (Cenni et al., 2015, Bias and Gollier, 1997). However, empirical evidence is still lacking for how an SCSP integrates information in a supply chain and the impact of information integration on its SCF decisions (Jia et al., 2020a, Gelsomino et al., 2016). Thus, the first research question addressed by this paper is: what are the impacts of information integration on an SCSP's SCF decisions?

The impacts of SCF on supply chain members' operations, performance and capability development have attracted increasing research interest (Xu et al., 2018, Jia et al., 2020b). Because SCF connects operational with financial decisions, it has been viewed as a critical way for supply chains to improve transparency and stability and manage financial risks (Caniato et al., 2016, Silvestro and Lustrato, 2014). Researchers have argued that SCF can improve supply chain performance by shortening the cash-to-cash (C2C) cycle and optimising working capital in a supply chain through a decrease in accounts receivable or an increase in accounts payable (Xu et al., 2018). Empirical evidence also reveals that SCF solutions allow supply chains to decrease financial costs and improve access to finance, alleviating supply chain members' financial distress (Caniato et al., 2016, Gelsomino et al., 2016). For example, purchase order finance allows an SCFB to obtain financing to fulfil an order from a buyer. An SCF lender can also reduce its credit risk because of the greater

control and reassurance in the trading relationship between the SCFB and its buyer (Global Supply Chain Finance Forum, 2016). Although researchers have argued that SCF may serve as a catalyst for innovation, the empirical evidence on the impact of SCF solutions on innovation performance is limited (Jia et al., 2020b). The second research question addressed by this paper is therefore: what are the impacts of SCF on an SCFB's product innovation performance?

The study contributes to the literature in three ways. First, the findings enhance current understandings of how information integration enables and supports SCF. Caniato et al. (2019) highlight the need to address the role of real-time information and digital technologies in SCF implementation. Bals (2019) calls for a broader discussion of how information technologies (ITs) support SCF. Jia et al. (2020a) argue that empirical evidence of how inter-organisational relationships affect SCF practices is scarce. This study advances previous conceptual studies by providing empirical evidence of the distinctive effects of information system integration and social interaction on an SCSP's SCF decisions (Bals, 2019, Jia et al., 2020a). The findings also improve existing knowledge on the coordination of information and financial flows in supply chains and provide insights into how SCF lenders manage financial risks (Gelsomino et al., 2016, Liu et al., 2015).

Second, this study provides empirical evidence of the impact of SCF solutions on product innovation performance, thus demonstrating the non-financial benefits of SCF solutions (Caniato et al., 2019). In a literature review, Gelsomino et al. (2016) find that SCF solutions can bring financial and operational benefits, such as improved supply chain visibility and C2C cycles, reduced risk of bankruptcy and strengthened supply chain links. In another literature review, Xu et al. (2018) find that SCF positively influences operational performance. Jia et al. (2020b) argue that SCF solutions enable supply chain innovation, which improves sustainability. The present study sheds light on the benefits to SCFBs of adopting SCF solutions, enhancing the knowledge of the performance outcomes of SCF (Liu et al., 2015).

Third, this study presents a case study that focuses on an SCSP in the Chinese smartphone industry and purchase order finance. Liu et al. (2015) find that the SCF phenomenon is contingent on specific national or business system characteristics. Xu et al. (2018) call for more research examining SCF in specific industries. Jia et al. (2020a) find that most of the SCF studies focus on banks and manufacturers as SCF providers. They call for further investigation into the roles of supply chain orchestrators in integrating supply chain flows. The present study enhances current understandings of how SCSPs, who are innovative

SCF lenders, integrate information and financial flows and implement SCF (Jia et al., 2020b, Caniato et al., 2019). In addition, researchers have shown that most SCF studies focus on reverse factoring (Bals, 2019) and trade credit (Xu et al., 2018). Other innovative SCF solutions have received less attention (Gelsomino et al., 2016). This study contributes to the literature by providing empirical evidence on the implementation of purchase order finance. Moreover, researchers have highlighted a lack of empirical research on SCF (Liu et al., 2015, Gelsomino et al., 2016, Caniato et al., 2019, Jia et al., 2020b). Using a mixed method, this study collects qualitative and quantitative data from an SCF lender and borrowers. The findings provide empirical evidence on different stakeholders' views of SCF, leading to a better understanding of SCF implementation (Bals, 2019, Xu et al., 2018).

The next section reviews the literature on SCF. Section 3 introduces the research methods and presents the findings of the exploratory and confirmatory case studies. In section 4, we discuss the empirical findings, highlight the theoretical and practical implications, and point out the study's limitations and future research directions.

2. Literature review

SCF is a topic of increasing interest in academia, and several researchers have conducted literature reviews on the topic. One stream of literature reviews focuses on classifying existing studies to identify research themes. For example, Liu et al. (2015) review SCF research published in Chinese journals. They find that existing studies focus on concept development, the operation and coordination of involved parties, risk management, collateral and the institutional environment of SCF in China. They argue that the integration of material, information and financial flows and the performance measurement of SCF are two themes that require critical attention. Gelsomino et al. (2016) identify two main ways that SCF has been defined. The finance oriented perspective views financial institutions (i.e., lenders) as an essential component and focuses on payables and receivables, whereas the supply chain oriented perspective focuses on working capital optimisation in terms of inventories and fixed asset financing. The researchers highlight the lack of empirically based holistic analyses of the application of SCF. Xu et al. (2018) argue that SCF research includes two main streams. The first focuses on how financial mechanisms affect operation decisions through inventory models, and the second on how financial mechanisms influence operation decisions in the entire supply chain and how SCF services create value for the supply chain. They similarly call for empirical and case studies of SCF in specific industries. Another stream of literature reviews focuses on developing research frameworks. For example, Bals (2019) proposes a

framework for SCF ecosystems that includes dimensions for supply chain collaboration, organisation, finance, technology, market and regulation, products, stakeholders and life cycles. The author also suggests that future research should explore SCF from the perspective of solution providers and the implementation of various SCF solutions. Jia et al. (2020a) develop a framework using the information processing theory and identify mapping financial structures, designing financial business processes and sharing financial information systems as three SCF capabilities that enable financial supply chain integration. They call for more research to investigate the impacts of technologies and inter-organisational relationships on different SCF practices and the roles of logistics service providers and supply chain orchestrators in SCF. Jia et al. (2020b) develop a framework for sustainable SCF by identifying motivations, solutions, enablers, barriers and performance for supply chains. They suggest that future research explore SCF in the context of specific industries and developing regions, and apply more empirical methods and case studies.

The literature reviews reveal that the existing empirical evidence on SCF implementation is still limited and fragmented (Bals, 2019, Gelsomino et al., 2016). There are few empirical studies investigating the applications of innovative SCF solutions in specific industrial and regional contexts (Gelsomino et al., 2016, Xu et al., 2018). Although existing research has shown that SCF can improve operational and financial performance (Xu et al., 2018), it is necessary to identify the performance outcomes of SCF beyond financial indicators (Caniato et al., 2019, Jia et al., 2020b). Researchers have shown that technology and supply chain collaboration enable the integration of supply chain financial and information flows (Bals, 2019); however, there is insufficient empirical evidence for the impact of inter-organisational relationships and ITs on the application of SCF (Caniato et al., 2019, Jia et al., 2020a). In addition, researchers have highlighted that knowledge about the role of innovative SCF lenders and the interactions between different SCF stakeholders remains limited (Caniato et al., 2019, Jia et al., 2020a).

Analytical models have shown that SCF by third party logistics (3PL) firms improves supply chain performance. For example, Chen and Cai (2011) find that a 3PL firm's integration of logistics and financial services can bring profits to both itself and the entire supply chain. Chen et al. (2019) find that some 3PL firms have emerged as supply chain orchestrators and SCSPs through providing procurement and financial services. They find that these firms play a critical intermediary role in supply chains by offering SCF, and that supply chains led by such firms can achieve higher profit. Huang et al. (2019) show that financial services offered by a 3PL firm can lead to the Pareto improvement of the profit of a

supply chain. Although some scholars have started to empirically investigate the SCF offered by 3PL firms and SCSPs (Li and Chen, 2019), empirical evidence on how they make SCF decisions is limited.

Several researchers have conducted qualitative case studies to empirically investigate the implementation of SCF solutions. For example, Wuttke et al. (2013a) explore the SCF adoption process. They find that supplier relationship has a positive impact on the dissemination of SCF and that supplier involvement can enhance the effectiveness of the interrelated processes of restructuring the organisation and redefining SCF. Wuttke et al. (2013b) investigate the consequences of pre- and post-shipment financial supply chain management. They find that the former can improve upstream supply chain working capital, whereas the latter can improve downstream supply chain working capital. They also report that both forms of financial supply chain management can reduce the risks of supply chain and cash flow disruption, and the effects are influenced by supply chain integration. Caniato et al. (2016) study the implementation of traditional financial solutions (reverse factoring and captive factoring), innovative financial solutions (advanced forms of reverse factoring, inventory financing, dynamic discounting and seller-based invoice auction) and supply chain collaboration solutions (vendor managed inventory and consignment stock). They find that digitalisation is positively associated with innovative and supply chain collaboration solutions but negatively affects traditional financial solutions. Moreover, inter-firm collaboration and power are critical when SCF is adopted to improve financial performance. Martin and Hofmann (2019) classify SCF practices according to the time of financing and source of funds. They find that the financial service provider's IT capabilities and supply chain relationship-related factors influence the application of SCF practices. Therefore, the case studies reveal that IT and social relationships play critical roles in the application of SCF. However, the case studies were conducted in Europe, and they do not furnish empirical evidence on the application of innovative SCF solutions (e.g., purchase order finance). Recently, quantitative studies have been conducted to investigate SCF adoption. For example, using data collected from an SCF technology platform, Wuttke et al. (2019) find that suppliers adopt SCF faster when they face increased mimetic and normative pressures, anticipate larger cost reductions and have less access to finance.

3. Research methods

This study adopts a mixed method design and combines exploratory and confirmatory case study approaches (Ridder, 2017). There are four reasons that we use a mixed method

(Saunders et al., 2019): 1) initiation: qualitative data are used to develop measures and hypotheses, and quantitative data are used to test the hypotheses. An exploratory case study is used for contextualisation and to define the nature and scope of the confirmatory case study; 2) generalisability: the confirmatory case study helps us validate, extend and modify the findings of the exploratory case study; 3) diversity: qualitative and quantitative data are collected from an SCF lender and borrowers, allowing the study to reflect the diverse views of different stakeholders; 4) triangulation: combining qualitative and quantitative data from multiple sources allows us to ascertain if the findings from exploratory and confirmatory case studies corroborate each other.

3.1 Exploratory case study

3.1.1 Case selection

Theoretical sampling was used to select the case (Yin, 2009). We selected a supply chain service provider (i.e., SCFL) in the Chinese smartphone industry as a representative case that enables us to capture the application of purchase order finance (Yin, 2009). Because of China's immature market mechanism and under-developed credit rating system, Chinese SMEs suffering from a shortage of fixed assets experience difficulty in obtaining access to liquidity through conventional bank loans (Liu et al., 2015). This has been a longstanding issue for the Chinese smartphone industry, which is characterised by hyper-competitiveness, fast-changing consumer tastes and very short product life cycles. The industry has a growing number of product designers that are expanding their business in the international market. The rapid, successful launch of new products is critical for them to gain competitive advantages in this industry. They are typically cash-constrained SMEs that focus on research and development (R&D) but lack production and supply chain management capabilities. They also face challenges due to prolonged customs clearances (usually 1 to 2 days), frequent inspections of imported materials and exported goods, and prolonged waits for tax refunds. They cannot provide advance payment for procurement after receiving orders from customers nor obtain loans from banks. The SCF provided by SCSPs has been viewed as a solution to this problem, as product designers can obtain working capital in this way to support product innovation using purchase orders as collateral (Liu et al., 2015, 10000link, 2019, Li and Chen, 2019).

SCFL has been acknowledged as one of the most successful SCSPs in the Greater Bay Area of China. In its early days, SCFL mainly offered import and export services, such as customs clearance and duty drawback. Nowadays, it offers an '*Internet plus supply chain plus financing*' business model. Specifically, it has developed an E-SCM platform and offers

supply chain execution services (e.g., customs clearance for imports and exports, international and domestic logistics, warehouse management, vendor managed inventory, free trade zone logistics, purchasing and sales) and supply chain integration services (e.g., manufacturing, distribution and full-integration supply chain services). SCFL has been given an ‘AA’ rating among enterprises recognised by the Chinese customs and has been awarded ‘Direct Passage’ status by the Shenzhen tax bureau. SCFL has also developed close collaborative relationships with commercial banks. It has received a combined credit line of 10 billion Chinese yuan. It has also received the designation of ‘headquarter-level business partner’ from the China Construction Bank and ‘branch-level key customer’ from the Bank of China and Industrial and Commercial Bank of China. Based on its supply chain management services and support from banks, SCFL has offered SCF to product designers since 2009 to finance the procurement of components and raw materials, which can improve their financial efficiency by decreasing borrowing costs and loan barriers. In addition, SCFL has made a major effort to integrate information flows with product designers. Therefore, this case study offers the opportunity to unpack the relationships between information integration, SCF, and product innovation performance (Ridder, 2017).

3.1.2 Data collection

The data sources include semi-structured interviews and secondary data (e.g., company reports and information from the Internet). Triangulation on important issues allows the research team to cross-verify the findings (Yin, 2009).

The interviews were guided by a research protocol (Appendix I), which was developed based on the research questions, literature review and secondary data. In total, this research project spanned a period of 18 months. The research team interviewed 10 senior managers in SCFL, including the president, director and vice director of the information system department, the director and vice director of the risk control department, the director of the financial department, two business managers, and two operations managers. We also interviewed four general managers and one finance manager from four product designers (i.e., SCFBs). Each interview lasted approximately two to three hours and was conducted in Chinese. The interviews were all audio-recorded. The team members conducted debriefing meetings both before and after each interview to share information and experiences and to review the logic and contents of the interviews to establish a chain of evidence. The recordings were sent to a professional for transcription; the results were then translated into English by a professional translator. In addition, the research team stayed in informal contact

with the managers via telephone, e-mail and instant message software to clarify the issues raised in the debriefing meetings and ask for further explanations. The case database includes transcripts, notes, documents gained from SCFL, and information from the Internet. The reliability of this study is addressed by the research protocol and the development of the case study database (Yin, 2009). Using multiple data sources and maintaining a chain of evidence help this study to establish construct validity (Yin, 2009).

3.1.3 Findings

3.1.3.1 SCF

The SCFBs have limited physical assets for collateral and their cash flows are weak, resulting in low credit ratings and hence difficulty in obtaining loans from banks (Pfohl and Gomm, 2009). SCFL's president commented that *'the financing for these product designers is difficult, expensive, and chaotic'*. The general managers of SCFBs highlighted that they *'cannot provide advance payment for purchasing raw materials and components after receiving orders from customers'* and *'lack funds to conduct R&D and commercialise new product designs'*.

According to SCFL's president, SCF is managed on a project basis, and involves two players: SCFBs, which are the product designers selling to domestic and foreign customers, and SCFL, which is the finance provider. An SCF project begins with a purchase order confirmed by a customer (Zhao and Huchzermeier, 2019). SCFL provides purchase order finance to cover a certain percentage of the SCFBs' procurement costs (Global Supply Chain Finance Forum, 2016). A key SCF decision made by SCFL is the proportion of the loan to the total purchasing cost of raw materials and components, which is determined by SCFL's assessment of risks. An SCF project is initiated by SCFBs after they receive purchase orders and ends when SCFL receives payment (principal, interest and service fees) from customers. Although customers are not directly involved in the SCF project, the source of the repayment is usually the sales from the customers. The director of SCFL's risk control department mentioned that the main risks of the SCF projects are SCFBs' willingness and ability to fulfil the purchase orders (Liu et al., 2015). To control financial risks, SCFL requires SCFBs to ask their customers to pay the deposit and retainage directly to SCFL. The financial manager of an SCFB commented, *'SCFL helped us evaluate the credit history of an international customer and the validity of its orders, because different customers used different forms of payments, such as Teletext, Letter of Credit (LC), or even Open Account. SCFL has to be more watchful than us because the LC is sent to SCFL, not us!'* Moreover, using the loan, SCFL purchases the raw materials and components in international and domestic markets on

behalf of the SCFBs. It also requires SCFBs to use its supply chain management services: for example, it directly sends the components from suppliers to assembly plants and helps the SCFBs with export customs clearance (including paying tax), international and domestic logistics, inventory management (including storage, sorting and delivery), settlement and tax refunds (Chen et al., 2019). In addition, SCFL requires SCFBs to share large amounts of information and knowledge about the supply chain processes.

As SCFL's president commented, SCFL is '*deeply integrated into SCFBs' supply chain processes to control its assets prior to shipment*'. The directors of SCFL's risk control and financial departments mentioned that social interactions and information systems play critical roles in SCFL's risk assessment of an SCF project, because they can reduce information asymmetry (Martin and Hofmann, 2019). The SCFBs' general managers commented that SCF allows them to obtain financing to fulfil customer orders. They also commented that the collaboration with SCFL helps them reduce the lead time and costs in supply chains, optimise working capital and invest more in R&D (Li and Chen, 2019). The president of SCFL explained that combining SCF with supply chain management services gives it greater control of the loans, which reduces financial risks (Wuttke et al., 2013a). Moreover, managing supply chains jointly with SCFBs allows them to build '*a "joint-win" and "joint-management" chain*' and achieve a '*win-win relationship*'.

3.1.3.2 Information integration

SCFL's managers all agreed that information integration with SCFBs plays a critical role in SCF decisions. The connectivity and information transparency of supply chains can be significantly improved, leading to lower information asymmetry between SCFL and SCFBs (Gimenez and Venture, 2005). Data synchronisation and knowledge sharing allow SCFL to offer supply chain management services and integrate operational and financial processes (Silvestro and Lustrato, 2014, Jia et al., 2020a). As a result, information integration can significantly reduce SCFL's financial risks. As SCFL's president commented, '*SCFBs do not necessarily have low credibility. Sometimes, their transactions are scattered around and lack transparency to banks. Information integration gives them a place to aggregate their scattered transactions together with quantifiable data to prove their credibility*'.

SCFL's business and operations managers explained that communication and interaction between SCFL's and SCFBs' employees ensure the SCFBs understand SCFL's supply chain management services and their obligations (Zhang et al., 2015), and especially how SCFL manages SCF projects and business processes. SCFL's president highlighted that SCFL offered SCF to SCFBs '*that have a vision, customer orders, and technology, but lack capital,*

supply chains, and a strong credit history'. Social interactions allow SCFL to identify such SCFBs and establish a cooperative relationship with them (Bals, 2019). Managers in the SCFBs all mentioned that their employees maintain close contact with SCFL to ensure they receive support in their purchasing, inventory and logistics operations and solve problems quickly. Thus, social interactions allow SCFL and SCFBs to integrate supply chain processes (Huo et al., 2013). Moreover, SCFL's operations managers commented that interactions between employees enable SCFL to obtain suggestions for improvement and technical knowhow from SCFBs (Gimenez and Venture, 2005). According to SCFL's president, through frequent social interactions, SCFL and SCFBs can align business processes and coordinate decision making.

SCFL has spent a great deal of effort and resources on IT and has developed an E-SCM system that features a range of software and applications. The director of SCFL's information system department explained that SCFL uses the SAP ERP system as the backbone of the IT infrastructure, and it has an IBM Si integrated data centre and an in-house developed B2B web-based database. SCFBs can access the E-SCM system through an Internet portal. SCFL's president commented that the system enables *'faster communication, shorter lead time, lower transaction costs, lower pipeline inventory, and more effective planning and coordination in supply chains'* (Devaraj et al., 2007). SCFL has encouraged the SCFBs to use the E-SCM system directly to acquire, share and analyse data, or to develop an information system compatible with the E-SCM system to synchronise data. SCFBs' managers agreed that using the E-SCM system improves the quality, quantity and speed of information flows (Zhang et al., 2018). SCFL also verifies the information by checking the materials and products in supply chains, such as warehouse shelves, assembly lines and trucks. The E-SCM system gives SCFL an advantage over banks in managing risks when lending to SCFBs, as the banks normally cannot control the physical, information, and financial flows in supply chains at the operational level (Liu et al., 2015, Li and Chen, 2019). The operational and financial information exchanged via the E-SCM system enables SCFL to build a *'closed-loop system'*, reducing the information asymmetry and risks of SCF projects (Lee et al., 2015, Xu et al., 2018). Therefore, the case evidence reveals that SCFL integrates information flows with SCFBs through social interaction and information system integration.

3.1.3.3 The impact of information integration on SCF

Social interaction allows employees in SCFL and SCFBs to develop a common understanding of their roles and responsibilities and to agree upon inter-organisational processes in managing supply chains and SCF projects (Huo et al., 2013). As SCFL's

president explained, interactions with SCFBs' employees help it identify and collaborate with the SCFBs that have compatible cultures, goals and strategies, thus developing trust and long-term relationships (Villena et al., 2011). The directors of SCFL's risk control and financial departments emphasised that such relationships can discourage SCFBs' opportunistic behaviours, reducing SCF risks (Ferri and Murro, 2015, Kirschenmann, 2016). In addition, SCFBs' general managers commented that frequent, regular interactions with SCFL, such as by attending conferences, seminars and workshops, help them obtain support on supply chain management, integrate their business processes with SCFL and solve problems quickly. Doing so improves the SCFBs' capabilities to fulfil customers' orders, reducing the probability of default (Zhao and Huchzermeier, 2019). Moreover, social interactions facilitate the exchange of soft information such as private knowledge about supply chain partners, industrial knowhow and suggestions for improvement (Zhang et al., 2018). This knowledge can decrease information asymmetry in supply chains, reducing operational uncertainties and financial risks (Stiglitz and Weiss, 1981). As a result, SCFL can accumulate more knowledge about SCFBs' strategies, capabilities and operational processes via social interaction, enabling it to better evaluate, monitor and control SCF projects (Bias and Gollier, 1997). Therefore, we propose the following hypothesis.

H1. Social interaction between SCFL and SCFBs is positively associated with the SCF received by the SCFBs.

As the director of SCFL's information system department commented, the E-SCM system is '*a common service platform on the Internet to promote fully automated data exchange*'. SCFL's president argued that the '*E-SCM system gives us a control lever for all flows: We can see and control all flows of the data, goods, and money passing through the platform! With this tight control, SCFL has been able to provide financing to its clients who have a hard time getting loans from traditional channels.*' SCFL encourages SCFBs to either use the E-SCM system to manage their supply chains or integrate their information systems with it. As a result, the information systems in the supply chains can be fully integrated (Devaraj et al., 2007). Sharing information on physical and financial flows in integrated information systems improves the transparency of the supply chains, reducing SCFL's financial risks (Martin and Hofmann, 2019). Using integrated information systems to manage supply chain and business processes allows SCFL to acquire timely, accurate hard information about procurement, production, inventory, delivery and settlement from SCFBs, which improves the transparency of their operations and allows SCFL to monitor and control the physical and financial flows to ensure the repayment of SCF (Caniato et al., 2016, Jia et al., 2020a). In

addition, information system integration furnishes SCFL with a large amount of data on SCFBs' past supply chain operations and SCF projects, giving it a better understanding of SCFBs' ability to fulfil customer orders, and enabling it to predict the profitability and risks associated with SCF projects. Therefore, information system integration can reduce the information asymmetry and uncertainties of SCF projects (Caniato et al., 2019). As a result, integration between SCFBs' information systems and the E-SCM system plays a critical role in the success of SCF projects, and the degree of information system integration is a key criterion for SCFL when making SCF decisions. Therefore, we propose the following hypothesis.

H2. Information system integration between SCFL and SCFBs is positively associated with the SCF received by the SCFBs.

3.1.3.4 The impact of information integration on product innovation performance

The managers in SCFBs commented that quickly introducing high quality products is critical for their survival and growth. They also highlighted that although SCFL does not directly participate in R&D processes, social interactions with SCFL enable them to obtain knowledge about market and supply chain partners and suggestions for improvement (Zhang et al., 2015, Zhang and Li, 2010). According to SCFL's president, supply chain coordination is one of its core competences. He explained that *'more and more smartphone supply chain partners, from foreign clients who make orders to upstream component suppliers and logistics providers, band together to use our supply chain management services. Therefore, I usually say that our supply chain services are "embedded" in the (smartphone) industry'*. As a result, SCFL has developed good relationships with various stakeholders in supply chains and accumulated knowledge through offering supply chain management services, such as changes in customer preferences and market demand, the capabilities and service level of supply chain members, and the technical specifications and quality of components (e.g., display, speaker and camera). Active and frequent interactions and communications enable SCFBs to acquire private knowledge and technical knowhow when integrating business processes with SCFL (Villena et al., 2011). The knowledge helps SCFBs identify high quality suppliers for different components and develop a deeper understanding of customer preferences, which ensure the successful launch of new products (Vorhies and Morgan, 2005). The SCFBs' managers also highlighted that social interactions help them obtain support from SCFL with supply chain management. For example, SCFL offers a *'three in one'* supply chain project service, which includes consultation, service and supply chain execution. It provides the design and planning of an integrated supply chain for a new product and helps

SCFBs purchase components and services, which enables them to establish relationships with a bundle of trustworthy, high-quality component suppliers, assembly plants, warehouses and 3PL firms. These can not only ensure the quality of new products but also speed up new product introduction (Zhang and Li, 2010). In addition, SCFBs' managers mentioned that active and frequent social interactions help them quickly solve problems related to purchasing, manufacturing, inventory and logistics, which enables them to launch new products at high speed (Zhang and Li, 2010, Zhang et al., 2018). Therefore, we propose the following hypothesis.

H3. Social interaction between SCFL and SCFBs is positively associated with the SCFBs' product innovation performance.

The director of SCFL's information department explained that the E-SCM system provides 'a common infrastructure and protocol to enable real-time information exchange among supply chain members.' Integrating information systems with the E-SCM system allows SCFBs to obtain real-time transaction data on component purchasing and delivery, inventory management and delivery, which allows them to improve operational scheduling and strategic planning for new product development (Vorhies and Morgan, 2005). The director also mentioned that the E-SCM system collected a great deal of hard information in areas such as overseas demand, bill of materials of different smartphone designs and qualified component suppliers and contracting manufacturers. Using the E-SCM system can help SCFBs digitalise operations and use big data analytical tools to identify market opportunities, screen new product ideas and design and plan supply chains, enabling them to successfully launch new products (Zhang and Li, 2010). Therefore, using information systems to support supply chain collaboration enables SCFBs to develop seamless business processes and avoid miscommunication and delays, which reduces the costs and lead-time of new product introduction (Zhang et al., 2018). Synchronising data and exchanging information using information systems greatly improves the efficiency and effectiveness of the information flows, which enables SCFL to grasp the technical specifications of the new products and components and the requirements of the production processes (Devaraj et al., 2007). As a result, SCFL can help the SCFBs source and purchase high quality components and services, improving the quality of new products (Zhang and Li, 2010). Therefore, we propose the following hypothesis.

H4. Information system integration between SCFL and SCFBs is positively associated with the SCFBs' product innovation performance.

3.1.3.5 The impact of SCF on product innovation performance

The SCFBs' managers explained that SCF plays a critical role in supporting new product development by providing financial resources and reducing purchasing costs (Jia et al., 2020b). One manager of an SCFB mentioned that *'we relied on SCFL to get a good price for our components because SCFL can purchase a component by aggregating multiple orders from different customers. A 500-pixel automatic-focus camera lens, for instance, has a current market price of \$2.50 each. However, with a large purchase volume, the unit price can be lowered to \$1.50. There is no way I can get this price without going through SCFL.'* Therefore, when an SCFB receives more SCF, it can greatly reduce the cash used for purchasing components, which allows the SCFB to spend more resources to speed product commercialisation (Pfohl and Gomm, 2009). SCF allows SCFBs to expand their businesses and serve more customers even if they have limited financial resources (Liu et al., 2015). As a result, they can invest more capital in human resources, information technologies, market research and customer relationship management (Silvestro and Lustrato, 2014). The SCFBs can hire more engineers and invest more resources in industrial design and branding, improving the speed of new product introduction and the quality of the new products (Zhang and Li, 2010). In addition, SCF can reduce SCFBs' working capital pressure, and hence their management can focus on product innovation, ensuring the successful launch of new products (Vorhies and Morgan, 2005). Therefore, we propose the following hypothesis.

H5. SCF received by SCFBs is positively associated with the SCFBs' product innovation performance.

The conceptual framework is presented in Figure 1.

Figure 1 about here

3.2 Confirmatory case study

3.2.1 Data collection

Quantitative data were collected from SCFL and SCFBs to test the hypotheses. Specifically, objective data about SCF were collected from SCFL, and survey data about information integration and product innovation performance were collected from SCFBs. A total of 39 product designers successfully obtained purchasing order finance from SCFL in the year under study. Of these, 33 were willing to participate in this research, and these SCFBs conducted 207 SCF projects with SCFL in the given year. Their profile is provided in Table 1. They allowed SCFL to share data about SCF projects with us. Firm (e.g., number of

employees, annual sales and interest rates) and project level data (e.g., SCF, total purchase amount and payment terms) were collected from the E-SCM system.

Table 1 about here

A questionnaire was designed to collect data related to information integration and product innovation performance from the SCFBs. After consulting with SCFL and based on the findings from the exploratory case study, the general managers of the SCFBs were chosen as the respondents. The questionnaire was pilot tested by four general managers from SCFBs and then revised according to their comments. The questionnaire was then sent to the 33 SCFBs, and all of them answered and returned the questionnaires.

3.2.2 Variables

Social interaction, information system integration and product innovation performance were measured in the questionnaire using a seven-point Likert scale to capture the perceptions of the respondents (Appendix II). The measure was developed based on the findings of the exploratory case study and the existing literature. Social interaction was measured by four items concerning the interactions between SCFL's and SCFBs' employees by which they share knowledge and collaborate on supply chain and business process management. Information system integration was measured by four items about the interconnectedness between SCFL's and SCFBs' information systems and the practices of sharing information and managing business processes using information systems (Huo et al., 2013). Product innovation performance was measured by four items about quickly introducing high quality new products to the market (Zhang and Li, 2010, Vorhies and Morgan, 2005). The respondents were asked about the extent to which they agreed with the statements (1 = 'totally disagree'; 7 = 'totally agree').

The data about SCF were extracted from the E-SCM system. SCF was measured by the proportion of the loan obtained from SCFL to the total purchasing cost of raw materials and components for a customer order (Danielson and Scott, 2004). A high SCF value indicates that SCFL is willing to finance a large proportion of the purchasing cost. The directors of SCFL's financial and risk control departments explained that the amount of the loan provided to a project is largely influenced by the overall purchasing cost. A large loan may result from the high purchasing cost of a large scale project (Danielson and Scott, 2004). Therefore, the key SCF decision made by SCFL is the ratio of the loan given by SCFL to the total purchasing cost, which reflects SCFL's overall evaluation of the project.

We also included firm size, as measured by annual sales, as a control variable for SCF and product innovation performance. Large firms tend to have more resources and higher resilience, and hence SCFL faces lower financial risks (Cenni et al., 2015). Large firms may also have higher capabilities in managing cash flows and more resources for R&D, and hence have better product innovation performance (Zhang et al., 2018). In addition, we controlled for the effects of the interest rate, uncertainty of purchase and uncertainty of receivables on SCF, as they reflect the attractiveness of an SCF project (Bals, 2019). The interest rate affects the profit SCFL may gain from SCF projects and hence influences SCFL's SCF decisions. Uncertainty of purchase was calculated as the standard deviation of the total purchase amount across a series of projects (Yang and Zhao, 2016). Uncertainty of receivables was calculated based on the payment terms by using one minus the sum of the proportion of deposits paid by a customer and the proportion of the balance to be paid by the customer through letter of credit (Luo et al., 2012). Uncertainties of purchase and receivables affect the risks of an SCF project and hence may influence SCFL's SCF decisions.

3.2.3 Analysis and results

We first conducted psychometric tests of the three multi-item constructs (i.e., social interaction, information system integration, and product innovation performance). An exploratory factor analysis (EFA) was conducted. The results indicate that the items have strong loadings on their corresponding constructs (Table 2). We used composite reliability and Cronbach's α to evaluate reliability. The results show that the composite reliability values range from 0.900 to 0.921, and the Cronbach's α values range from 0.877 to 0.919, showing that the reliability of the constructs is acceptable. Average variance extracted (AVE) was used to test for convergent and discriminant validity. The AVE values range from 0.700 to 0.747, indicating that the convergent validity is acceptable. Discriminant validity is demonstrated when the square root of the AVE of each construct is higher than the correlations between the focal construct and each other construct. Table 3 shows the means and standard deviations of the variables, their correlations, and the square roots of the AVEs. A comparison of the correlations and square roots of the AVEs indicates that the constructs have adequate discriminant validity.

Table 2 and 3 about here

We conducted a multicollinearity test of the variables. The results reveal that the smallest tolerance is 0.692 and the largest variance inflation factor is 1.444, indicating that multicollinearity is not a serious problem. We used multilevel structural equation modelling with robust maximum likelihood and MPLUS software to test the hypotheses because data were collected from both firm and project levels. The unidimensional parcels of the multi-item constructs, calculated using the principal component scores, were used in data analysis (Coffman and Maccallum, 2005). All of the other variables were standardised. The results of the data analysis, including the standardised path coefficients, are shown in Figure 2. The model fit indices are as follows: chi-square/df = 1.07, comparative fit index = 0.989, Tucker-Lewis index = 0.936, root mean square error of approximation = 0.018 and standardised root mean square residual = 0.026, which are better than the corresponding threshold values suggested by Hu and Bentler (1999). The findings show that the R^2 for SCF is 29.4%. Information system integration is positively associated with SCF ($b = 0.267, p < 0.05$), whereas social interaction is negatively associated with SCF ($b = -0.340, p < 0.05$). Therefore, H2 is supported, whereas H1 is not. The results also show that the interest rate ($b = 0.100, p < 0.01$) and uncertainty of purchase ($b = 0.278, p < 0.001$) are positively associated with SCF, whereas the uncertainty of receivables ($b = -0.213, p < 0.05$) is negatively associated with SCF. We find that R^2 for product innovation performance is 21.9%. Social interaction ($b = 0.373, p < 0.05$) and SCF ($b = 0.410, p < 0.05$) are positively associated with product innovation performance, whereas the impact of information system integration is not significant. Therefore, H3 and H5 are supported, whereas H4 is not.

We find that the impacts of firm size on SCF and product innovation performance are not significant. As most of the product designers are SMEs, they all have limited resources to invest in R&D and improve resilience even if some are larger in size. A high interest rate indicates that SCFL can profit more from SCF, and hence it increases SCF. Uncertainty of receivables reflects the unpredictability of payment from customers (Luo et al., 2012). High uncertainty of receivables indicates high risks of the SCF not being repaid, and hence SCFL provides less SCF. Uncertainty of purchase reflects volatility of purchasing cost (Yang and Zhao, 2016). High uncertainty of purchase indicates the SCFB may need more cash than expected for purchasing components. As SCF is controlled by SCFL, it tends to provide more SCF to ensure the SCFB can successfully fulfil the purchase order.

Figure 2 about here

4. Discussion and conclusions

4.1 The impact of information integration on SCF: A credit rationing perspective

The findings of the confirmatory case study show that social interaction and information system integration have different effects on SCF. The credit rationing theory provides a useful perspective to explain the findings (Jaffee and Russell, 1976). Credit rationing has been widely applied by SCF lenders to deal with SCFBs' opportunistic behaviours and control financial risks (Kirschenmann, 2016). SCFBs normally have information advantages over an SCF lender because they have private knowledge about the uncertainties and risks of SCF projects. When information asymmetry is high, a lender tends to implement high credit rationing by reducing SCF (Kirschenmann, 2016, Stiglitz and Weiss, 1981). Thus, credit rationing will be high for opaque borrowers who do not share private knowledge such as balance sheets, inventory levels, production scheduling and other financial and operational information because information asymmetry makes it difficult for lenders to determine the probability of default of a specific SCF project (Jaffee and Russell, 1976, Ferri and Murro, 2015). The influence of information integration on credit rationing may vary depending on its efficacy in improving supply chain visibility and transparency and overcoming information gaps between SCF lenders and SCFBs (Ferri and Murro, 2015, Cenni et al., 2015). The impact of information integration on a SCF lender's SCF decisions therefore will be determined by how effectively it enables the SCF lenders to screen and control SCFBs and to identify valuable projects (Cenni et al., 2015, Bias and Gollier, 1997).

The statistical analysis reveals that social interaction is negatively associated with SCF, which is inconsistent with the findings of the exploratory case study. The result indicates that SCFL implements high credit rationing when an SCFB relies on social interactions to integrate information. SCFL's president mentioned that social interactions mainly rely on telephone, e-mail and face-to-face meetings to integrate information. Although they can reduce the information gap between SCFBs and SCFL, the efficiency of information exchange is very low. It is extremely difficult for SCFL to acquire a large amount of financial and operational information in real time via social interactions. Moreover, SCFBs may hide private knowledge or provide exaggerated or even fabricated information because it is very difficult for SCFL to verify information and monitor SCFBs and SCF projects through social interactions. For example, SCFBs may divert SCF loans to other projects or opportunistically declare bankruptcy. The president mentioned that one of SCFL's biggest losses from SCF projects was the result of this kind of fraud. Therefore, compared with information system integration, social interactions are not an effective way to improve the speed, quantity and

quality of the information flows and the visibility of operational processes involved in a specific SCF project. As a result, SCFL will feel that an SCFB is a non-transparent borrower if it mainly relies on social interactions to integrate information, and hence it will apply high credit rationing to control risks (Ferri and Murro, 2015, Cenni et al., 2015).

The statistical analysis reveals that information system integration significantly improves SCF, which is consistent with the findings of the exploratory case study. The result indicates that SCFL reduces credit rationing if an SCFB closely integrates its information system with SCFL. SCFL's president emphasised that digitalisation is its key strategy to manage information, physical and financial flows in supply chains (Caniato et al., 2016). The E-SCM system plays a pivotal role in collecting and analysing information, supporting various operations and processes and fuelling the rapid growth of SCFL's SCF business (Martin and Hofmann, 2019). Through information system integration, SCFL can exchange a large volume of data with SCFBs in real time. The information allows SCFL to monitor and manage SCFBs' purchasing, inventory, production and delivery processes and to plan and optimise their supply chains (Jia et al., 2020a, Bals, 2019). Therefore, information system integration can reduce information asymmetry in supply chains (Devaraj et al., 2007) and allows SCFL to evaluate SCF projects at the operational level and control the projects in real time. In addition, as mentioned by SCFL's president, a high degree of information system integration requires SCFBs to make relationship-specific investments in IT infrastructure and operational processes, which reflects commitment to the relationship (Huo et al., 2013). SCFL viewed this as a gesture of goodwill or *guanxi*, which is critical for acquiring private knowledge from SCFBs in Chinese culture (Li and Chen, 2019).

4.2 The impact of information integration and SCF on product innovation performance: A resource-based view

The resource-based view provides a useful perspective to explain the impact of SCF and information integration on product innovation performance. Resources refer to tangible and intangible assets, such as money, people, technology, knowledge and relationships, that are inherent to a firm, and which are valuable, rare and difficult to imitate or substitute (Barney, 1991). The resource-based view argues that the competitive advantages of a firm derive primarily from the application of the resources at the firm's disposal (Barney, 1991). Our statistical analysis confirms that SCF is positively associated with SCFBs' product innovation performance, which is consistent with the finding of the exploratory case study. Most SCFBs are cash-constrained SMEs with limited financial resources. Thus, SCF is a valuable resource for product innovation because it provides SCFBs with more capital to invest in technologies,

IT, R&D and marketing, which improves the speed of new product introduction and the quality of new products (Zhang and Li, 2010, Zhang et al., 2018). SCF is also rare, as it is very difficult for SCFBs to obtain financial resources from banks or other financial institutions, or find strategically equivalent substitutes in China (Liu et al., 2015). Moreover, SCF is imperfectly imitable because it requires SCFBs to share information and integrates business processes with SCFL, and it uses SCFL's supply chain management services (Martin and Hofmann, 2019). Therefore, SCF is a strategic resource that enables SCFBs to improve product innovation performance.

Our findings show that social interaction is positively associated with product innovation performance, which is consistent with the findings of the exploratory case study. Through interactions between employees, SCFBs can obtain SCFL's tacit knowledge of market trends, new technologies and the capacity and expertise of component suppliers and assembly plants (Zhang et al., 2015). Such knowledge is critical for SCFBs in developing and launching new products (Zhang and Li, 2010), and hence it is a valuable resource for product innovation (Barney, 1991). This knowledge is also rare, because SCFL accumulates it by offering integrated supply chain management services and through closely collaborating with various stakeholders in the smartphone industry, and hence it is not available to SCFBs' competitors. It is also difficult for SCFBs to quickly find substitutes for this knowledge, because it takes time for SCFBs and SCFL to develop a collaborative relationship. Moreover, social interactions bring SCFBs soft information, which has a personal quality and is deeply rooted in relationships. Such knowledge acquisition is based in a complex social phenomenon, and hence SCFBs' competitors cannot perfectly imitate this resource (Barney, 1991).

We find that the impact of information system integration on product innovation performance is not significant, which is inconsistent with the findings of the exploratory case study. Although information system integration greatly improves supply chain transparency and visibility, SCFBs and SCFL mainly exchange hard information or explicit knowledge using information systems, which enables them to jointly optimise procurement, production and delivery decisions and improve forecasting and planning. This knowledge helps SCFBs improve operational processes and supply chain management (Gimenez and Venture, 2005), and allows SCFL to manage and control SCF risks. However, it cannot be applied directly to improve new product development (Zhang et al., 2015). It is difficult for SCFBs to gain knowhow about market trends, new technologies and components, and suppliers' capabilities, and hence, information system integration cannot contribute valuable knowledge resources for product innovation.

4.3 Theoretical contributions

This study contributes to the SCF literature in three ways. First, it focuses on SCSPs and purchase order finance. The findings provide empirical evidence on how an innovative SCF lender (i.e., SCSP) implements and manages SCF (Jia et al., 2020a, Caniato et al., 2019). The results also improve the knowledge about the application of purchase order finance, which is an innovative SCF solution (Gelsomino et al., 2016). By providing empirical evidence that SCF is positively associated with SCFBs' product innovation performance, the study improves current understandings of the performance outcomes of SCF solutions (Jia et al., 2020b, Bals, 2019). We also find that social interaction is positively associated with SCFBs' product innovation performance, whereas information system integration does not significantly affect it. The study thus provides insights on the benefits SCFBs can obtain through integrating information flows with SCSPs.

Second, we find that information system integration is positively associated with SCF, whereas social interaction is negatively associated with SCF. The result reveals the two ways that SCSPs and SCFBs integrate information and their distinctive effects on SCF, shedding light on how an SCSP makes SCF decisions and jointly manages information and financial flows (Jia et al., 2020a, Bals, 2019). The findings thus highlight the importance of ITs in reducing information asymmetry and supporting SCF solutions (Caniato et al., 2019). In addition, this study provides empirical evidence on the implementation of SCF in the Chinese smartphone industry, enriching current understandings of the antecedents and consequences of SCF solutions in a specific industry (Bals, 2019, Gelsomino et al., 2016).

Third, the case study offers a balanced view of the relationships between information integration, SCF, and product innovation performance from both SCSPs' and SCFBs' perspectives. The findings thus enhance current knowledge on the interactions and collaboration between different SCF stakeholders (Caniato et al., 2019, Jia et al., 2020a). By combining qualitative and quantitative data, we triangulate the empirical evidence to verify and generalise the findings. This study combines theory building (i.e., an exploratory case study) and theory testing (i.e., a confirmatory case study) approaches, which allows us to capture the richness of the empirical context and generate internally valid explanations (Ridder, 2017). The mixed method design also allows us to contextualise the relationships between information integration, SCF and product innovation performance and to statistically test them, and hence to provide a holistic picture of SCF implementation (Saunders et al., 2019).

4.4 Managerial implications

The findings provide guidelines for SCF lenders and borrowers to successfully adopt SCF and benefit from its application. When providing SCF (e.g., purchase order finance), we suggest a lender offer supply chain management services to borrowers (e.g., procurement, logistics, inventory management and payment services) and integrate information systems with them (Li and Chen, 2019). We also suggest that SCF lenders jointly manage information, material and financial flows (Jia et al., 2020a). We recommend that the SCF lenders make SCF decisions based on the practices and degree of information integration (Stiglitz and Weiss, 1981). The lenders should provide more SCF to borrowers that directly use their information systems or have a high level of information system integration. The lenders should also offer more SCF to borrowers who use information systems to synchronise data and collaborate with the lenders on supply chain management. An SCF lender should be aware that although social interactions with borrowers make it easier to obtain suggestions for improvement and integrate business processes, they are not effective for managing and controlling SCF projects. We thus suggest that a lender should provide less SCF to a borrower if the borrower relies only on social interactions to integrate information.

We suggest that cash-constrained firms who focus on product innovation to adopt SCF solutions. We suggest these firms should borrow more SCF from lenders because SCF can bring them more financial resources to ensure the successful launch of new products and commercialisation of new product designs. The borrowers should be aware that jointly managing supply chains and business processes and integrating information with an SCF lender are critical for obtaining more SCF (Bals, 2019). Therefore, we suggest that borrowers closely integrate their information systems with the SCF lender or directly use the lender's information system (Huo et al., 2013). We also suggest that borrowers use information systems to share information and collaborate on supply chain management with the lender. However, they should understand that information system integration does not directly contribute to their product innovation. Moreover, we suggest that borrowers encourage their employees to frequently interact with the SCF lender to obtain support for supply chain management, solve problems and integrate business processes. Such social interactions can help them improve product innovation performance (Zhang et al., 2018). However, borrowers should be warned that relying only on social interaction to integrate information with the SCF lender will reduce the SCF they receive. Therefore, we recommend that borrowers integrate information systems with the lender at the same time.

4.5 Limitations and future research directions

This study has three main limitations that open avenues for future research. First, the findings are based on a case study in the smartphone industry in China. The implementation of SCF may be influenced by the industrial, business and institutional environments. Future studies could verify and generalise the findings in other contexts (Bals, 2019, Jia et al., 2020b). Second, this study focuses on purchase order finance. Other SCF solutions, such as dynamic discounting, inventory financing and reverse factoring, are also widely applied (Extra et al., 2019). Future studies could compare the findings with other SCF solutions and investigate how managers make decisions for different SCF solutions. Third, this study focuses on the interactions and collaboration between product designers and SCFL. SCFL's E-SCM system provides a platform through which different stakeholders, including product designers, suppliers, assemblers, 3PL firms, customers and government agencies, collaborate with each other to create an ecosystem (Bals, 2019). Future research could adopt a longitudinal design to explore the establishment of this ecosystem and how the ecosystem affects SCF and the performance of supply chain members.

References

- Bals, C. 2019. Toward a supply chain finance (SCF) ecosystem – Proposing a framework and agenda for future research. *Journal of Purchasing and Supply Management*, 25, 105-117.
- Barney, J. 1991. Firm resources and sustained competitive advantage. *Journal of Management*, 17, 99-120.
- Bias, B. & Gollier, C. 1997. Trade credit and credit rationing. *Review of Financial Studies*, 10, 903-937.
- Bickers, M. 2019. World Supply Chain Finance Report 2019. [Online]. Available: <https://bcrapub.com/publications/world-supply-chain-finance-report-2019> [Accessed 14/02/2020].
- Caniato, F., Gelsomino, L. M., Perego, A. & Ronchi, S. 2016. Does finance solve the supply chain financing problem? *Supply Chain Management: An International Journal*, 21, 534-549.
- Caniato, F., Henke, M. & Zsidisin, G. A. 2019. Supply chain finance: Historical foundations, current research, future developments. *Journal of Purchasing and Supply Management*, 25.

- Cenni, S., Monferra, S., Salotti, V., Sangiorgi, M. & Torluccio, G. 2015. Credit rationing and relationship lending. Does firm size matter? *Journal of Banking & Finance* 53, 249-265.
- Chen, X. & Cai, G. 2011. Joint logistics and financial services by a 3PL firm. *European Journal of Operational Research*, 214, 579-587.
- Chen, X., Cai, G. & Song, J. 2019. The cash flow advantages of 3PLs as supply chain orchestrators. *Manufacturing & Service Operations Management*, 21, 435-451.
- Coffman, D. L. & Maccallum, R. C. 2005. Using parcels to convert path analysis models into latent variable models. *Multivariate Behavioral Research*, 40, 235-259.
- Danielson, M. G. & Scott, J. A. 2004. Bank loan availability and trade credit demand. *The Financial Review*, 39, 579-600.
- Devaraj, S., Krajewski, L. & Wei, J. C. 2007. Impact of eBusiness technologies on operational performance: The role of production information integration in the supply chain. *Journal of Operations Management*, 25, 1199-1216.
- Extra, W., Kotman, R., Siemes, D., Caniato, F., Gelsomino, L. M., Moretto, A., Bonzani, A., Corten, R., Dellermann, S., Mogagan, L. & Ronchini, A. 2019. SCF Barometer 2018/2019. [Online]. Available: <https://www.pwc.com/vn/en/deals/assets/scf-barometer-2018-2019.pdf> [Accessed 14/02/2020].
- Ferri, G. & Murro, P. 2015. Do firm–bank ‘odd couples’ exacerbate credit rationing? *Journal of Financial Intermediation*, 24, 231-251.
- Gelsomino, L. M., Mangiaracina, R., Perego, A. & Tumino, A. 2016. Supply chain finance: A literature review. *International Journal of Physical Distribution & Logistics Management*, 46, 393-413.
- Gimenez, C. & Venture, E. 2005. Logistics-production, logistics-marketing and external integration: Their impact on performance. *International Journal of Operations and Production Management*, 21, 20-38.
- Global Supply Chain Finance Forum 2016. Standard definitions for techniques of supply chain finance. [Online]. Available: <https://iccwbo.org/publication/standard-definitions-techniques-supply-chain-finance> [Accessed 14/02/2020].
- Greensill. 2019. Changing finance to change the world [Online]. Available: <https://www.greensill.com/whitepapers/working-capital-finance-as-an-asset-class/> [Accessed 14/02/2020].
- Hu, L. & Bentler, P. M. 1999. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6, 1-55.

- Huang, S., Fan, Z. & Wang, X. 2019. Optimal operational strategies of supply chain under financing service by a 3PL firm. *International Journal of Production Research*, 57, 3405-3420.
- Huo, B., Han, Z., Zhao, X., Zhou, H., Wood, C. H. & Zhai, X. 2013. The impact of institutional pressures on supplier integration and financial performance: Evidence from China. *International Journal of Production Economics*, 146, 82-94.
- Jaffee, D. & Russell, T. 1976. Imperfect information, uncertainty, and credit rationing. *Quarterly Journal of Economics*, 90, 651-666.
- Jia, F., Blome, C., Sun, H., Yang, Y. & Zhi., B. 2020a. Towards an integrated conceptual framework of supply chain finance: An information processing perspective. *International Journal of Production Economics*, 219, 18-30.
- Jia, F., Zhang, T. & Chen, L. 2020b. Sustainable supply chain finance: Towards a research agenda. *Journal of Cleaner Production*, 243, 1-14.
- Kirschenmann, K. 2016. Credit rationing in small firm-bank relationships. *Journal of Financial Intermediation*, 26, 68-99.
- Lee, N., Sameen, H. & Cowling, M. 2015. Access to finance for innovative SMEs since the financial crisis. *Research Policy*, 44, 370-380.
- Li, S. & Chen, X. 2019. The role of supply chain finance in third-party logistics industry: A case study from China. *International Journal of Logistics: Research and Applications*, 22, 154-171.
- Liu, X., Zhou, L. & Wu, Y. J. 2015. Supply chain finance in China: Business innovation and theory development. *Sustainability*, 7, 14689-14709.
- Martin, J. & Hofmann, E. 2019. Towards a framework for supply chain finance for the supply side. *Journal of Purchasing and Supply Management*, 25, 157-171.
- Pfohl, H. & Gomm, M. 2009. Supply chain finance: Optimizing financial flows in supply chains. *Logistics Research*, 1, 149-161.
- Ridder, H. 2017. The theory contribution of case study research designs. *Business Research*, 10, 281-305.
- Saunders, M. N. K., Lewis, P. & Thornhill, A. 2019. *Research methods for business students*. Harlow, Pearson Education Limited.
- Silvestro, R. & Lustrato, P. 2014. Integrating financial and physical supply chains: The role of banks in enabling supply chain integration. *International Journal of Operations & Production Management*, 34, 298-324.

- Stiglitz, J. E. & Weiss, A. 1981. Credit rationing in markets with imperfect information. *American Economic Review*, 71, 393-410.
- 10000link. 2019. China supply chain financial innovation practice white paper 2019 (in Chinese). [Online]. Available: www.10000link.com [Accessed 14/02/2020].
- Villena, V. H., Revilla, E. & Choi, T. Y. 2011. The dark side of buyer–supplier relationships: A social capital perspective. *Journal of Operations Management*, 29, 561-576.
- Vorhies, D. W. & Morgan, N. A. 2005. Benchmarking marketing capabilities for sustainable competitive advantage. *Journal of Marketing*, 69, 80-94.
- Wuttke, D. A., Blome, C., Foerstl, K. & Henke, M. 2013a. Managing the innovation adoption of supply chain finance – Empirical evidence from six European case studies. *Journal of Business Logistics*, 34, 148-166.
- Wuttke, D. A., Blome, C. & Henke, M. 2013b. Focusing the financial flow of supply chains: An empirical investigation of financial supply chain management. *International Journal of Production Economics*, 145, 773-789.
- Wuttke, D. A., Rosenzweig, E. D. & Heese, H. S. 2019. An empirical analysis of supply chain finance adoption. *Journal of Operations Management*, 65, 242-261.
- Xu, X., Chen, X., Jia, F., Brown, S., Gong, Y. & Xu, Y. 2018. Supply chain finance: A systematic literature review and bibliometric analysis. *International Journal of Production Economics*, 204, 160-173.
- Yang, Q. & Zhao, X. 2016. Are logistics outsourcing partners more integrated in a more volatile environment? *International Journal of Production Economics*, 171, 211-220.
- Yin, R. K. 2009. *Case study research*. Thousand Oaks, CA, Sage.
- Zhang, M., Zhao, X. & Lyles, M. 2018. Effects of absorptive capacity, trust and information systems on product innovation. *International Journal of Operations & Production Management*, 38, 493-512.
- Zhang, M., Zhao, X., Lyles, M. & Guo, H. 2015. Absorptive capacity and mass customization capability. *International Journal of Operations & Production Management*, 35, 1275-1294.
- Zhang, Y. & Li, H. 2010. Innovation search of new ventures in a technology cluster: The role of ties with service intermediaries. *Strategic Management Journal*, 31, 88-109.
- Zhao, L. & Huchzermeier, A. 2019. Managing supplier financial distress with advance payment discount and purchase order financing. *Omega*, 88, 77-90.

Appendix I. Semi-structured interview protocol

SCFL

1. Please introduce and describe the key stakeholders and processes of your supply chains.
2. What are the supply chain management services SCFL provides to supply chain members, especially product designers? Why does SCFL provide the services? Could you give us some examples? What benefits do the services bring to SCFL and the product designers?
3. How do SCFL and supply chain members, especially product designers, collaborate on supply chain management? Could you give us some examples?
4. Please introduce and describe the SCF solutions offered by SCFL. Could you give us some examples to illustrate how SCFL makes SCF decisions?
5. Why does SCFL provide SCF to supply chain members? What are the main drivers and enablers? What are the challenges and how they are solved?
6. How does SCFL manage and control the financial risks of SCF projects? Could you give us some examples?
7. Please describe how SCFL establishes and maintains collaborative relationships with SCFBs when conducting SCF projects. What problems has SCFL encountered and how does SCFL deal with the problems? Please give us some examples.
8. Please introduce how SCFL and SCFBs integrate information flows. Could you give us some examples? How does information integration affect the management of SCF projects?
9. Please introduce SCFL's IT infrastructure and the functions of the information system. How does the information system support supply chain management and collaboration with supply chain members?
10. How do SCFL and SCFBs integrate their information systems? How does the integration influence SCFL's SCF decisions and the management of SCF projects?
11. How do SCFL's and SCFBs' employees communicate and interact with each other? What roles does this interaction play in SCFL's SCF decisions and the management of SCF projects?

SCFB

1. Please introduce and describe the key stakeholders and processes of your supply chains.
2. What are the key challenges of your current operations? How can SCFL help to tackle the challenges?

3. Why do you collaborate with SCFL and apply SCF? What are the key drivers for using the SCF offered by SCFL? What are the differences between the SCF offered by SCFL and the loans obtained from banks and other financial institutions?
4. Please describe the SCF projects with SCFL. How does the SCF influence your operations and supply chain management processes? Please give us some examples.
5. What are the benefits and challenges when adopting SCF? How do you evaluate the success of SCF projects? How does SCF influence product innovation?
6. What are the key practices you have adopted to facilitate the collaboration with SCFL? What are the roles played by the practices when you apply SCF?
7. Have you integrated your information system with SCFL? If yes, through what means? How does the integration affect SCF projects and product innovation?
8. Do your employees interact and communicate with SCFL? If yes, through what means? How does the interaction affect SCF projects and product innovation?

Appendix II. Measurement items

Social interaction

SI1: Our employees actively interact with SCFL to ensure that we obtain support from SCFL on supply chain management.

SI2: Our employees frequently interact with SCFL to provide suggestions for improvement.

SI3: The interactions between our employees and SCFL enable us to integrate business processes with SCFL.

SI4: The interactions between our employees and SCFL enable us to quickly solve problems.

Information system integration

ISI1: Our information system is closely integrated with SCFL's E-SCM system.

ISI2: We use SCFL's E-SCM system to manage our supply chains.

ISI3: We rely on information systems to exchange information and synchronise data with SCFL.

ISI4: We rely on information systems to collaborate with SCFL on supply chain and business process management.

Product innovation performance

PIP1: We successfully launch new products.

PIP2: We are first in new product introductions in the market.

PIP3: We quickly launch new products into the market.

PIP4: We develop new products with superior quality.

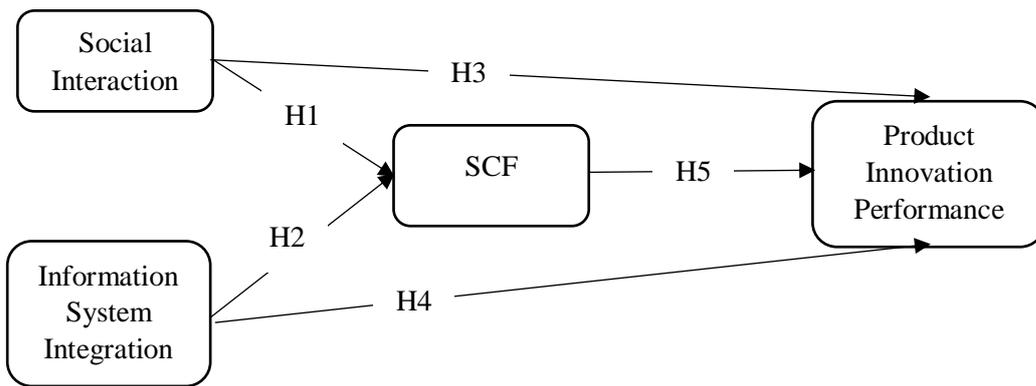
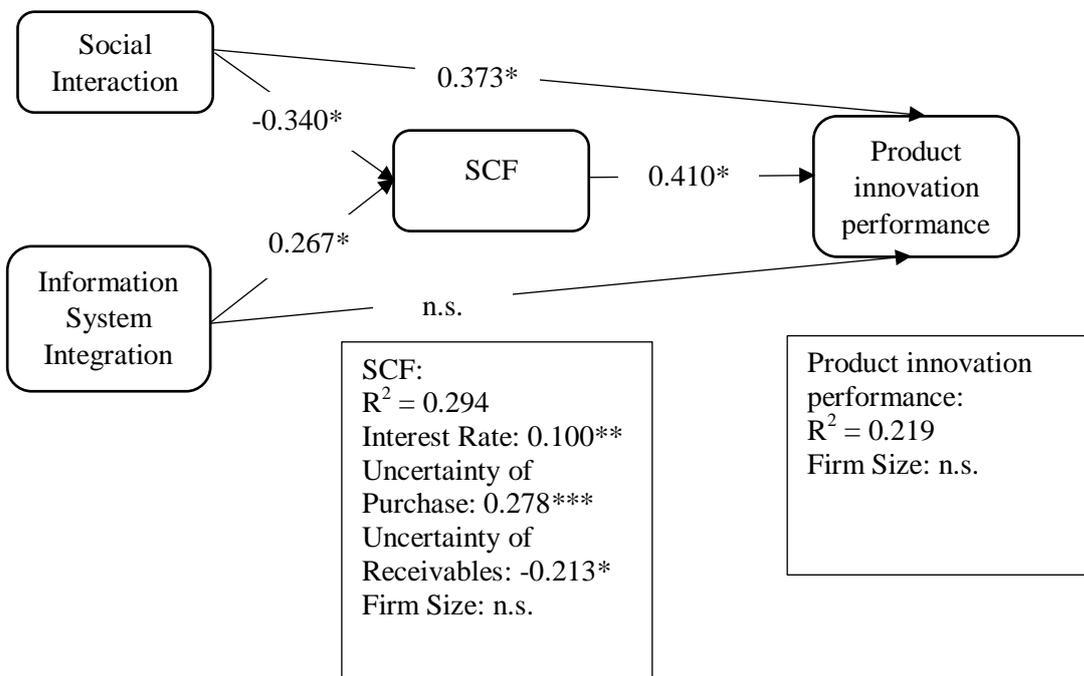


Figure 1. Conceptual framework



Note: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, n.s.: not significant

Figure 2. Results of statistical analysis

Table 1. Profile of SCFBs

Annual sales (Chinese yuan)			Number of employees		
	Number	Percentage		Number	Percentage
<50 Million	13	39.4%	<50	20	60.6%
50 Million to 3 Billion	13	39.4%	50-100	9	27.3%
3 Billion to 10 Billion	7	21.2%	101-300	4	12.1%
Total	33	100%	Total	33	100%
Years of collaboration with SCFL			Number of SCF projects with SCFL		
	Number	Percentage		Number	Percentage
<1	11	33.3%	<5	13	39.4%
1-3	20	60.6%	5 to 10	17	51.5%
>3	2	6.1%	11 to 20	3	9.1%
Total	33	100%	Total	33	100%

Table 2. The results of EFA analysis

	Factor loading		
	Social interaction (SI)	Information system integration (ISI)	Product innovation performance (PIP)
SI1	0.915	0.047	0.116
SI2	0.924	0.202	0.018
SI3	0.875	-0.250	0.055
SI4	0.871	0.110	0.163
ISI1	0.071	0.714	-0.050
ISI2	-0.063	0.828	0.167
ISI3	0.084	0.941	0.048
ISI4	0.019	0.949	-0.006
PIP1	0.084	-0.163	0.898
PIP2	0.020	-0.061	0.867
PIP3	0.115	0.138	0.929
PIP4	0.156	0.313	0.822
Eigenvalue	4.069	3.046	2.581
Variance explained	33.906%	25.383%	21.511%

Note: Extraction method: principal component analysis; rotation method: Varimax with Kaiser normalisation. Please refer to Appendix II for the details of the measurement items.

Table 3. Descriptive statistics

	Mean	S.D.	PIP	SCF	SI	ISI	UP	UR	IR
Product innovation performance (PIP)	4.658	1.125	0.849						
SCF	0.446	0.217	0.229**						
Social interaction (SI)	6.127	0.823	0.203**	-0.168*	0.864				
Information system integration (ISI)	4.487	1.942	0.113	0.133	0.071	0.837			
Uncertainty of purchase (UP)	19.29	28.458	0.323**	0.155*	0.245**	0.076			
Uncertainty of receivables (UR)	0.481	0.428	0.152*	-0.039	-0.160*	0.197**	0.105		
Interest rate (IR)	0.001	0.002	-0.121	0.095	-0.039	-0.057	-0.093	-0.036	
Firm size	3.450	1.569	0.012	-0.067	0.291**	0.118	0.222**	0.005	-0.199**

Note: The numbers in bold on the diagonal are the square root of AVE; *: Correlation is significant at the 0.1 level (2-tailed); **: Correlation is significant at the 0.05 level (2-tailed).