COORDINATING WORKING CAPITAL MANAGEMENT MODEL IN COLLABORATIVE SUPPLY CHAINS

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Abstract: The paper is devoted to development of working capital management (WCM) model providing optimal levels of working capital (WC) to all individual business partners through collaborative actions of capital reallocation along the supply chain (SC). As such, we suggest the tool of WC optimization through financial terms and cash flows verified on Russian collaborative SC data. Mathematical modeling is suggested as a method to upgrade existing collaborative cash conversion cycle (CCC) model by optimizing it in terms of minimization of total financial costs associated with working capital in a three-stage SC. Three sets of constraints – for each SC partner, for the whole SC and for SC structure consequently – are imposed. The application of the suggested optimization model to focal SC provided significant speed up of individual CCCs and investments in WC on the grounds of combination of extension of days of accounts payable, reduction of days of inventories and reduction of days of accounts receivable in different proportions for SC participants. The theoretical contribution resides in integration of collaboration and WC concepts adding a holistic perspective to extant WCM models, as well as in integration of financial and operational measures of SCM. The suggested model financially illustrates the motivation of SC partners to cooperate in order to simultaneously achieve target levels of WC investments and improve individual financial performance through collaborative operations.

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Coordinating Working Capital Management Model in Collaborative Supply Chains

1. Introduction

In the field of supply chain management cooperation and collaboration of linked through the flows of goods, information and finance business partners (basic raw materials and components suppliers, manufacturers, distributors, transporters, banks and financial institutions, etc.) are core concepts. Research on supply chains has mainly focused on inventory cost, transportation cost and cost related to goods procurement. However, there has been very little research work focusing on the flow of money (Kouvelis et al., 2006). In terms of swiftly changing business environment, Gupta and Dutta (2011, p.47) state that “for an effective supply chain system, the management of upstream flow of money is as important as the management of downstream flow of goods”. From this perspective, working capital management (WCM) as an essential element of financial supply chain management (FSCM) has gained a lot of attention (Deloof, 2003; Garcia-Teruel and Martínez-Solano, 2007; Johnson and Templar, 2011; Shin and Soenen, 1998; Viskari et al., 2011; Viskari and Karri, 2012; Matyac, 2015) due to the fact, that it is a way to accelerate the cycle time of working capital and increase the profitability of the company in respond to financial volatility in business environment (Viskari et al., 2012) and enacted Basel II restraining external financing from banks and in turn increased demand for capital from within the SC (Hofmann and Kotzab, 2010; Talonpoika et al., 2016).

For this reason, importance of effective WCM increased dramatically, especially for SCs from emerging markets, that matter-of-factly faced difficulties with access to capital, limited financial infrastructure and legal, regulatory and accounting uncertainties in the first place (ACCA, 2014). Apart from that, the focus of the study on emerging markets is as well prompted by the fact that SCs stretch across the globe with a diverse range of suppliers in emerging markets, and it is failure of a supplier that can impact most severely the whole production process putting viability and continuity of a whole SC at threat. So, WCM is increasingly transcending boundaries of mature markets and has potential for economic stabilization, however most emerging market companies have not yet fully realized its benefits. Likewise, coordinating mechanisms of WCM in SCs have received little attention due to the fact, that the role of financial coordinators (financial service providers, banks, FinTech companies and other financial intermediaries) as core participants in facilitating and enabling FSCM has only recently been identified in academic literature (Silvestro and Lustrato, 2014).

Along with that, the research is motivated by the call for more holistic approach to SCM on the grounds of merging financial and operational SC measures as existing literature either considers them separately or does not give insights on financial flows (Protopappa-Sieke and Seifert, 2010; Kroes and Manikas, 2014). We address these gaps and aim to develop WCM model providing optimal levels of working capital to all individual business partners through collaborative actions of capital reallocation along the SC. As such, the main aim of the research is to suggest the tool of working capital optimization through financial terms and cash flows verified on Russian collaborative SCs data.

The paper begins with the review of SC collaboration and working capital management literature leading to research question:

RQ1. How to improve the financial performance of all the SC business-partners improving the integral performance of the SC at the same time?

In response to RQ1 the model is developed; this is followed by the case study analysis and discussion of findings. The paper closes with a conclusion, identifying further research directions.
2. Theoretical Background

Supply chain management revolves around coordination and cooperation among several business partners that are linked through flows of material, money and information (Barratt, 2004; Gunasekaran et al., 2004; Kouvelis et al., 2006; Gupta and Dutta, 2011). These partners in particular include suppliers of basic raw materials and component parts, manufacturers, wholesalers, distributors, transporters, retailers, banks and financial institutions. In general, materials, component parts and finished goods flow downstream although the returned merchandise flows upstream. Money in contrast flows upstream in a supply chain, whereas information flows in both directions. For an effective SC, management of upstream flow of money is as important as management of downstream flow of goods (Gupta and Dutta, 2011). Nevertheless, the research work in SCM has primarily focused on the study of materials flow and very little work has been done on the study of upstream flow of money (Gupta and Dutta, 2011; Wuttke, Blome and Henke, 2013).

2.1. Concept of Cooperation, Coordination and Collaboration in Supply Chains

Increasing supply chain complexity and numerous activities spread over multiple functions and organizations pose interesting challenges for effective SC collaboration (SCC), however, collaboration is an amorphous meta-concept that has been interpreted in many different ways by both organizations and individuals (Barratt, 2004). SCC has proven difficult to implement although having the potential to offer significantly improved performance (Aberdeen, 2006; Steeman, 2014). It is suggested that many of the problems related to SCC are due to a lack of understanding of what collaboration actually implies. This poor understanding is further increased due to the association of collaboration with the hype surrounding e-business whereby technology has been promoted as the key to enabling wide scale inter-organizational collaboration. Various perspectives of SCC as reported in the literature are testimony to the lack of standard definition of SCC, but basically they fall into two groups of conceptualization: process focus and relationship focus. Some of these perspectives present the inherent capability or intangibles required to coordinate like responsibility, mutuality, cooperation and trust (Larsen, 2000; McClellan, 2003). The other perspectives can be visualized, based on the coordination effort required in achieving common goals in various activities of SC (Xu and Beamon, 2006). Since the activities are different, the coordination requirements also vary with the complexity of the activity. Simatupang and Sridharan (2002) introduced one of the most cited definitions of SCC: “A collaborative supply chain simply means that two or more independent companies work jointly to plan and execute supply chain operations with greater success than when acting in isolation” (Simatupang and Sridharan, 2002). As this definition is limited by the boundaries of the inter-organizational processes, Flynn et al. (2010) suggested a more comprehensive definition of SC “as the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organization processes. The goal is to achieve effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the customer at low cost and high speed” (Flynn, Hou and Zhao, 2010).

In order to inform future SCM development, it is helpful to reflect on where the gaps are in current theoretical perspectives on SCC. The following discussion is not meant to be an exhaustive list; rather, it is more a consideration of potential avenues of thought that may have saliency for SCM in general and SCC in particular. From the strategic management point of view, one of the most challenging coordination perspective is to extend the concept of coordination from within an organization to coordination between organizations as they do not exist in isolation (Gadde and Snehota, 2000; Håkansson and Snehota, 2006). Any
organization, whether a large corporation, public body, or a small business aims to meet the needs of its various customers and stakeholders, will need resources in order to do this, and will acquire many of its materials, equipment, facilities, and supplies from other organizations. The performance of an organization is thus influenced by the actions of the organizations that make up the supply chain (Kirca et al., 2005). Therefore, focus has moved from competition between firms at the same level in the production process to competition between supply chains, from raw materials to end customers (Håkansson and Ford, 2002). A company’s ability to create trust-based and long-term business relationships with customers, suppliers, and other strategic partners becomes a crucial competitive parameter. Though it is accepted that external relationships in SCM are strategically important, still many questions concerning operations integration with suppliers and customers in SC remain unanswered (Frochlich and Westbrook, 2001).

SCC is specifically important to manage external relationships with suppliers and customers. The empirical results (Shi and Yu, 2013) indicate that SCC considerably improve collaborative advantage, which in turn, has significant positive effect on firms’ financial performance (in particular, the mediator role of collaborative advantage is stronger for small firms than medium and large firms). Furthermore, the lack of coordination may result in poor performance of the whole SC. The consequences of lack of coordination are dramatic: inaccurate forecasts, low capacity utilization, excessive inventory, inadequate customer service, inventory turns, inventory costs, time to market, order fulfillment response, quality, customer focus, and customer satisfaction (Ramdas and Spekman, 2000), not even mentioning the perspective representing the “dark side” of inter-firm collaboration, which characterizes many buyer-supplier relationships (Rokkan, Heide and Wathne, 2003; Noordhoff et al., 2011; Seggie, Griffith, and Jap, 2013).

It has been well documented by operations management scholars and practitioners, that communication of business partners is the essence of organizational life (Rokkan, Heide and Wathne, 2003; Galaskiewicz, 2011). In relationship marketing it has also been recognized as well how collaborative communication is critical to fostering and maintaining value-enhancing inter-organizational relationships (Malshe and Agarwal, 2015). However, such work has remained disjointed and without a strong theoretical underpinning. In empirical studies, researchers have typically considered inter-organizational communication as a part of a broader construct or examined the extent to which the use of select communication strategies by buyer firms enhances supplier firm operational performance. Furthermore, the majority of research focuses on economic value for buyers or for suppliers; few studies investigate how strategic orientations of buyers and suppliers affect the relative relationship performance for the individual dyad members (Paulraj et al., 2008). Traditional perspectives that suppliers and buyers act as independent economic agents are being replaced with an understanding that these exchange partners are co-producers of value, and thus their performances are interlinked (Blackman, Holland, and Westcott, 2013; Silvestro and Lustrato, 2014; Stevens and Johnson, 2016).

2.2. Concept of Supply Chain Performance

Supply chain performance measurement and particularly financial supply chain performance measurement are the focus of our research. Previous studies have outlined the importance of integration of financial decision making and supply chain management as the most relevant stream of literature in our research. Continuing the arguments from previous section, there is a growing recognition among company executives that today’s business competition is no longer between individual firms, but between supply chains (SCs). If a SC is properly managed, its whole value can be greater than the sum of its parts. Not surprisingly,
there is an increasing demand for both scholars and business practitioners to make SCM more financially accountable. Optimizing financial performance along the SCs should be the ultimate goal of any SCM strategy. Despite the constantly growing attention to SCM, contributions to the link between supply chain management practices (SCMPs) and performance are very diverse in scope and nature, and most often remain dispersed and incomplete.

There are two main perspectives of working capital. The first one defines the ability of the company to cover its short-term debt with current assets. Jones (2006) defines the concept of this working capital perspective and described it with the equation:

\[ \text{Working capital} = \text{Current assets} - \text{Current liabilities} \]  

(1)

According to Jones (2006) current assets comprised of cash, total inventory, accounts receivable, securities and cash equivalents. On the other side, current liabilities refer to accounts payable, accruals, notes payable and short-term debt. The positive result of working capital means that the amount of cash the company will receive in the next 12 months is bigger than that company needs to cover its liabilities. The negative meaning of working capital means that company will not be able to cover its short-term debt.

Another perspective of working capital is widely used on the most of the studies dedicated to operational working capital and comprises of total level of inventory, accounts receivable (A/R) and accounts payable (A/P). According to Pirttilä (2014) the equation is following:

\[ \text{Working capital} = \text{Inventories} + AR - AP \]  

(2)

The operational approach to measure working capital is working capital cycle time – the cash conversion cycle approach is one of the main topics of this paper. Modification and optimization of it in collaborative supply chains will be discussed further.

2.3. Working Capital Measurement

The cash conversion cycle (CCC) concept presents one possibility for measuring and controlling the effectiveness of working capital management on the basis of relative ratios. Richards and Laughlin (1980) developed the CCC to criticize the use of current ratio and quick ratio as key indicators of a firm’s liquidity position. They state that the usefulness of these static liquidity indicators is limited by their failure to provide adequate information on cash flow attributes of the transformation process within a firm's working capital position. Current ratio and quick ratio emphasize essentially liquidation, rather than a going-concern. Richards and Laughlin stress that management should focus on avoiding default situations, and that cannot be supported by using ratios that indicate a firm’s ability to meet its obligations through asset liquidation in the event of default. Shin and Soenen (1998), Deloof (2003), Hutchison et al. (2007), and Ulbrich et al. (2008) have agreed that CCC is an adequate proxy for working capital management.

The cash conversion cycle presents the length (in days) of time a firm has funds tied up in working capital, starting from the payment of purchases to the supplier and ending when remittance of sales is received from the customers. In other words, the CCC is a collection of three activity ratios: the cycle time of inventories (DIO) plus the cycle time of accounts receivable (DSO) less the cycle time of accounts payable (DPO). The importance of the CCC from the perspective of value chain management is that it bridges purchasing activities with
suppliers, internal supply chain activities and sales activities with the customer (Farris and Hutchison, 2002).

\[ CCC = DIO + DRO - DPO \]  

(3)

The cash conversion cycle is also known as cash-to-cash (C2C). Where the parallel term originated from, is not clear. C2C is widely used in managerial articles (e.g. Sherida, 2000; Bowman, 2001; Ward, 2004) and supply chain management journal articles (e.g. Farris and Hutchison, 2002), whereas CCC is commonly used in financial journal articles (e.g. Deloof, 2003; Lazaridis and Tryfonidis, 2006). Lately, the streams have merged, possibly because more interest is shown towards financial supply chain management (Hofmann and Kotzab, 2010; Blackman and Holland, 2006).

The development of CCC was directed to two branches after it was published in 1980. The first branch of development improved the accuracy of measure. Gentry et al. (1990) developed weighted cash conversion cycle (WCCC), which takes into account the amount of funds committed at each step of the cycle. The weights are calculated by dividing the amount of cash tied up in each component by the final value of the product. The WCCC includes both the number of days and the amount of funds that is tied up at each stage of the cash cycle. Furthermore, Viskari et al (2012) introduced the advanced cash conversion cycle (ACCC) for controlling the amount and cost of working capital. It refines and extends the concept of WCCC. The ACCC is designed for the operational level, and it observes the capital tied up in the operating cycle of an order from raw material purchases to the remittance of the customer for the delivered product. Both WCCC and ACCC are based on the internal data of a company or the value chain of a product, for example. Evaluation and validation of these models is difficult because data used in these models is not available in a database or in public.

The other branch of development criticizes the denominators for the three components of CCC. Shin and Soenen (1998) introduced the net trade cycle (NTC) where all three components of CCC are expressed as a percentage of sales. They stated that the denominators are all different, making the addition not particularly useful. Farris and Hutchison (2003) suggest that inventories and accounts payable should be divided by the cost of goods sold and accounts receivable by net sales. When the interest in the management of financial supply chains increased, a new problem emerged: the company’s cost of goods sold is not shown in the profit and loss account. At the moment, the cost of sales method is only absolutely mandatory according to US GAAP (Generally Accepted Accounting Principles in US). The International Financial Reporting Standards (IFRS) allow the use of the cost of sales method and the nature of expense method which does not reallocate expenses among functions within the company. Hofmann and Kotzab (2010) introduced the calculation of CCC based on the definition of Farris and Hutchison (2003), but actually they use the definition of Shin and Soenen (1998). In the footnotes, Hofmann and Kotzab (2010, p. 308) state: “Many companies use the cost of goods sold instead of net sales when calculating DPO and DIO. The article uses net sales across each working capital component to allow a balanced comparison across each C2C cycle element and provides true comparisons between industries”. Soenen (1993) notes that the net trade cycle increases the uniformity and simplicity of calculation. Losbichler et al. (2008) point out that revenue data is usually more readily available than the cost of goods sold. It is not unambiguous to define the value of COGS for a company that follows the nature of expense method in its financial reporting. When the value of sales is used as the denominator instead of the COGS, the cycle time of inventories and accounts payable is shorter for most companies, because normally the value of sales is higher than the value of the COGS.
CCC as working capital can be either negative or positive. Negative CCC means that the company has a low amount of inventory and a company receives money from its customers before it has to pay its A/R or make A/E. In other words, in negative CCC scenario, a company receives its A/R before it should pay A/P. Many authors provide a view that the lower CCC the better and a company can manage it cycles efficiently although the too low CCC can cause problems with each component of CCC.

Although there are financial studies that investigate the inter-organizational level of cash conversion cycle using accounting perspective (Gomm, 2010; Protopappa-Sieke and Seifert, 2010; Wuttke et al., 2016) but not from collaborative supply chain view. A lot of authors though state that CCC research in supply chain should be done with a holistic point of view (Gelsomino et al., 2016).

3. Methodology

The objective of our research is to develop WCM model providing optimal levels of working capital to all individual business partners through collaborative actions of capital reallocation along the SC. In this section we develop a mathematical model capturing the financial planning decisions and operational activities of SC business partners. For this purpose, we firstly consider the cash conversion cycle concept from inter-organizational perspective and on the grounds of it proceed to suggested model description.

3.1. Coordinating Collaborative Cash Conversion Cycle Model

The collaborative cash conversion cycle (CCCC) was originally introduced by Hofmann and Kotzab (2010), stating that the reduction of CCC only for one company in a supply chain does not add value to other supply chain partners. From the internal position of supply chain participants and their external relationships, the CCCC for whole supply chain is calculated as the sum of every CCC in the supply chain, however, Hofmann and Kotzab (2010) provide the justification of the approach to calculate the collaborative CCC excluding the internal payments among the participants. Concerning the simple three-stage collaborative supply chain the CCCC is calculated the following way:

\[ CCC = DIO_1 + DIO_2 + DIO_3 + DSO_3 - DPO_1 \]  
(4)

The CCCC approach has the same advantages as CCC, but on the collaborative supply chain scale, as such, more accurate cycle time evaluation and thus working capital associated at each stage of a supply chain. Holistic view to the supply chain and high level of trust ensuring information exchange is critical if there is an objective to improve the performance of supply chain collaborators. However, the limitations of this approach include the factor of competition taking place in real life, when companies operate with several suppliers and customers.

Considering the problem of cost minimization along the supply chain, we use the formula of financial costs associated with each supply chain stage introduced by Viskari et al. (2013), Eq. (5):

\[
FC_j\left(d_{ij}, d_{2j}, d_{3j}, INV_j, AR_j, AP_j \right) = \\
INV_j \left(1 + c_j \right)^{365} - 1 + AR_j \left(1 + c_j \right)^{365} - 1 - \\
AP_j \left(1 + c_j \right)^{365} - 1.
\]  
(5)
\( j = 1, 2, 3 \) (1 – supplier, 2 – wholesaler, 3 – distributor),
\( c = (c_j) \) – annual cost of capital for company \( j \), mln. USD,
\( d = (d_{1j}, d_{2j}, d_{3j}) = (DIO_j, DRO_j, DPO_j) \) – elements of CCCC,
\( DIO_j \) – days of inventory outstanding for company \( j \),
\( DRO_j \) – days of accounts receivable outstanding for company \( j \),
\( DPO_j \) – days of accounts payable outstanding for company \( j \),
\( l = (INV_j) \) – level of inventory at year-end for company \( j \), mln. USD,
\( R = (AR_j) \) – level of accounts receivable at year-end for company \( j \), mln. USD,
\( P = (AP_j) \) – level of accounts payable at year-end for company \( j \), mln. USD.

Collaborative financial costs function \( FC(d, I, R, P) \) sums financial costs (1.5) of all supply chain participants:

\[
FC(d, I, R, P) = \sum_{j=1}^{3} FC(j(d_{1j}, d_{2j}, d_{3j}, INV_j, AR_j, AP_j))
\]  

Optimization of CCCC has two goals: shortening of CCCC and reduction of total financial costs. The decision maker sets the goal to minimize collaborative financial costs function (6) under two sets of constraints – for each SC partner and for the whole SC consequently. Firstly, financial costs and CCC of each SC participant after optimization (\( FC_j \) and \( CCC_j \)) should not exceed their current values (\( FC_j^0 \) and \( CCC_j^0 \)), as shown in Eq. (7) and Eq. (8).

\[
FC_j \leq FC_j^0, j = 1, 2, 3
\]  

\[
CCC_j \leq CCC_j^0, j = 1, 2, 3
\]

Secondly, total SC inventories, total SC accounts receivable, total SC accounts payable after optimization should reach EU industry median levels (REL, 2016) through collaborative actions at fixed levels – fixed percentage decrease of total inventory (\( INV \)) and total A/R (\( AR \)) and fixed percentage increase for total A/P (\( AP \)): 

\[
INV \geq (1 - t)INV^0, AR \geq (1 - t)AR^0, AP \leq (1 + t)AP^0,
\]

\[
t \in (0,1), t \text{ – target level parameter (YoY change)}
\]

\[
INV = \sum_{j=1,2,3} INV_j, AR = \sum_{j=1,2,3} AR_j, AP = \sum_{j=1,2,3} AP_j
\]

Additionally, we introduce constraints on SC structure according to the definition of CCCC:
\[ DRO_1 = DPO_2, DRO_2 = DPO_3 \]  

Furthermore, there is a requirement for elements of CCCC (4) to be nonnegative and continuous as Figueira, Greco and Ehrgott (2005) recommend:

\[ d \geq 0 \]  

Finally, we receive the following optimization problem: to minimize total financial costs (6) under constraints (7) – (11).

As a result, the model provides a holistic view of how the goals stated to be achieved using CCCC components based on cost criteria. The result of the optimization model is minimized collaborative financial costs in diapason of goals set and reduced length of CCCC, what affects the efficiency and profitability of the companies – business partners in a collaborative supply chain.

4. Case Description

This section provides the results of developed optimized CCCC model testing on the case of a collaborative supply chain from information and communications technology (ICT) industry. The ICT industry in general is characterized by an integrated business environment and fast technology development. It is service-oriented, and has a large variety of end products and customers. Besides, even though individual companies in the ICT industry have been used in many case studies, and the supply chains of single products or companies have been examined, the ICT networks at the industry level have been studied relatively little (Viskari et al., 2011). The largest global ICT companies are well known and they have been examined a lot (e.g. Ali-Yrkkö et al., 2011; Aspara et al., 2011).

For the purposes of our research, we consider the chain in question to be simple three-stage SC consisting of a single supplier, distributor and retailer, what is actually a simplifying assumption. The focal company in a chain is a Russian public telecommunication services provider, holding licenses for local, long-distance and mobile telephone services, data, TV and value-added solutions to residential, corporate and governmental subscribers and third party operators. The company operates across all regions of the Russian Federation, Europe and Asia.

The data concerning the supply chain business partners was retrieved from semi-structured interviews with middle-level operations managers, that was further triangulated with secondary data sources (annual financial reports downloaded from Thomson Reuters Eikon).

The results (see Appendix 1) depict elements of CCC and financial costs (FC) for supply chain business-partners – namely, supplier, wholesaler and distributor – before and after optimization, as well as percentage change of CCCC and collaborative financial costs (CFC) for the supply chain integrally and for each supply chain business-partner (Table 2). In accordance with the developed model and EU Working Capital Survey 2016, the target level of CCCC components was set as following: 13% decrease of inventories, 12% decrease of accounts receivable and 3% decrease of accounts payable (REL, 2016, p. 5).

The application of the collaborative cash conversion cycle optimization framework (see Appendix 2) to the ICT industry focal supply chain provided the decrease of CCCC by 37,6% and total financial costs by 62,9%. The speed up of the cash conversion cycle is mainly a consequence of days of accounts payable increase (by 284,5% for supplier and 254,9% for retailer) and days in inventory change (mainly due to reallocation from wholesaler to supplier). The CCCC boost is achieved on the grounds of both capital reallocations to the upstream business partners (days of inventories increase for supplier) and tightening of trade
credit conditions (significant decrease of days of receivables and simultaneous increase of
days of payables for supplier as well as for retailer). Generally, speaking, a short, even
negative CCC improves the performance of the company itself, providing it benefits from the
situation where no working capital is tied up in its operations. However, a company’s
achievement of a cash conversion cycle unambiguously is perceived positively from a wider
perspective. A short or negative CCC of one company may improve the performance of other
actors as well, for example when managing inventories effectively. Payment term adjustments
at the expense of suppliers and customers, in turn, harms the partners.

In our case, it may seem, that supplier is the main benefiter of such an approach to
WCM, however, this is not true: despite the evident payment condition restrictions for
downstream companies, they reconfigure their financial statements for the better. As such,
collaborative optimization model allows to achieve better financial outcomes by reallocating
the elements of total inventory, A/R and A/P along the supply chain, than these companies
operating separately: supplier decreases its financial costs up to 200% with 47% decrease for
the wholesaler.

5. Discussions and Implications

Managerial actions towards working capital in collaborative supply chains are critical at
the operational level for such operations as supply chain management, production,
procurement and finance. The companies have gained knowledge how to assess cycle time of
working capital at intra-organizational level, but estimation of that at inter-organizational
level still causes difficulties for the companies involved in collaborative supply chains. This
paper provides insights into collaborative evaluation of CCC using optimization CCCC model
by accurately assessing the length of cycle time of working capital and total financial costs
associated with it.

There are two main theoretical implication of paper that correspond the main objectives
justified by the empirical study. Current studies outline the importance of working capital
management in supply chains because companies need to adjust their operations to volatile
economic and financial environment. Firstly, the research gap of lack of the study that
connects CCC approach and three-stage collaborative supply chains in fulfilled by the
development of CCCC concept. Secondly, the authors contributed to improvement of the
methodology of working capital assessment in collaborative supply chains by introduction of
the optimization CCCC model that provides a holistic view to the collaborative supply chains.
The developed methodology is suitable for three-stage collaborative supply chain and is
applicable for usage for business, consultancy, 3PL or bank as an intermediary or the decision
maker.

6. Conclusion

FSCM and WCM are increasingly recognized as important means of liquidity and
profitability improvement, specifically in terms of globalization and growing competition
between SCs. Nevertheless, companies still focus on their individual SC issues and take their
own interests into account rather than understanding the whole SC and coordinating with their
partners. Authors address this distinct gap and show that FSCM optimizes planning,
managing, and controlling of SC cash flows by developing coordinating working capital
model aimed at minimizing total financial costs associated with each SC stage. The main goal
of this paper was to develop the coordinating model of WCM in collaborative SCs. The
suggested model was further verified on the grounds of the combination of mathematical
modeling and case study of Russian collaborative SC from ICT industry.
The theoretical contribution of the research resides not only in integration of collaboration concept and working capital concept adding a holistic perspective to the extant WCM models, but also in integration of financial and operational measures of SCM. The suggested model financially illustrates the motivation of SC partners to cooperate in order to simultaneously achieve their target levels of working capital investments and improve their individual financial performance through collaborative operations.

The practical contribution of the suggested model is its suitability for three stage collaborative SCs and rather easy implementation by SCM professionals, consultancy, 3PL or bank as an intermediary or the decision maker solving the problem of SC coordination.

There are two main ways of development for CCCC concept and CCCC optimization model. The extension of CCCC concept could be done with the additional component of tax items. The further study of optimization CCCC model concerns the extension of number of members of supply chain. Besides, additional goals can be implemented and CCCC components can be weighted with the expert opinions or factor of crisis.

7. References


### Appendix 1. Results of Optimization in ICT Case Study

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<td>51,8</td>
<td>46</td>
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<td>CCC</td>
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<td>148,1</td>
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<tr>
<td></td>
<td>FC</td>
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<td>258,1</td>
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### Appendix 2. Results of the Case Study. Percentage Change after Optimization

<p>| | | | | | |</p>
<table>
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</tbody>
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