A Review of

Value Creation By Trade Credits and Reverse Factoring in Supply Chains

Advanced Seminar Operations & Supply Chain Management: Supply Chain Finance & Supply Chain Risk Management

(Master in Management, TUM School of Management, Campus Heilbronn)

WS 2020

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Submitted on: 03.02.2020

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1. Introduction

Trade credits have always been an integral part of supply chains. As per a report of the World Trade Organisation, 80 to 90% of trade globally takes place with trade credits (The World Trade Organization, 2019). This huge amount of credit enables significant trade and business. However, there is a noteworthy risk involved in this system that is shared by suppliers and buyers (Birge, 2000; Hult et al., 2010; Wu & Olson, 2010). If the suppliers are large enough and have easy access of finance, there is no problem, otherwise substantial problems can occur. Small and medium enterprises (SMEs) can have strict credit constraints and higher financing costs. Despite this, suppliers provide credits to buyers who are generally in a better position to finance the business operations. In addition to this, there are often delays in payment from buyers' side resulting in a constricted liquidity position and in additional expenses to collect the payment for suppliers (Seifert et al., 2013). An important mechanism introduced to reduce risks in supply chains is known as reverse factoring (Bergerab & Udellc, 2006; Klapper, 2006). It is not straightforward to evaluate whether trade credits strengthen or weaken supply chains. One has to take into consideration several factors when setting up the trade contract terms. It is very useful and important for business and policy makers to understand how payment terms in a trade contract affect supply chains in order to create healthy supply chain systems and to optimise business practices. We will review three central studies done in this field by Hu et al. (2018), Tanrisever et al. (2012) and Grüter and Wuttke (2017). All three studies assess financing in supply chains with a focus on trade credits and reverse factoring. Hu et al. (2018) explain under which mechanism trade credits are beneficial through the concept of financial pooling. They also examine reverse factoring and compare it with trade credits. Sections 2 and 3 of this paper focus on their study. Tanrisever et al. (2012) examine the effects of demand volatility on the parameters which affect the value of reverse factoring. Section 4 focuses on Tanrisever et al.'s (2012) study. Grüter and Wuttke (2017) explain the effects of industry growth and volatility in liquidity needs on reverse factoring. Section 5 focuses on their study. Section 6 discusses managerial insights from Grüter and Wuttke (2017) and Tanrisever et al. (2012). All three studies use game theoretic model. The studies vary in their assumptions and show some similar and some contradictory findings. We discuss this along with the potential future avenues in the respective sections and summarise it in section 7.

2. Concept of financial pooling and effects of trade credits

Hu et al. (2018) introduce financial pooling and demonstrate how it works, how pooling and its result – trade credits – help to reduce the overall cost of financing in the entire supply chain. They advocate reverse factoring endorsed pooling. The authors study the effects of trade credits in comparison to cash on delivery. Hu et al. (2018) argue that under certain conditions, trade credits can be more efficient, i.e. cheaper for the entire supply chain than cash on delivery. The paper rotates around the debt collection charges incurred in a supply chain set up and compares its relation to other charges like pre and post financing costs under liquidity shocks.

2.1 Extending the concept of pooling

Hu et al. (2018) generalise the concept of pooling from resource or inventory to cash as an asset. With trade credits, the supplier retains more cash than with cash on delivery in anticipation of having to incur additional expenditures to collect the buyer's payment, resulting in higher financing costs. On the other side, the buyer can overstretch the payment and thus can hold lower working capital with trade credits than cash on delivery. With trade credits, the buyer pools a part of working capital from the supplier for his own use. Even though the cost of maintaining working capital is higher for the supplier, it can still be more profitable for the buyer to borrow from the supplier.

2.2 Modelling cash on delivery and trade credits

All three papers use game theoretic models. Game theoretic approach requires an assumption on the sequence of events. Each paper assumes different types of interactions between and decisions taken by the supplier and the buyer. In a Stackelberg model, Hu et al. (2018) assume a constant demand under liquidity shocks in their model in order to focus on the financial pooling perspective. Tanrisever et al. (2012) and Grüter and Wuttke (2017) differ in their assumption of demand which we will discuss in section 4 and 5. Hu et al. (2018) examine the cost of financing for both the players based on three parameters namely regular financing cost (for both the players), emergency financing cost (for both the players), and payment collection cost (for the supplier). The authors elaborate that in order to cope with the liquidity shocks the buyer and the supplier both retain a buffer cash balance. Tanrisever et al. (2012) and Grüter and Wuttke (2017) make different assumptions for liquidity shocks which we will discuss in section 4 and 5. Hu et al. (2018) assume that the fund to cope with liquidity shocks can be raised before or during and after the liquidity shock at a regular rate or at an emergency financing rate, respectively. The emergency borrowing rate is higher than the normal borrowing rate and both the rates are higher for the supplier than for the buyer, under the assumption that the buyer has a stronger market power. Another assumption is, that the supplier chooses his working capital based on the buyer's working capital. With trade credits the buyer extends the payment period and he can pay sometime after the delivery is done. During this period both the players face a liquidity shock and have to use their buffer cash. When the payment is due and the supplier faces a liquidity shock, he can react by generating finance through the buffer cash, borrowing money on high emergency rate, or by trying

to collect the payment (full or partial) from the buyer. The collection of payment has a unit cost. This cost involves the administrative time spent on the collection. Whatever is due and not collected from the supplier is paid by the buyer at the end of the game. There is no discount given to the buyer if he chooses to pay earlier than the due date.

With above assumptions in cash on delivery, Hu et al. (2018) assume that the additional cash that the supplier needs is a subtraction of the sum of the payment value and the buffer cash from the value of the liquidity shock. If the liquidity shock is small, then there is no extra cash needed by the supplier. Similarly, the buyer's cost function is a function of liquidity shock and payment paid, subtracted from cash buffer. The financial transaction between the supplier and the buyer takes place before the liquidity shock. The liquidity need's assumptions are in line with Grüter and Wuttke's (2017) assumptions about working capital. Hu et al. (2018) assume, the supplier's and the buyer's optimal initial cash levels are irrespective of their counterpart's cash level and liquidity shock. Thus, the higher the ratio of emergency rate versus regular rate is, the more cash firms will hold. The total profit of the supply chain is simply the cost of both the players subtracted by the profit of both the players. With trade credits, the cash policy of the supplier includes one more parameter that is the collection of the payment from the buyer in addition to the cash on delivery mechanism. Here, the supplier holds more cash if the cost of payment collection rises. The cash holdings increase if the value of payment from the buyer decreases and similarly if the variability of the liquidity shock increases. Additionally, the same authors argue that the optimal price with trade credits will be different from cash on delivery and will rely on the collection cost of the supplier and the liquidity shocks of the supplier. If the supplier has no collection cost then the trade credits price will be equal to the cash on delivery price.

2.3 Effectiveness of trade credits

In this section we will discuss the conditions under which trade credits are more effective than cash on delivery.

Positive and low collection cost: Hu et al. (2018) show that there exists a threshold value of the collection cost under which trade credits are beneficial and above which cash on delivery is beneficial, looking at the entire supply chain's cost. The figure below shows the ratio of initial cash reserves under trade credits (TC) over cash on delivery (COD) for the buyer (retailer) and the supply chain. Given the greater amount of cash on the supplier's side, as demonstrated in Figure 1 (a), trade credits reduce the buyer's initial cash buffer. Figure 1 (b) reveals that the cash reserve held by the entire chain is small, combining the supplier's and the buyer's cash buffers. The analysis demonstrates that, when the collection cost (α) is small, trade credits are more effective than cash on delivery by reducing the total supply chain financing costs. This happens because if the supplier has a minor liquidity shock and does not need to take expensive action to compel the buyer to pay the full amount, the buyer can use the uncollected part of the trade credits as a hedge to cope with his own liquidity shock.

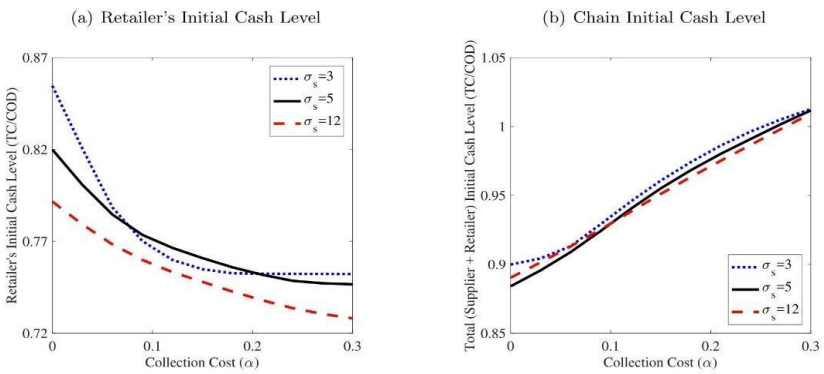

Figure 1: Initial cash level with trade credits relative to cash on delivery (Hu et al., 2018, p. 14)

Regular cost: low for the supplier and high for the buyer

Hu et al. (2018) describe that for a low regular rate of the supplier trade credits are more beneficial because his cost of raising funds is lower. On the other side, since the buyer does not have to pay the ex-ante wholesale price with trade credits, the benefits are more significant if his regular borrowing costs are higher. The other two studies show similar results which we will discuss in section 4 and 5.

High emergency expense rate of the buyer

Hu et al. (2018) show that the savings in the chain are due to pooling and that if the buyer's expenses are too low, the savings generated cannot compensate the losses due to the payment term extension with trade credits. In this case, cash on delivery is more effective. For trade credits to be effective buyer's emergency financing rate should be high. This finding is in line with Grüter and Wuttke (2017) and Tanrisever et al. (2012) for reverse factoring.

Lower ratio of emergency rate over regular rate of the buyer than of the supplier

Further, Hu et al. (2018) point out that the ratio of buyer's emergency cost to the regular cost (βb/rb) must be lower than the ratio of the supplier's emergency cost to the regular cost (βs/rs) for the overall financing costs of the supply chain to be lower with trade credits than with cash on delivery. It is possible that this (βb/rb < βs/rs) assumption holds true in reality. For example, there may be similar regular rates for both supplier and buyer (e.g. bank loans). Nevertheless, the buyer, e.g. being a larger company, may have recourse to a safe credit line via emergency networks. This only holds true if the additional requirement of low collection costs is satisfied. It reconfirms the fact that the study is centred on the collection cost whose effect is displayed in figure 1.

Kouvelis and Zhao's (2012) study on optimum trade contract terms shows similar results. Further, Hu et al. (2018) extend the game for multiple players and find that the benefits of trade credits are multiplied with the higher number of suppliers. Intuitively, the value created here is due to pooling. Having more suppliers, the buyer can pool more cash from the suppliers thus the overall savings of the

entire chain increase (Hu et al., 2018). This case is clearly observable with huge buyers such as Aldi, Walmart, Amazon, and JD (Tunca & Zhu, 2017).

High variability of the supplier's liquidity shock

Hu et al. (2018) argue that in the absence of volatility in the liquidity shock of the supplier, he can handle his liquidity accurately by having the exact amount of cash required and therefore there will not be necessary savings generated from pooling. However, Grüter and Wuttke (2017) find mixed results for volatility that are discussed at the end of section 5.

Hu et al. (2018) study payment extensions and trade credits from a whole chain's perspective. However, as discussed in the introduction, suppliers are often in a weaker position in the chain. The chain being more efficient in general does not necessarily imply that suppliers are better off. In order to target this issue, the research should examine suppliers' perspective and mechanisms like reverse factoring. We will discuss reverse factoring and the question when it is beneficial including the supplier's and the buyer's perspective on reverse factoring in sections 3 to 5.

3. Concept of reverse factoring

As the name suggests, reverse factoring represents a development of conventional factoring. Klapper (2006) describe reverse factoring as a mechanism to provide credits to the supplier at buyer's credit rate. They say that, generally it is observed that the buyer has a strong market power and thus a lower credit rate than the supplier. If the supplier can borrow money at the buyer's rate, he can reduce his own financing cost and can also provide a longer payment period to the buyer.

Hu et al. (2018) show that despite the extended payment period, with reverse factoring the supply chain is better off than just with trade credits or cash on delivery. The distinction in this arrangement is that if the supplier wants some or all of the accounts payable, instead of incurring the debt collection cost, he pays the charges at the reverse factoring interest rate for early payment. Even if the collection rate is as high as the reverse factoring rate, reverse factoring is still more effective than trade credits. In trade credits for debt collection an analogous amount is paid, which is seen as a deadweight loss in the supply chain. Reverse factoring's unique feature is to formalize the vertical pooling process (i.e. the buyer's payment stretching) and prevent the dead weight losses. The same authors show that reverse factoring creates more value for the chain than trade credits and cash on delivery. It will be interesting to understand how the value created in reverse factoring changes with the change in assumptions. We will discuss more on this in following sections.

As mentioned above, Hu et al.'s (2018) model is based on an important assumption of the collection cost of the supplier. The findings are valid only for low collection costs as shown in figure 1. Thus, in a set up where the collection cost is little higher or zero the findings do not hold true. This is a

limitation of the model. Additionally, Hu et al. (2018) used single period model. The study can be extended further to see repeated interaction of the players.

4. Effects of demand uncertainty on value created by reverse factoring

In this section we will discuss how the value created by reverse factoring changes when demand uncertainty in terms of size and time is introduced into a game theoretic model.

4.1 Modelling uncertain demand

Tanrisever et al. (2012) measure the change in value created in reverse factoring under demand uncertainty by observing parameters like (1) the spread of deadweight in external financing costs, (2) payment term extensions, (3) market volatility and working capital strategy and (4) the risk-free interest rate. They model two scenarios where the supplier with limited internal capital uses 1) traditional financing and 2) reverse factoring to meet the liquidity needs under stochastic demand. They divide the model in two parts. Case 1 is built as a base case to compare the value creation in reverse factoring. The supplier is assumed to have some cash reserves at the beginning of the model period. At the end of the period, current liabilities are due. The supplier can produce cash flows from operations during that time, but the timing of cash receipts depends on the demand realisation from the buyer. The study observes demand in two variants. In the first variant only the time of demand realisation is uncertain with a certain demand quantity and in the second variant this assumption is released, i.e. the time and the quantity (size) of the demand both are uncertain. Tanrisever et al.'s (2012) model assumes all demand realised at one point of time during the single period model. Upon realisation of demand the supplier's account receivables go up and his cash account goes down due to the purchase of raw materials. In the traditional case, if the internal capital is not high enough to meet the demand requirement, external financing help is taken by the supplier. The supplier is charged a certain cost - that is higher than the risk-free rate - by the finance provider which is the deadweight cost. In contrast to Hu et al. (2018), Tanrisever et al. (2012) assume no liquidity shock for the buyer, i.e. the buyer has adequate internal capital and does not need external financing. If the supplier receives the payments from the buyer early enough, i.e. before the due date of the liabilities payment then there occurs no need of external financing from the supplier. This case relates to the cash on delivery case in Hu et al.'s (2018) model and to the supplier's financing cost without reverse factoring in Grüter and Wuttke's (2017) model. Additionally, Tanrisever et al. (2012) assume, when the payment is delayed, the supplier borrows the exact amount of the debt that is needed to cover the shortage of cash in meeting short-term liabilities. The supplier manages liabilities with the leverage and pays the bank principal and interest back upon receiving the payment from the buyer.

In the 2nd case, Tanrisever et al. (2012) assume that the supplier uses reverse factoring to finance the short-term liabilities. Thus, the charge that the supplier has to pay is a sum of cost of capital of the buyer and the facility/transition fees. The model assumes a strong market position and debt rating of the buyer which is also close to the practical scenario. This implies the assumption that the cost of

capital of the buyer is solely driven by transition charges and is less than the cost of capital of the supplier. Another assumption is that the cost of capital remains constant for both the parties during the game. The authors use the first order Tailor series to discount cash flows that they claim to be close to the exact results.

4.2 Evaluating value creation by reverse factoring with uncertain demand

Tanrisever et al.'s (2012) model examines the supplier's value gain based on three aspects: 1) the expected external financing cost without reverse factoring, 2) the expected external financing cost with reverse factoring and 3) the opportunity cost of reverse factoring due to return favours asked from the buyer. The value gain for the buyer is the interest earnings on the extended time of the accounts payable. The total value added by reverse factoring relies on three key market factors: 1) the spread of deadweight capital costs between the supplier and buyer; 2) the supplier's working capital policy and operating characteristics; and 3) the risk-free rate. The impact of these parameters on value creation for the supplier, the buyer (corporation) and for the supply chain is demonstrated in the table below. The notations are as follows: delayed payment (lext), reverse factoring (lrev), supplier's cost of capital (bs), buyer's cost of capital (bo), the risk-free rate (rf), initial cash reserve (y). The table displays whether the value creation increases or decreases with an increase in above listed parameters. The spread of deadweight cost is a difference between the interest rates of the supplier and the buyer. With an increase in the spread of deadweight costs of capital among the parties, the supplier sees a greater decrease in external financing costs and gains more from reverse factoring. Supplier's working capital policy determines how much and how frequent cash in-flows are needed. It depends on the buffer cash holding, short term liability, and demand volatility. An aggressive working policy means maintaining low cash buffer and relatively higher liabilities in spite of a more volatile demand. Such working policy leads to strong needs of financing; thus, reverse factoring becomes very useful. With an increase in the risk-free rate the opportunity cost of reverse factoring increases for the supplier thus it works negatively in the supplier's case and positively in the buyer's case as the buyer can earn more interest. These results are consistent with Hu et al. (2018) as shown in section 2.3.

	l_{ext}	l_{rev}	b_s	b_o	r_f	y
Supplier	Increases	Decreases	Increases	Decreases	Decreases	Decreases
Corporation	Decreases	Increases	Constant	Constant	Increases	Constant
Total	Increases	Decreases	Increases	Decreases	Constant	Decreases

Figure 2: Impact of different parameters on the value creation (Tanrisever et al., 2012, p. 17)

Tanrisever et al. (2012) demonstrate that reverse factoring will raise the transaction value by more than 10% for low profit margin suppliers who operate with strict working capital policy. Grüter and

Wuttke (2017) add additional insight on the working capital policy and find mixed results based on the initial cash reserves and volatility. We will discuss them in section 5.2.2.

4.3 Optimum reverse factoring implementation strategy for the buyer

Tanrisever et al. (2012) evaluate the implementation strategy by calculating the participation constraints and the payoffs of both the players. The buyer is described as being interested in payment term extensions. For the supplier, however, the extension of the payment term leads to two critical effects: With a prolongation of the payment term, the supplier bares the extra cost of financing over a longer time period and it becomes more probable that the supplier will deficit cash and require external funds. Thus, the participation constraint of the supplier is a function of the payment period extension and the reverse factoring rate. The function is further moderated by risk-free rates. As the risk-free rate increases, the supplier seeks for larger reductions in his cost of external financing thus the constraint becomes tighter. If the supplier has a prudent working capital strategy (i.e. he maintains more cash than in the strict working capital case), the constraint becomes even tighter. The authors emphasise that with a positive risk-free rate the participation constraints of the supply chain and of the supplier diverge. In their words, *"a reverse factoring contract which generates value for the supply chain may be rejected by the SME if the opportunity cost of payment period extension is sufficiently large"* (Tanrisever et al., 2012, p. 20).

4.3.1 Optimising payoffs with uncertain demand

In Tanrisever et al.'s (2012) model the buyer's payoff is at the maximum when there are no bank fees and the payment term is increased to the point where the supplier break-evens. However, the authors argue that capturing maximum value is not possible for the buyer. They explain the concept in the diagram below.

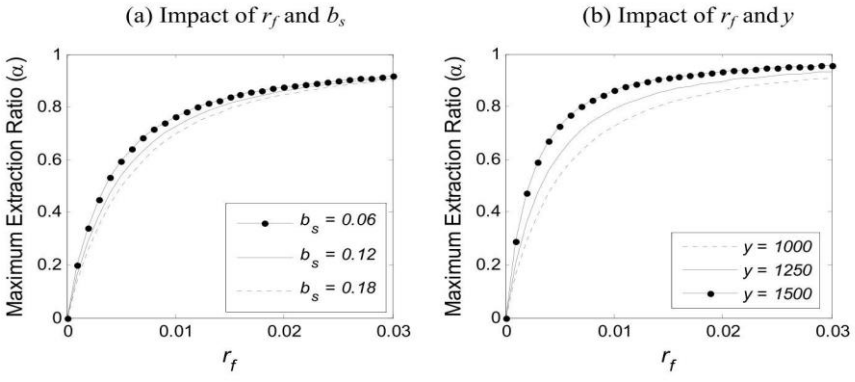

Figure 3 Maximum Payoff of the buyer (Tanrisever et al., 2012, p. 22)

The buyer's maximum extraction level in figure 3 (a), i.e. the maximum payoff that the buyer can realize is demonstrated as a function of the risk-free rate (rf) and the cost of capital of the supplier (bs). In figure 3 (b), buyer's maximum extraction is demonstrated as a function of risk-free rate, and cash holdings of the supplier (y). When approaching the maximum payoff for the buyer, the risk-free rate

increases. Assuming constant cost of capital for the buyer, increased reverse factoring will extend the deadweight spread in the supply chain. Due to this, the maximum payoff of the buyer grows at a slower rate than the maximum payoff of the supply chain. Thus, the buyer cannot proficiently capture the benefits as the participation function of the supplier is non-linear. Grüter and Wuttke (2017) however, assume that the buyer can extract complete benefits and show payment term extension as an optimum strategy. We will discuss this in section 5.3.

Tanrisever et al. (2012) show that reverse factoring maximizes the rewards of suppliers when the payment period is the same and the supplier is paying the buyer's cost of capital (i.e. when there are no reverse factoring bank charges). The buyer is at the breakeven point in this set up. All the value generation by reverse factoring is captured by the supplier. Notably, value created by reverse factoring is optimal for the entire chain in this set up, as it eliminates the deadweight loss completely. Tanrisever et al. (2012) state that the buyer can benefit from payment term extension though he should be cautious in extracting the benefits. They consider payment term extensions as an inefficient strategy.

4.3.2 Introducing uncertainty in demand size

In the next stage of their study, Tranrisever et al. (2012) examine demand uncertainty in terms of size in addition to all the other assumptions being constant. They demonstrate that the results for the first model hold true with some additional insights. They show that uncertainty in demand leads to an expansion of the participant constraint of the supplier. The higher variance in demand also increases the maximum benefits of the buyer as the payment period can be extended further while retaining the participation of the supplier. While the maximum benefit of the buyer grows with demand volatility, the maximum payoff ratio declines as the total benefit grows quickly.

Tanrisever et al. (2012) studied interaction between one supplier and one buyer. However, in practice this is rarely the case. Hu et al. (2018) show that the multiple players' game theoretic model is workable. Thus, one supplier one buyer assumption is a limitation of the analysis. Furthermore, it will be interesting to see repeated interaction between players rather than a single time model. In addition, they model a supplier with a single product which often does not hold true in practice. Observing the effects of changing interest rates will also be interesting.

5. Effects of uncertain growth and liquidity needs on value creation by reverse factoring

In this section we will discuss the changes in value created by reverse factoring when industry parameters like growth and volatility change.

5.1 Modelling uncertain growth and liquidity needs

Under the assumption that the net liquidity needs of the players follow Geometric Brownian Motion, Grüter & Wuttke (2017) observe the effects of firm's growth and volatility in liquidity needs on value creation by reverse factoring. They compute supplier's financing costs without reverse factoring and

use it as a benchmark to compare the financing costs with reverse factoring. This is in line with the approaches of Hu et al. (2018) and Tanrisever et al. (2012).

Grüter and Wuttke (2017) define the supplier's financing costs as follows: The supplier can borrow a certain amount by external sources at a certain rate in order to finance his liquidity needs. If the liquidity needs are high and the borrowed amount is not high enough, the supplier faces a negative impact on his operations such as reduction in service level or increase in lead time. The authors assume these losses to be less than the interest paid per unit overrun. Grüter and Wuttke (2017) model financing cost with reverse factoring under the following assumptions: accounts receivables are strongly correlated with working capital and accounts payable. Later, they release the assumption of account receivables as a constant multiple of liquidity needs and demonstrate that the constant relation reflects the actual account quite well. Another assumption is that if the reverse factoring interest rate is lower than the external financing rate, there is an arbitrage opportunity and in this case the supplier will always prefer reverse factoring. If there is no arbitrage, the supplier uses reverse factoring to finance liquidity needs after the external credit limit is exhausted. This he does in order to reduce the losses in operation. Based on this set of assumptions, the authors compute the value added by reverse factoring in comparison to supplier's financing cost without reverse factoring.

5.2 Evaluating value creation by reverse factoring with uncertain growth and liquidity needs

In this section we will discuss how value creation in reverse factoring is measured in a model with uncertain growth and liquidity needs.

5.2.1 Arbitrage focus leading to value loss

Grüter and Wuttke (2017) calculate the value generated by interest arbitrage (as a singular parameter) and compare it with the value generated by reverse factoring when the reverse factoring rate is higher than the external financing rate. They compute the results in the following table where *a* is a share of accounts receivable, i.e. a constant share of net liquidity, N0/L is credit line, ν is growth and σ is volatility in liquidity.

	$a = 10\%$			$a = 25\%$		
	$\frac{N_0}{L} = 50\%$	$\frac{N_0}{L} = 100\%$	$\frac{N_0}{L} = 150\%$	$\frac{N_0}{L} = 50\%$	$\frac{N_0}{L} = 100\%$	$\frac{N_0}{L} = 150\%$
$\sigma = 5\%$						
$\nu = 0\%$	99%	71%	46%	99%	81%	47%
$\nu = 5\%$	70%	49%	46%	73%	51%	46%
$\sigma = 30\%$						
$\nu = -2\%$	82%	61%	52%	83%	64%	53%
$\nu = 0\%$	76%	58%	50%	78%	60%	51%
$\nu = 5\%$	61%	52%	48%	63%	53%	48%

Figure 4 Relative portion of the reverse factoring value stemming from arbitrage (V/V) for external financing < reverse factoring (Grüter & Wuttke, 2017, p. 6)*

Tanrisever et al. (2012) evaluate the value purely based on arbitrage. Grüter and Wuttke (2017) explain that evaluating the value created only based on arbitrage, i.e. without considering the losses into operations that can be reduced by reverse factoring, leads to value loss. Figure 4 demonstrates that arbitrage formula is relatively accurate for slow growing firms with low volatility in the net liquidity thus there is less value loss. With an increase in account receivables (last three columns in the table), the value generated by reverse factoring increases. Thus, evaluating value generation only based on arbitrage leads to further loss in value.

5.2.2 Effectiveness of reverse factoring

Grüter and Wuttke (2017) identify the conditions under which reverse factoring creates high value for the supplier. They differentiate the value creating conditions in two levels namely firm level and industry level. Firm level conditions have an impact on the supplier only, whereas industry level conditions have an impact on both the players. Under the following conditions, the supplier is more in favour of adopting reverse factoring:

High share of account receivables in working capital: High account receivables relate to more gain from arbitrage and the supplier may be able to get out of distress due to large account receivables by adopting reverse factoring. This is in line with the findings of Tanrisever et al. (2012) and Hu et al. (2018) about long payment delays.

High initial capital requirement compared to credit availability: If the supplier cannot finance initial capital and the credit limit is low, reverse factoring comes out as an additional resource of financing. This relates to the strict working capital policy in the study of Tanrisever et al. (2012)

High operational loss, running out of liquidity: Small buffer inventory levels can lead to high marginal losses if the operation is disturbed. This can be avoided by reverse factoring.

Low reverse factoring rate and high external financing rate: An option with low cost of capital is attractive for any kind of investment. The findings here are in line with Hu et al. (2018) and Tanrisever et al. (2012).

Industry growth: High industry growth rate leads to more value generation by reverse factoring, as shown in figure 4.

Industry volatility: Grüter and Wuttke (2017) find mixed results for volatility. If at the time of reverse factoring adaptation, the supplier is unable to meet his financing needs with existing resources, additional volatility increases the likelihood of meeting the financing requirements. Thus, the value of reverse factoring decreases. However, if volatility is low and still the supplier cannot meet financing needs, he values reverse factoring even more as that becomes the only way to meet the needs. On the other hand, if the supplier maintains an excess availability for liquidity with high volatility, he may

need the additional resources to maintain his liquidity position. This increases the value of reverse factoring.

5.3 Optimum reverse factoring implementation strategy for the buyer

In this section we will discuss the optimum strategy to implement reverse factoring and costs of falsely implementing it.

5.3.1 Optimum strategy

Grüter and Wuttke (2017) evaluate the optimum strategy for the buyer to implement reverse factoring by comparing price discount and payment term extension strategies with each other. They argue that the decision driving factor in reverse factoring implementation is credit line utilization. They plot an indifference curve with supplier's credit line on x axis and buyer's credit line on y axis.

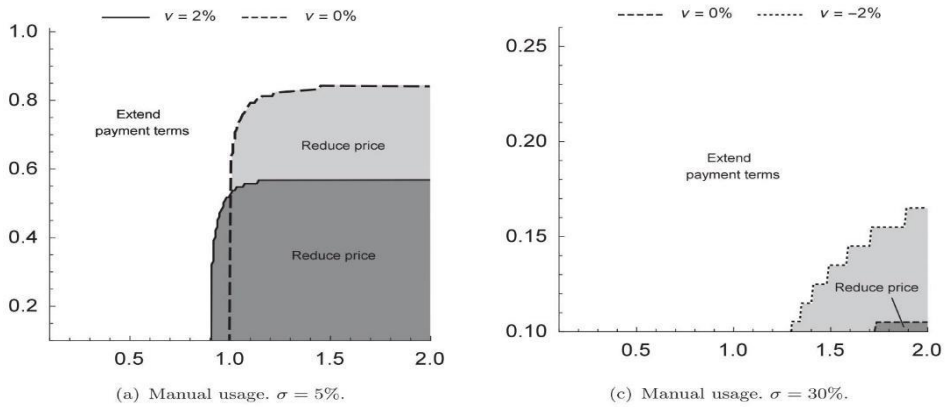

Figure 5 Optimum reverse factoring implementation strategy (Grüter & Wuttke, 2017, p. 9)

Payment extension is optimal in the north or east corner of the graph, while price discount is optimal in the west or south corner of figure 5 (shaded areas). Figure 5 (c) indicates that when there is a higher volatility, payment term extension becomes optimal. Figure 5 (a) shows that with lower volatility price reduction turns out to be more optimal as the buyers have small credit lines and do not require payment term extensions to support operations. The authors conclude that payment terms extension is suitable for high growth and highly volatile industries. As the high growth leads to high accounts receivables, payment term extension increases account receivables further. Grüter & Wuttke (2017) argue that, this creates a reinforcing effect of reverse factoring which can be exploited by the buyer. Price reduction on the other hand reduces account receivables thus it is not an optimal strategy for high growth firms. It is however optimal for slow to declining growth industries. This applies to mature industries. The firms here may have an excellent source of external financing and in this case, they are better off by asking for a price reduction.

5.3.2 Cost of falsely implementing reverse factoring

The authors conclude that *"Falsely opting for reducing prices costs 10% of the value while falsely extending payment terms can cost up to 90% of the value"* (Grüter & Wuttke, 2017, p. 8). The authors

show that an increase in volatility reduces the cost of false implementation of strategies. This is in line with Tanrisever et al.'s (2012) study.

Grüter and Wuttke (2017) also examine the model for one buyer and one supplier. It will be interesting to observe how buyer's indifference curve changes based on a multiple supplier model. What additional constraints and synergies will occur in a model with different financial positions of various suppliers should be examined further. Such a model will also be closer to reality. The authors assume complete value extraction from buyer's side, however Tanrisever et al. (2012) show in their analysis that a complete value extraction is not possible due to supplier's participation constraints being non-linear. A simulation-based approach can be adopted for further research to observe the effects of changing interest rates and repeated interaction.

6. Managerial Insights

Tanrisever et al. (2012) point out payment term extensions as inefficient strategy. They emphasise the long-term effects of payment term extensions on the supplier's operations and finances. They show that reverse factoring implementation without payment term extension creates the highest value for the supply chain. A study from Tunca and Zhu (2017) on buyer intermediate finance shows similar results in a real life example of JD retailer. However, Grüter and Wuttke (2017) point out evaluating value only based on arbitrage - such as adopted by Tanrisever et al. (2012) - is an inefficient technique.

Grüter and Wuttke (2017) add further insight into the recommendation of Tanrisever et al. (2012) to calculate operation enabling effects of reverse factoring and propose a formula for managers to evaluate the best strategy to implement reverse factoring. The authors, based on their analysis, propose adjustments to the formula considering different cases of growth, volatility and supplier's financial situation. Grüter and Wuttke (2017) state that the reverse factoring value for the buyer increases by 30% if the buyer is heavily dependent on the supplier. They show payment term extensions as optimum strategy over price discounts for the buyer in a growing industry. Additionally, Payment period extensions appear to be more commonly used in practice by firms (Milne 2009; Ng 2013).

Tanrisever et al. (2012) show that payment term extensions are beneficial to the buyer but he should be highly cautious in implementing them. Grüter and Wuttke (2017) point out that even without any specific benefits on working capital or liquidity, the buyer should still consider implementing reverse factoring because it allows a credit constrained supplier to stay in business. This ensures the continuity of supply without which the buyer is exposed to operational losses.

7. Conclusion

All three studies are based on different sets of assumptions. For example, Hu et al. (2018) assume demand certainty while Tanrisever et al. (2012) and Grüter and Wuttke (2017) take uncertain demand into consideration. Hu et al. (2018) model liquidity shocks and volatility separately for both the players, and Tanrisever et al. (2012) consider no liquidity shocks for the buyer, whereas Grüter and

Wuttke (2017) assume the shocks to be an industry parameter that affects both the players in the chain equally. Grüter and Wuttke (2017) and Tanrisever et al. (2012) make different assumptions about the value extraction from buyer's side.

All three studies take different perspectives to model the problem, however they show some similar results: Low reverse factoring rates and high external financing rates for the supplier make reverse factoring more attractive for him. Long payment periods or high account receivables have a similar effect. Suppliers with low initial cash or a strict working capital policy will prefer to implement reverse factoring. In most of the cases payment term extension is an optimal value creator for the buyer compared to price discounts. All three studies also point out that reverse factoring should be implemented cautiously by not only evaluating beneficial factors for buyers but by also considering the operational effects on the supplier. One should adopt a long-term perspective of creating a strong supply chain. Cautiously implemented reverse factoring strengthens supply chains by eliminating deadweight losses in trade credits and creates significant value for suppliers and buyers.

The assumptions of all three studies may not hold true in special situations like financial crises and recessions. Additionally, the theoretical findings of the studies can be linked to practical cases like done by Tunca and Zhu (2017). Tanrisever et al. (2012) and Grüter and Wuttke (2017) used a one supplier one buyer interaction. A situation with multiple supplier and multiple buyers will be closer to reality and can be examined further. Hu et al. (2018) show a multiple supplier and one buyer game theoretic model. Further research can be done for multi-time period models. It will be interesting to understand repeated interactions between the players and observe the role of negotiation. Multi-time models can also capture the changes in interest rates over the time which can impact the value creation in reverse factoring to a great extent. A simulation-based approach or a multi period game theoretical model can be used for computation. In addition, observing value creation through a reverse factoring solution provider (i.e. financial service provider) will be interesting.

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