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Operating in Environments Affected by Uncertainty: Supply Chain Finance, Timely Information Sharing using Advanced Technology, and Financial Performance in Supply Chain Management 4.0

ABSTRACT

Digitally enabled supply chains, particularly operating in uncertain environments, have been offering emerging domains for research. The effects of Timely Information Sharing (TIS) on Financial Performance (FP) in the context of Supply Chain Finance (SCF) have been hitherto neglected, especially in the context of environments affected by uncertainty. The study contributes to the related literature by developing an integrated framework interlinked with Information Processing and Contingency theories and it facilitates the understanding of the relationships that exist among SCF, TIS using advanced technology, and FP in the context of the environments affected by uncertainty caused by unpredictable events like terrorist attacks and pandemics. To corroborate the relationships and validate the relative framework, we applied Structural Equation Modelling to the data collected from 261 firms. Our findings show that SCF significantly influences FP and that TIS plays a mediating role in enhancing FP interlinked with modern technology. The study also provides the implications of SCF and TIS in strengthening Supply Chain Management 4.0 operations affected by unprecedented circumstances that hinder FP and its viability within the supply chains' context.

Keywords: Uncertainty, Supply chain finance, Timely information sharing using advanced technology, Financial performance, Pakistan, Structural equation modelling, Supply Chain Management 4.0

1. Introduction

The key goal of supply chain management (SCM) is to enhance the effectiveness, timeliness, and accuracy of addressing rapidly evolving customer needs by effectively coordinating and integrating the movement of materials, information, and financial resources (Gunasekaran et al., 2008; Govindan et al., 2017). The COVID-19 pandemic has caused an economic downturn and variations in international trade. These, in turn, have caused a drought of liquidity and a lack of working capital for global supply chains (SCs), resulting in a significant increase in the cost of corporate borrowing. This has considerably raised the risk to Supply Chain Finance (SCF) services; e.g., due to buyer firms cancelling their orders with suppliers in order to improve their cash cycles, current invoices being delayed and defaulted, and financial institutions withdrawing from their SCF services (Murray, 2020; Karmaker et al., 2021). Timely Information Sharing (TIS) and digitization in global SCs may act as a catalyst for non-physical goods and the streamlining of supply chain operations. Thus, resilience, working capital, and cash-conversion cycles can become important strategic priorities for firms, particularly in environments affected by uncertainty, such as that brought about by the COVID-19 pandemic (Murray, 2020; Ivanov and Dolgui, 2021). As reported by Tang et al. (2020), due to the pandemic, the Deutsche Bank has only 15-weeks of liquidity left before it reaches the minimum obligatory cash reserves it needs to operate. Similarly, huge redundancies in the airline and hospitality industries, (e.g., British Airway and Marriott) and furloughs enacted by auto manufacturers (e.g., Honda, Jaguar, and Volkswagen) and by the retail industry (e.g., the Neiman Marcus Group Inc. and Debenhams) have taken many firms to the threshold of bankruptcy, making it likely for them to suspend or postpone payments to their suppliers or even to those of their customers who have cancelled orders. These examples show how SCF—particularly in regard to financial arrangements and payments—is essential in aiding firms and their supply chain operations. Various SCF solutions can act as enablers, facilitating smooth physical flows among SC partners. Moreover, SCF needs to be better integrated with TIS and emerging technologies—particularly in environments affected by uncertainty—because they significantly affect revenue. For instance, the COVID-19 pandemic caused trade finance revenues to contract by more than 1% in the first quarter of 2020 (Wass, 2020).

Supply chains include the flows of a) information, which refers to the large-scale collection and transfer of information among manufacturers, logistic service providers, retailers, and customers; b) goods/services; and c) finance (Mentzer et al., 2001), which are all interconnected with the monetary transactions that take place among buyers, sellers, and other

involved parties (Camerinelli, 2009; Song et al., 2018). The financial flow, which had hitherto been largely ignored within the context of SCM, has been receiving increasing attention from both practitioners and academics since the global financial crisis of 2008 (Pfohl and Gomm, 2009; More and Basu, 2013; Gelsomino et al., 2016; Wandfluh et al., 2016), particularly Supply Chain Management 4.0 that uses new and advanced technology (e.g., Big Data, Machine Learning, Automation, the Internet of Things) (Akhtar et al., 2018,2019). The need for effective SCM requires researchers to extend their focus to financial flows, rather than limiting it to those of goods/services and information (Pfohl & Gomm 2009; Wuttke 2013a, 2013b) given the role of supply chain financing in making supply chains more robust to deal with the external shocks. A thorough examination of the extant literature reviews shows that research on SCF is still in its infancy, with a disconnected focus (see the details of this knowledge review in Section 2 and Table 3) that the SCM literature is currently trying to grapple with. Additionally, buyer-supplier financial and information sharing—e.g., the cross-company alignment of financing processes, strategies, and decisions—can improve Financing Performance (FP) and are intensively discussed in the literature (Chen et al., 2004; Lai et al., 2007; Wu et al., 2014). However, the effects of TIS on FP in the context of SCF have been hitherto neglected, especially in the context of environments affected by uncertainty. This lack of investigation has been mainly caused by the complexities and difficulties linked to identifying and understanding the core influencing factors and their interactions on supply chains' financial performance.

Given the above-referenced knowledge gap, our study makes two contributions. Theoretically, it contributes to Information Processing and Contingency theories and comprehensively reviews the relevant studies on SCF, starting from the shaping of its definitions over time (as encapsulated in Table 1, Section 2). It then systematically identifies how different studies have emphasized the relevant constructs (e.g., SCF, TIS, or FP) but have missed the opportunity to connect them in order to develop a framework by building inter-relationships among them. It provides a more nuanced unpacking of SCF, one that can enable readers to understand its different aspects and effects on interlocking supply chain operations. Empirically, building on the theoretical foundations, it develops cognate measures suited to corroborate the framework based on data collected from supply chain firms operating in Pakistan and to investigate the central role played by TIS, along with other linkages, among the underlying constructs. Overall, the study contributes to Information Processing and Contingency theories by documenting the important role played by timely information processing, supply chain financing, and supply

chains' financial performance in the context of firms operating under uncertainties. Furthermore, our study contributes to the contingency theory, which states that there is no single best way to organize firms and to make optimal decisions, and that the optimal outcomes depend on contingencies related to internal and external specific circumstances.

The remainder of the paper is structured as follows. In Section 2, the relevant literature and theoretical aspects of the framework are discussed in detail. This is followed, in Section 3, by a presentation of the development of four hypotheses suited to assess the impact of SCF and TIS on FP. Then, we describe our research methodology, including the data collection and measurement development (Section 4), and hypotheses testing, data analyses, and findings (Section 5). Last, our study's theoretical and practical contributions and directions for future research are highlighted in Section 6.

2. The relevant literature and theoretical aspects

2.1 Information Processing Theory and Contingency Theory

Information Processing Theory (IPT) posits that organizations collect, analyze, and manage information to facilitate operational and strategic decision-making. It focuses on improving the organization's ability to process information effectively, which can be achieved through various methods such as following rules, procedures, backgrounds, communication mechanisms, and leveraging information systems (Daft and Weick, 1984). According to Fan et al., (2017), the changes in the business environment and firms must employ two strategies to enhance their performance: First, acquiring a greater quantity of reliable and valuable information. Second, firms should dedicate more resources to improve their capacity to successfully process that information. Hence, IPT proposes a broad theoretical basis for developing a research framework based on firm resilience. It suggests that the ability of a firm to survive and recover from challenges is dependent on its ability to gain resources and its level of competence in employing those resources to navigate uncertain environmental conditions.

When faced with higher levels of uncertainty and ambiguity, decision-makers within the firms must manage a substantial level of information while conducting tasks. To successfully manage the intensified information load, the firm must invest more effort in improving its capacities in gathering, processing, and utilizing information to mitigate external shocks and uncertainties (Ellram et al., 2004). Similarly, the SCF is confronted with an uncertain situation, and the inadequate management of information processing challenges could jeopardize the integration of the entire financial supply chain. Timely information processing can be vital for lowering

investment risks and improving supply chain financing decisions (Pfohl & Gomm, 2009). Timely gathering and processing of information is also important to mitigate contingencies arising from the task-related environment.

The previous studies rooted in contingency theory have indicated various environmental contingency variables that help to create clusters and in turn affect firm level outcomes including performance. These variables are firm size, age, environment, and technology. These studies also acknowledge three different types of variables: *Contextual variables*, which signify the situational characteristics exogenous to the pivotal company; *Response variables*, which are the firm or managerial actions taken in response to existing or predicted contingency variables; and *Performance variables*, which are dependent measures and represent the specific features of effectiveness that are suitable to assess the fit between the above two variables (Sousa & Voss, 2008). Many studies in the SCM literature have adopted Contingency Theory to examine the impact of SCM practices on firm performance (e.g., Park et al., 2016). Similarly, Trkman and McCormack (2009) adopted Contingency Theory to examine how contingent variables affect supplier risk and supply chain disruptions. From a theoretical point of view, they posited that SCM strategies should be company-specific and based on supplier contextual factors, and found that the fit between the companies' cluster and SCM strategies improves SC performance. However, a limited number of studies have adopted Contingency Theory in the context of a terrorism-affected region—e.g., Pakistan—or in the current situation characterized by COVID-19-related uncertainty. Therefore, this study significantly contributes to Contingency Theory in terms of the impact of SCM strategies (SCF and IS—being part of Information Processing Theory and linking with contingency aspects) on FP in terrorism-affected regions and in environments riddled with uncertainties.

2.2 Supply chain finance

Supply chain finance deals with the financial aspects pertaining to the exchange of goods and services. Acting as financial intermediaries, financial institutions and firms provide SC partners with the credit needed to bridge the time gap between the delivery of goods/services and the related payments, or before the payment due dates (McGuinness et al., 2018). Gelsomino et al. (2016) defined SCF by stressing two perspectives.

First, the 'finance oriented' perspective, which emphasizes the short-term financial solutions that are provided by financial institutions and involve account payables and receivables. This

perspective concentrates on the timely arrangements offered by finance-related organizations, leading to creditor liabilities and receivables.

Second, the “supply chain-oriented” perspective, which focuses on the optimisation of working capital in terms of the account payables, receivables, inventories, and, sometimes, even of the fixed asset between the SC upstream and downstream. At present, scholars have defined SCF differently based on their expertise and/or knowledge backgrounds. However, Steeman (2016) argued that the current literature touches on various SCF themes and provides guidelines for its definition, instead of providing a commonly accepted standard one. To bridge this knowledge gap, we reviewed different definitions of SCF, as summarised in Table 1.

(Insert Table 1 here)

The key published studies address two closely related topics, including i) financial SCM (e.g., Fairchild 2005; Wuttke 2013b) and ii) SCF (e.g., Hofman, 2005; Pfohl & Gomm, 2009; Wuttke et al., 2016). According to Gelsomino et al. (2016), the distinction between SCF and financial SCM would appear to be negligible. Fairchild (2005) highlighted that SCF can be segmented into different constituents within financial SCM. It is worth to point out that SCF is not a new concept; rather, *“it is more the coming together of a number of traditional financing approaches, the increases of electronic exchange of data between organizations and emergence of an alternative source of finance”* (Templar et al., 2016:150).

Financial SCM mainly emphasizes the financial aspects of strategic decisions. It is not uncommon for a financial strategy to be made up of two components: i) the raising of the funds required by an organization in the most appropriate manner and ii) the management of the use of those funds within the organization. Traditionally, to evaluate the credit risk of a firm in relation to SCF, financial institutions adopt a credit rating strategy. Similarly, to the end of avoiding future disruption, SC buyers also frequently evaluate the credit scores of their suppliers (Moretto et al., 2018). Various financial strategies can be found in the SCM context, such as keeping sufficient liquidity reserves in banks, financial hedging, credit rating models, long-term contracts, revenue sharing, the transfer or sharing of currency risk, currency call and put options, and factoring and reserve factoring. More and Basu (2013) conceptually divided SCF into three categories; finance type, time interval, and SCF solutions, as shown in Table 2.

(Insert Table 2 here)

Although non-scholarly sources and general discussions on SCF have been mushrooming, the literature is rather limited and lacks rigor and specifications (cf. Jia et al., 2020). For instance, in a review paper, Hofmann (2013) examined 21 articles dealing with SCF, while Gelsomino et al. (2016) included 109 articles in their systematic review of the SCF literature. In a recent paper, Xu et al. (2018) conducted a systematic literature review combined with bibliometric, network, and content analyses. They identified four research clusters: i) inventory decisions with trade credit policy in complex situations; ii) deteriorating inventory models under trade credit policy, based on the EOQ/EPQ model; iii) relations between replenishment decisions; and iv) delayed payment strategies and the roles played by financial services in the SC. Nevertheless, we acknowledge that some studies have provided academics with foundations suited to explore this topic using a variety of methods such as: a single (Blackman et al., 2013) or multiple case (Wuttke et al., 2013 b; Caniato et al., 2016; Song et al., 2018) approach; interviews and survey questionnaires (Fellenz et al., 2009; More & Basu, 2013; Wandfluh et al., 2016); simulation models (Wuttke et al., 2016; Pellegrino et al., 2018); and conceptual model building (Pfohl & Gomm, 2009).

2.3 Timely information sharing

Timely IS involves the timely distribution of useful information among systems, people or organizational units aimed at facilitating agile operations as well as to deal with uncertainties (Li, et al., 2006). Specifically, Lai et al. (2007) defined it as the timely use of information and communication technologies to the end of coordinating decisions and activities between a pivotal firm and its partners. TIS requires a firm's willingness to make its strategic and tactical data available to its SC partners (Mentzer et al., 2001). Lotfi et al. (2013) also referred to IS as knowledge sharing or information integration.

To survive in today's business world—which is characterised by uncertainties such as those brought about by the COVID-19 pandemic (Murray, 2020; Karmaker et al., 2021)—SC partners need to improve their competitive advantages by capitalizing on TIS. In this regard, TIS is critical to strengthening the relationships among SC partners; it acts as a glue that binds together SC partners in times of crisis. Additionally, as highlighted by different scholars (Lotfi et al., 2013; Murray, 2020), TIS represents an important approach for the survival of firms and enables SC integration. Furthermore, the better coordination of timely information about good/service flows can reduce the uncertainties found in a SC and improve SC process visibility (Zhao et al., 2002; Christopher and Lee, 2004; Murray, 2020). As noted by

Christopher and Lee (2004:391), “*The key to improved supply chain visibility is shared information among supply chain members.*”

Business, strategic, tactical, and logistics levels of information, among others, are shared in a SC (Lotfi et al., 2013). With a focus on demand, IS has been categorized into three types. In the first, demand information is not shared with all SC partners. In the second, firms share their projected net demand with their suppliers. In the last type, firms share their future demand forecasts and their present and future order plans with suppliers (Zhao et al., 2002). Pandey et al. (2010) identified the different types of information shared among SC partners—i.e., purchases and sales, inventory status, product development, sales and forecasting, market development, future plan, production cost, technology know-how, and order tracking information.

Being a vital feature among businesses, IS acts as a value-creating factor that enables the shift from physical and financial assets to intangible ones (Kocoglu et al., 2011). An effective and efficient IS strategy is capable of reducing costs, raising customer-service levels, and enhancing the robustness of a SC (Yang et al., 2011). Similarly, information transparency enables firms to select capable suppliers with lower prices, and thus produce and deliver products and services at a lower cost (Chen et al., 2004). It also enables firms to make enhanced decisions on ordering, capacity allocations, production, and material planning through increased visibility of demand, supply, and inventory (Ding et al., 2011). However, the current variations in business practices produce uncertainties and increase decision-making complexity, making it difficult for firms to determine suitable TIS strategies (Yang et al., 2011; Murray, 2020) and truly develop digital entrepreneurship (Zhao., 2023).

In general, an effective IS strategy improves mutual communication, decreases miscommunication, and avoids unnecessary errors, thus cutting transaction costs across SCs (Wu et al., 2006). Information technology-based solutions—such as RFID, ERP, and GPRS—are vital IS tools to increase information visibility and can be employed in different IS strategies. They also facilitate the intensive interactions between customers and vendors, thus encouraging more effective IS (Boyle et al., 2008). It is interesting to point out that Carr and Kaynak (2007) argued that advanced communication technologies have no significant influence on the TIS performance of firms in an SC.

Supply Chain Management can be effectively carried out if accurate and timely information is available to SC partners. In this regard, an IS strategy should include information about costs,

processes, customer needs and demand, products, and performance metrics (Karaesmen et al., 2002). It is not uncommon for firms to be cautious about sharing information with their SC partners due to fears of its unethical use (Zhao et al., 2002). Jüttner and Maklan (2011) pointed out that an IS strategy may cause the disclosure of confidential information, leading to loss of privacy; however, such a strategy can reduce SC redundancy and increase SC flexibility against liquidity risks. Additionally, an open IS strategy can improve a firm's response to risk.

Despite the potential benefits of TIS, Fawcett et al. (2007:367) pointed out that "*The bridges to world-class information sharing are never built and neither the structure nor the culture needed to share information is established*". A major barrier to the adoption of IS strategies in SCs is the firms' limited understanding of the export markets and of exporting efforts and performance (Fawcett et al., 2007). Lotfi et al. (2013) identified firm deficiencies in coordinating actions among their units as a barrier to the adoption of IS strategies. Other key barriers to IS strategies are incentive issues, reliability, information privacy, the cost and complexity of technologies, accuracy, and the timely and effective utilization of information (Zhao et al., 2002; Fawcett et al., 2007; Levasseur et al., 2022). We used TIS in our study because i) our construct measured timely information sharing rather than just information sharing, ii) current business operations are highly dependent on time, and iii) limited studies have focussed on the timely aspect of IS.

2.4 Supply Chain Financial performance

Supply chain management is highly dependent on operational practicalities that are critical for supply chain financial performance (FP). Academics and practitioners have assessed SC performance through various metrics; the basic idea of FP is to minimize costs and maximize profits for firms (Ganga & Carpinetti, 2011; Akhtar et al., 2018:2019). The measurement of SCM performance is key to assessing the efficiency of SC operations in response to disruption, considering that "*even a small reduction in logistics costs, or narrowing of this gap between emergency operations and normative state would yield large savings*" (Whiting et al., 2009:1083). In the extant literature, SCM performance is classified into two types: operational and financial (Chen et al., 2004; Akhtar et al., 2019). Measures of operational performance include reliability, consistency, delivery speed, volume flexibility, schedule flexibility, delivery speed, specific costs, customer satisfaction, rapid confirmation of customer orders,

on-time deliveries, handling of complaints, and quality. The more widely adopted financial performance metrics are: profit, net income, economic added value, return on investments, and return on assets. Many studies have been carried out to investigate i) the impact of SCM on FP (e.g., D’Avanzo et al., 2003; Chen et al., 2004; Ellinger et al., 2011; Cao and Zhang, 2011) and ii) the influence of supply chain risk management on FP (e.g., Li et al., 2006; Hendricks and Singhal, 2008; Son and Orchard, 2013). However, a relatively limited number of studies has examined the impact on FP in the context of SCF (e.g., Protopappa-sieke and Seifert, 2010; Blackman et al., 2013; Xu et al., 2010; Pellegrino et al., 2018; Silvestro and Lustrato, 2014). Particularly, little attention has been paid to the links between SCF and FP.

To summarise, many prior studies have examined three constructs, including the two SCM strategies—SCF and TIS—and FP, individually. A few authors have investigated the interactions of either two together, e.g., SCF and TIS, FP and TIS. Moreover, limited studies have scrutinized the central role played by TIS in operating in environments affected by uncertainty. In addition, none of the prior listed studies has examined SCF, IS, and FP simultaneously, as shown in Table 3.

(Insert Table 3 here)

Upon identifying this research gap, we conducted our study to examine all the three constructs in a single framework while considering the central role played by TIS.

3. Hypotheses development

3.1 Supply chain finance and financial performance

Supply chain finance is aimed at diversifying the financial sources of firms and improving SC performance. It depends “*on the terms of payment that may include a penalty for late payments and/or discounts for early payments*” (Gupta & Dutta, 2011:47). Additionally, SCF focusses on the coordination of cash flows among SC firms to increase performance and efficiency (Wuttke et al., 2013a).

Generally speaking, SC operational performance is linked with FP. Previous research has indicated that various SC financial strategies have a positive impact on performance. Protopappa-sieke and Seifert (2010) examined the sensitivity of a firm’s operational performance and FP. Blackman et al. (2013) found that SC financial strategies contribute to i) reductions in financial risk and in the offsetting of international payments, ii) increases in the efficiency of foreign exchange processes, iii) shortening of the lead-times of payment cycles

within the banking system, and iv) decreases in the variability of customer-supplier settlement dates. Silvestro and Lustrato (2014) found that financial parameters synchronize the physical and information flows, thus contributing to the SC integration enablers. Lekkakos and Serrano (2016) stated that the application of reverse factoring significantly increases the operational performance and FP of small and medium enterprises (SMEs). Xu et al. (2010) found that SCF can significantly reduce the likelihood of bankruptcy for SC members. In the same vein, Zhao et al. (2015) noted that information on SC members (e.g., taxable sales revenue, value-added tax, firm age) is negatively correlated with business bankruptcy. Kutsuna et al. (2016) believed that, compared to firms without partnerships, SC members experience significantly higher rates of growth in revenue, cash balances, and PP&E (i.e., property, plant, and equipment), and the financial effects of positive liquidity shocks on SCs and financial strengthens. In the SC risk management context, Mello et al. (1995) found that operational flexibility and SC financial strategies have supportive features and can be interconnected by substituting for each other in a firm's performance. Chowdhry and Howe (1999) developed a model and highlighted that firms frequently use financial tools to hedge their short-term risk while depending on operational flexibility to do so for long-term risk. In the same vein, Hommel (2003) extended that model and differentiated between geographical discrepancy and operational flexibility, whereby hedging strategies are motivated by minimum cash flow constraints linked with financial factors. Ding et al. (2007) examined the financial strategies—e.g., currency call and put options and production postponement portfolios—employed to mitigate exchange-rate risk. Chen et al. (2014) concluded that financial strategies can partially substitute for operational strategies, thus contributing to overall performance. In addition, Steeman (2016) pointed out that SC financial strategies can improve the overall FP and mitigate the overall risks of SCs. Pellegrino et al. (2018) highlighted that SCM strategies—e.g., sourcing strategies—when used as commodity price volatility and mitigation approaches, can improve a firm's financial performance. To summarise, although SCF is an essential part of SCs, very little research has hitherto explicitly addressed the topics of strategy, implementation, and FP of global financial SCs (Blackman et al., 2013; Gelsomino et al., 2016).

Nevertheless, a few researchers have been able to draw a relation between SCF and FP. For instance, Randall and Farris (2009) provided SCF techniques suited to identify and quantify any potential opportunities to improve overall SC profitability and performance. Shou et al. (2012) analysed the critical relationship between a SC's structure and its key factors through a system dynamics model and showed that prepayments (i.e., payments made to suppliers in

advance of delivery and of the issue of invoices) may have a positive impact on FP. In the same vein, Wuttke et al. (2016) found that SC financial strategies can increase FP by i) providing suppliers with better access to finance and ii) facilitating longer payment terms for buyers. McGuinness et al. (2018) studied data drawn from 202,696 SMEs across 13 European countries. Based on the results, they posited that SCF has a positive impact on a firm's financial viability and performance.

Although the above discussion and literature leans towards a positive relationship between SCF and FP (e.g., Gelsomino et al., 2016), there are no conclusive arguments for how they are correlated in modern SCs that operate in environments affected by uncertainty caused by, for instance, terrorist attacks or pandemics. Thus, on the basis of the literature discussed above we developed Hypothesis 1 below.

Hypothesis 1: Supply chain finance is positively correlated to financial performance.

3.2 Timely information sharing and financial performance

The benefits of TIS in SCs are a growing area of interest among researchers and practitioners. Researchers have identified the benefits of TIS in different dimensions. For example, TIS strategies can significantly reduce the bullwhip effect and its relevant factors (Lee et al., 1997; Li et al., 2006), increase material flows (Lee et al., 2000), reduce levels of behavioural uncertainty, enhance levels of trust (Kwon & Suh, 2004), and improve channel coordination (Sahin & Robinson, 2005). Li et al. (2006) highlighted that the level and quality of TIS are the crucial factors influencing the competitive advantage of SC partners.

In the performance context, Li and Lin (2006) found that both TIS and information quality contribute to overall costs and service levels. Wu et al. (2014) highlighted that both IS and collaboration have a partial mediation effect on SC performance. Panahifar et al. (2018) found that secure IS i) is the most important factor for fostering IS-centred collaborations and ii) positively and significantly influences a firm's performance. Similarly, Carr and Kaynak (2007) found that traditional communication methods of both internal and external IS are significant factors in improving a buyer's performance, thus affecting that of a firm. Sezen (2008) concluded that IS and integration significantly influence SC performance. However, Liu et al. (2013) argued that IS affects only SC performance, while having no impact on overall business performance. Moreover, a number of studies have shown that IS/SC integration leads to improved FP and profitability. For instance, Ural (2009) demonstrated that IS has a positive

impact on financial export performance and satisfaction with an export venture. Schloetzer (2012) discovered that the degree of IS is positively correlated with the partners' financial and non-financial performance. Huo et al. (2014) revealed that a strong internal IS can generate sufficient requirements for firms to improve their FP. Zhao et al. (2015) found that IS is a key factor of FP; more specifically, that management uses the advantage of the strategic relationships linked to IS to increase FP. Chang et al. (2016) conducted a meta-analysis of 170 previous studies to examine the impact of IS on FP. They pointed out that an element of IS can certainly improve FP. However, Huo et al. (2017) claimed that there is no significant link between IS and FP.

In other studies, Lai et al. (2015) found that environmental management IS with suppliers could improve cost and environmental performance, but not profit. Gu et al. (2017) discovered that a strong relationship with suppliers not only improves their operational performance but also positively influences the manufacturers' operational performance (directly) and FP (indirectly). Lukas and Welling (2017) concluded that structured IS benefits partners in term of mutually maximizing profits and bringing about equitable profit sharing. Yu et al. (2018) highlighted that there is no significant relationship between IS and FP. Several studies have empirically established the link between IS and SC FP. However, a few studies, such as Oztekin et al. (2015), Huo et al. (2017) and Yu et al. (2018), failed to find a link between IS strategies and FP. Based on the prior studies discussed above, we developed Hypothesis 2 below.

Hypothesis 2: Timely information sharing is positively correlated to financial performance.

3.2 Supply chain finance and timely information sharing

It is not uncommon to consider a supply chain as a set of inter-company product, information and financial flows (Mentzer et al., 2001; Pfohl and Gomm, 2009; Blackman et al., 2013). The implications of IS have previously been considered only between buyers and suppliers in SCs (Chandra and Kumar, 2001). However, Fairchild (2005) argued that, in the rapidly changing markets caused by, for example, global competition, the shortening of technological innovation cycles, global information availability, and dramatic changes in cultural, social and political environments, SC financial information is crucial for financial institutions. Hofmann and Belin (2011) identified the lack of knowledge and IS as one of the major challenges of SCF. In dynamic environments, computer or artificial intelligence technology should be combined and coordinated in order to enable financial institutions and SCs to engage in effective and informed decision making (Hofmann, 2005; Akhtar, 2018). The role played by advanced

technology in SCF practice improves service efficiency and strengthens the relationship among SC partners through better IS and transparency, which is essential for SCF (Levina and Vilnai-Yavetz, 2015; Caniato et al., 2016; Akhtar 2018:2019). Similarly, Silvestro and Lustrato (2014) stressed that financial institutions have a crucial role to play in IS across SCs. SCF can be enhanced by i) synchronizing the flow of products with that of finance and information, ii) sharing information, and iii) increasing information visibility. Hasan et al. (2020) and Akhtar et al., (2018, 2019) revealed that SCF in modern supply chains like industry-4-driven provides an avenue for financial institutions to use information about current customer relationships when considering loans for other SC partners. The shared SC enables a financial institution to confirm information about the SC partners with greater certainty.

SCF may also increase the availability and accuracy of information, which, in turn, will support financial institutions in assessing the default probabilities tailored to specific SC firms (Hofmann, 2005). Pezza (2011) found that a deficiency of IS can make it harder for managers to make appropriate SCF decisions. It is important to ensure visibility in all stages of both the financial and physical SCs. For example, Motorola has set up an IS-based system among its customers, suppliers, and banks through which it shares information about financial flows and vendor ratings. This greatly rewards their suppliers with lower financing costs (Blackman et al., 2013). Similarly, Zhao et al. (2015) found that a firm's operational information is positively related with the performance of SCF. Wandfluh et al. (2016) pointed out that buyer-supplier financing arrangements and IS are significant in implementing SCF practices, because both have a positive influence on overall financial performance. Song et al. (2018) concluded that the acquisition of transaction information and business credit can reduce ex ante information irregularity risk. Zhao et al (2021) found that IS significant impacts product quality and financial performance. However, limited efforts have been made to empirically examine the direct link between SCF and IS. We thus developed Hypothesis 3 below to examine the positive impact of TIS on FP.

Hypothesis 3: Supply chain finance is positively related to timely information sharing.

3.4 The mediating role of timely information sharing by using advanced technology

Scholars have examined the central role played by IS in SC performance. For instance, Kwon and Suh (2004) conducted a study on the level of trust among SC partners. They found the mediating role played by IS on behavioural uncertainty and on the degree of relationship between trust and behavioural uncertainty. Im and Rai (2008) examined the mediating role of

explorative and exploitative IS in the long-term relationships of SC partners. They found that, although the impact of contextual ambidexterity on the relationship performance is only partially mediated by exploratory IS, it is fully mediated by exploitative IS. On the other hand, the direct impact of ontological commitment on relationship performance is fully mediated by both forms of IS. Kocoglu et al. (2011) suggested that IS plays a mediating role between SC integration and performance. Wu et al. (2014) studied four key social exchange issues—trust, commitment, reciprocity, and power—as antecedents of IS and collaboration. They found that both IS and collaboration have a partial mediating effect on SC performance. Marinagi et al. (2015) confirmed the central role played by IS in Greek manufacturing firms. They concluded that IS has a mediating impact on the relationship between information quality and SC performance. Chavez et al. (2015) examined the central role played by information quality in the relationship between customer integration and operational performance. They revealed that information quality plays a partial mediating role between customer integration and quality, delivery, and flexibility. Akhtar et al., (2018) studied promising links among the Internet of Things (IoT), dynamic data and information processing capabilities, and operational performance. They stated that dynamic data and information processing capabilities play a mediating role in the relationship between the use of IoT and operational performance. Hsin et al. (2019) investigated the relationships among the antecedents of business system leveraging, IS among group members, and SC performance. They concluded that IS partially mediates the relationship between business system leveraging and SC performance. IS has received increasing attention in relation to improving SC liquidity and working capital through IS and innovation (Song et al., 2018). However, far too little attention has been paid to the mediating role of TIS in the context of SCF (See Table 3). Based on the literature mentioned above, Fig. 1 presents a graphic version of the hypothesized conditions and their inter-relationships. We thus formulated Hypothesis 4 below.

Hypothesis 4: Timely information sharing through advanced technology mediates the relationship between supply chain finance and financial performance.

(Insert Fig1 here)

4. Research methodology

4.1 Questionnaire development, operationalization, and respondents

Using the three-stage procedure suggested by Malhotra et al. (2017), we developed a closed-ended multi-choice questionnaire. In the first stage, we carried out an extensive review of the

relevant literature, subsequently identifying the relevant items that described each construct and developing an initial questionnaire. The initial questionnaire utilized in this study was derived from the following studies (e.g., Chen et al., 2004; Lai et al., 2007; Wuttke et al., 2013b; More & Basu, 2013; Caniato et al., 2016; Wandfluh et al., 2016; Yu et al., 2018).

In the second stage, we conducted a pilot test of the initial questionnaire and fine-tuned it based on the comments and remarks made by the over 40 supply chain professionals (e.g., supply chain managers, logistics managers, supply chain team leaders) who were involved in our testing. In the last stage, we collected data using the finalized questionnaire. In the development of the questionnaire, we employed a seven-point Likert scale—a scale that is commonly used in empirical studies (Preston & Colman, 2000)—ranging from 1=strongly disagree to 7=strongly agree.

Additionally, any relevant endogeneity biases (e.g., common-method variance (CMV), measurement error, omitted variables, and simultaneous bias) were also addressed (Harman, 1960; Podsakoff et al., 2003) at the study/questionnaire design stage. For instance to deal with CMV issues—e.g., double-barrelled questions, technical terms, and unfamiliar words—we used the guidelines provided by Podsakoff et al. (2003).

For our data collection, we adopted a purposive sampling technique due to the following reasons: First, to select only those sample members who meet the study requirements such as LSPs, manufacturing firms, exporters and importers and registered with the Security & Exchange Commission Pakistan (SECP). Second, firms have their own company website, from which to obtain phone numbers and addresses. We used the SCEP database and selected 850 firms for a postal survey. The geographical focus of this study was Pakistan, a country that provided a good example of an uncertain environment due to being heavily affected by terrorism and weak formal institutions. Supply chains rooted in Pakistan had been repeatedly hit by terrorist attacks in the previous 15 years. Taking the scale of terrorism into account, the SCM practices enacted in Pakistan were expected to provide a true picture of man-made and natural uncertainties—e.g., terrorism and COVID-19—affecting SCs, thus offering valuable and potentially generalizable insights into the links among the three constructs, tested in an uncertain environment. The questionnaire, with a covering letter, was sent to the 850 sample firms in Pakistan. The response rate for this study was 31%, which was close to the average SCM research response rates in Pakistan. The response rate of this study is higher than to SCM

research in Pakistan with a 17 % response rate (Tipu and Fantazy, 2014). A total of 261 responses were then analysed through the use of Structural Equation Modelling (SEM). The characteristics of the respondents are shown in Table 4.

4.2 Measurement models and quality checks

We used multiple items to develop the measurement models. The SCF construct was measured using 11 items, the TIS five, and the FP six items. In addition, we included three control variables—respondent type, industry division, and firm size—to ensure the quality of this study, as shown in Table 4. A primary pool of scale items was generated through an extensive literature review of SCM strategies to establish the content validity of the survey constructs. As a validity criterion, we employed Pearson’s correlation coefficient to test the relationships between the two SCM strategies: SCF and IS and the outcome variable: FP. Two of the independent variables were found to have statistically significant positive correlations with FP.

Table 5 shows the constructs, loadings, Cronbach's α , average variance explained, and reliability measures. These numbers provide acceptable psychometric properties of our scales. Moreover, we found that there was no non-response bias in our sample. For discriminant validity, two methods were employed. First, the correlation between the constructs did not exceed the threshold value of 0.85 (Kline, 2015), and ranged between 0.32 and 0.59, as shown in Table 6. Second, the square of the correlation (ϕ^2) between each pair of constructs was lower than the average variance explained (AVE), thus being acceptable (Chiang et al., 2012). The descriptive statistics and correlation matrix of the constructs are shown in Table 7.

(Insert Tables 5, 6 & 7 here)

5. Hypothesis testing and results

We employed SEM to estimate the relationships among the constructs. The proposed model (Fig. 1) was tested by means of the maximum likelihood estimation method using the IBM AMOS 25 software. The model fit indices were found to be $\chi^2(129) = 149.20$, RMSEA = 0.025, CFI = 0.99, $\chi^2/df = 1.157$ and non-significant (χ^2) with p-value 0.108 (> 0.05). The measures were found to strongly support our model (Kline, 2015) with R^2 values ranging from 15% to 45%. Hypothesis 1 proposed that SCF would be positively related to FP. This hypothesis was found to be supported at $p < 0.00$ with $\beta = 0.32$. Hypothesis 2 (TIS is positively related to FP) and Hypothesis 3 (SCF is positively related to TIS) were also found to be supported with $\beta = 0.54$ ($p < 0.00$) and $\beta = 0.44$ ($p < 0.00$) respectively.

With regard to the mediating role of TIS, we tested Hypothesis 4 (see Fig. 1) based on three widely adopted approaches: the causal-steps approach (Baron and Kenny, 1986), Sobel typed-tests (Sobel, 1982), and bootstrapping (Preacher and Hayes, 2008). The results obtained based on the causal-steps approach showed that the SCF independent variable significantly affected the dependent variable FP with $\beta = 0.32$ and t-value = 5.30 at $p < 0.000$. The SCF independent variable was also found to significantly affect the TIS mediating variable, as $\beta = 0.44$ and t-value = 7.96 at $p < 0.000$. Further, TIS (the mediator) was found to significantly affect FP with $\beta = 0.54$ and t-value = 10.32 at $p < 0.000$. Finally, when the model was controlled for the mediating variable (TIS), the previous relationship (i.e., between SCF and FP) was reduced ($\beta = 0.09$ and t-value = 1.57 at $p < 0.119$) and became non-significant. To conclude, our results thus indicate the full mediation of TIS between SCF and FP. We obtained the same results based on the Sobel typed-tests. Finally, we used the bootstrapping method with 5,000 samples and a 95% confidence interval, with parcelling as a strategy (Preacher and Hayes, 2008). First, based on the results, we found that SCF was positively associated with FP with $\beta = 0.27$ and $t = 5.27$ at $p < 0.000$. We also found that SCF was positively related to TIS with $\beta = 0.37$ and $t = 7.96$ at $p < 0.000$. Moreover, the mediator (TIS) was positively associated with FP [$(\beta = 0.54, t = 10.32, p < 0.000)$]. Additionally, the result indicated that the direct effect of SCF on FP was reduced [$(\beta = 0.07, t = 1.57, p < 0.118)$] when controlling for TIS. Consequently, we cross-validated that, based on the bootstrapping approach, TIS fully mediated the relationship between SCF and FP.

6. Discussion and conclusions

6.1 Summary of findings and theoretical implications

The aim of our study was to examine the role played by supply chain finance (SCF) and its relationships with timely information sharing (TIS) and financial performance (FP), particularly the mediating role of TIS. Prior studies had noted the importance of SCF in SCs (e.g., Pfohl & Gomm, 2009; Blackman et al., 2013; Wuttke et al., 2013b; Caniato et al., 2016; Wuttke et al., 2016; Song et al., 2018; Moretto et al., 2018). SCF is also increasingly recognized as a significant factor in driving SC operational performance (Protopappa-sieke & Seifert, 2010). Various studies have been conducted to examine the effects of financial strategies on operational and financial performances (e.g., Mello et al., 1995; Chowdhry & Howe, 1999; Hommel, 2003; Ding et al., 2007; Chen et al., 2014; Steeman, 2016; Pellegrino et al., 2018).

However, very little was found in the literature in regard to investigation of the effects of SCF on FP in the context of environments (such as Pakistan) affected by uncertainty. Our study contributes to the literature (e.g., Randall & Farris, 2009; Shou et al., 2012; Wuttke et al., 2016; Gelsomino et al., 2016) by providing important and novel insights in the context of uncertain-risk environments and of SCF (Errico et al., 2022).

Our findings support the hypothesis stating that FP is significantly associated with TIS. In the literature, the role played by IS in SCM is the subject of extensive discussion (e.g., Li et al., 2006; Yu et al., 2010; Pandey et al., 2010). However, Oztekin et al. (2015) argued that it may increase a firm's redundancy and cause loss of information privacy. Hence, our findings are consistent with those in the existing literature and confirm the significant role played by IS in SCM. As mentioned in the literature review, information sharing has a positive impact on performance (e.g., Ural, 2009; Schloetzer, 2012). Similarly, it has also a positive impact on FP (e.g., Yang et al., 2011; Huo et al., 2014; Zhao et al., 2015; Chang et al., 2016). Information sharing strategies can increase FP by: building and strengthening the relationship between firms and customers through financial information, reducing default threats, increasing transaction visibility, increasing productivity and organizational efficiency, improving cash flows, and improving customer service. Our study differs from some published ones (e.g., Huo et al., 2017; Yu et al., 2018) in that it did not find any significant correlation between IS and FP.

There is a lack of studies on the empirical relationship between SCF and IS. The findings of our study support its third hypothesis—which stated that SCF is significantly correlated with IS—and provide novel empirical evidence. However, it partially supports Chen et al. (2004), who stated that effective and efficient information sharing can assist the SCF services in reducing costs, raising customer-service levels, enhancing the robustness the SCs, and enabling suppliers to lower their prices. This finding is also in line with those of Pezza (2011) and Hofmann and Belin (2011), who argued that a deficiency in information sharing can cause managers to make inappropriate decisions in the SCF context. For example, it is important for suppliers to know when an invoice is approved, so that they will be in a better position to forecast their incoming cash flows and take appropriate strategic decisions related to inventory management and financial performance.

Our results also show the mediating effects of IS on FP. We found a positive and significant relationship between IS and FP. Consequently, IS might be facilitated by improving SCF by

utilizing common IT platforms (Akhtar et al., 2018). However, when sharing relevant information is impossible, firms may encounter have hiccups in achieving high FP due to a lack of timely information. In addition, a specific SCM strategy may be non-significant when analysed for direct effects, but become valuable when combined with others (Ordanini & Rubera, 2008).

A large number of published studies have described the mediating role played by IS in various contexts (e.g., Kwon and Suh, 2004; Im and Rai, 2008; Kocoglu et al., 2011; Marinagi et al., 2015; Akhtar et al., 2018; Hsin et al. 2019); we make a contribution to this literature by linking it with SCF. In contrast, to our knowledge, no previous study had investigated the mediating effect of TIS on the correlation between SCF and FP. The significance of IS in mediating the correlation between SCF and FP confirms the hypothesis that the more TIS is enacted among SC partners, the greater is the effect on SCF services and on FP. One possible reason for the significant mediating effect of IS is that it may increase trust between financial institutions and firms. Timely IS in regard to SCF services can improve the quality of SC financial decisions and speed up SC credit processes, which, in turn can alleviate a firm's cash flow problems (Song et al., 2018; Ng and Ahmed, 2022).

Extensive reviews of the literature, (Blackman et al., 2013; More and Basu, 2013; Wuttke et al., 2013 b; Caniato et al., 2016; Wandfluh et al., 2016; Song et al., 2018) have found that most of the extant studies on SCF are conceptual in nature, therefore highlighting the need for empirical studies in this field, especially in the context of environments affected by uncertainty. Our study contributes to and extends the growing research on SCF by making a substantial contribution in identifying the knowledge gaps in the literature. The main aim of the study was to investigate the impact of SCM strategies (SCF and IS) on FP. Therefore, in the context of SCM, we contribute by identifying the impact of SCM strategies on financial performance. This major contribution to the SCM literature provides a better understanding of SCM strategies as predictors of financial performance.

6.2 Contributions and practical implications

Our findings validate the significant correlation between SCF, IS, and FP. The survey of Pakistani firms contributes to the managerial knowledge of SCF in environments affected by uncertainty. The ability to understand SCF and financial IS flexibility in such an environment enhances our understanding of the related practices enacted by firms in terrorism-affected areas like Pakistan. Furthermore, the current COVID-19 pandemic also engenders a similar set of

circumstances situation for supply chains. Our findings could be very useful for managers operating in environments affected by uncertainty. This study answers the calls made by previous studies (More and Basu, 2013; Lekkakos and Serrano, 2016; Caniato et al., 2016; Moretto et al., 2018; Pellegrino et al., 2018) for more research on SCF by covering the related knowledge gap and the impacts of SCF on FP. It also contributes to literature by answering the call made by Gao et al. (2018) in the context of IS influences on SCF. Furthermore, our findings contribute and validate the mediating role played by of TIS in the relationship between SCF and FP.

Firms and their managers should adopt SCF and TIS strategies to achieve high FP. Timely IS is significant for the enactment of successful SCF strategies. Also, managers should be more transparent in their payment processes through the extensive application of IS strategies. They should ensure the flexibility of the processes linked to the payment of their SC partners and increase financial collaboration in order to streamline their SC cash flows. Similarly, managers should provide small SC partners with credit support and offer advance payments to them. This could reduce end-to-end SC costs through the effective management of financial flows, the improvement of end-to-end SC working capital, an increase in financial collaboration support, and the sharing of SCF risks with SC partners. This may link to increases in contract facilitation in financial flows. Similarly, if TIS is integrated effectively, financial Institutes or banks may provide more SCF solutions to SC customers. When managers share more timely information with financial institutions to avoid unnecessary delays in payments and financial risks, they facilitate the operation of their SCs and other processes. These avenues provide directions that would enable managers to pursue high FP through TIS.

6.2 Limitations and future research directions

Although this study makes significant contributions to the SCF literature and practices, it does have some limitations. First, SCF is not context-free and varies from country to country, depending on local economic conditions and the strength of financial institutions. Therefore, it should be acknowledged that the findings of this study might not be easily generalizable. Second, the assumption of a symmetrical sharing of SCF information among SC partners may be optimistic. In reality, only the debtors are aware of their exact capital requirements, while the other SC partners may not have access to this information (Gao et al., 2018).

A cross-validation of the structural model could be achieved by widening the geographical scope of the study, which only investigated the SCM practices enacted in Pakistan, albeit through a suitable sample. It would be interesting to cross-validate our model and findings in other regions and establish whether they have general applicability. In particular, a comparative analysis performed between regions with high and low terrorism risk domains would provide a fresh understanding of the development of SCF. There is further scope for theory-guided development (e.g., by means of agent or stakeholder theory) to explain the value of financing models in SCs and evaluate the impact of SCF services on different stakeholders. In this regard, it would be interesting to examine this issue under condition of information asymmetry among SC partners as well as the role played by advanced technologies in facilitating information sharing and enhancing supply chains' performance.

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