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Trade Credit in Supply Chains: Multiple Creditors and Priority Rules

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ABSTRACT

Priority rules determine the order of repayment to different creditors when the debtor cannot repay all of his debt. In this Chapter, we study how different priority rules influence trade credit usage and supply chain efficiency under the risk-sharing role of trade credit. We find that with only demand risk, when the wholesale price is exogenous, trade credit with high priority can lead to high chain efficiency, yet trade credit with low priority allows more retailers to obtain trade credit and suppliers to gain higher profits. When the supplier has control of wholesale price, however, the supplier should extend unlimited trade credit, deeming priority rules irrelevant. When other non-demand risks, especially those with longer terms in nature, are present, we show several scenarios when the optimal trade credit policy should change according to different risks, and that in general, trade credit with low priority results in higher chain efficiency.

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0.1 Introduction

Allowing the upstream firm in a supply chain to finance the downstream firm, trade credit is an important source of external financing. Because of its wide usage, researchers have developed multiple theories explaining the roles of trade credit. See Peura *et al.* (2017) and Chod *et al.* (2019) for a summary of related theories. In particular, Kouvelis and Zhao (2012) and Yang and Birge (2018) propose that trade credit can improve supply chain efficiency through demand risk sharing. However, one aspect of trade credit that does not receive much attention is how the effectiveness of trade credit is affected by priority rules, which determine the amount of payoffs different creditors, including suppliers as trade creditors, receive when the debtor cannot meet all of his debt obligations. In practice, while priority rules may be determined in the form of a contractual agreement (e.g., debt covenant), there are certain legal statutes that govern priorities. Further, these legal statutes that govern priorities change constantly over time. For example, the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA) has strengthened the supplier's right of reclamation. That is, the supplier, when qualified, could receive (part of) the trade credit claim before other unsecured or secured creditors. Intuitively, these changes of law, together with different priority rules mutually agreed upon by the creditor and the debtor, will impact the term and usage of trade credit, as well as supply chain efficiency. This chapter aims to develop a deeper understanding of this impact.

This chapter lies on the interface of operations, finance and law. We refer the readers to our work is closely related to many areas in both subjects. We refer the readers to Babich and Kouvelis (2018), Yang and Birge (2011), and Yang *et al.* (2015) for a detailed discussion on the related literature.

0.2 Priority Rules Related to Trade Credit

Under the current US legal system, trade credit is normally treated as general unsecured claims, which belong to the class of claims with the lowest priority. Under different circumstances, however, trade credit may be assigned with a higher priority. This capture focuses on trade credit the seller extends when the buyer is out of bankruptcy. In this case, as a pre-petition claim, trade credit may have higher priorities through the following statutes.

First, outside bankruptcy, the seller's reclamation of goods is governed by Section 2-702 of the Uniform Commercial Code (U.C.C). Under this statute, the trade creditor, discovering that the buyer has received goods while insolvent, can reclaim goods that are sold to the buyer within 10 days after the the buyer received them.

Note that U.C.C. reclamation is only relevant before the buyer files bankruptcy. In bankruptcy cases, US Bankruptcy Code Section 546(c) allows Section 2-702 of U.C.C to have the same effect. Further, BAPCPA amended Section 546(c) by expending the reclamation period from 10 days to 45 days. However, even with this amendment, this reclamation right is weak. Although the statutes place the reclaiming seller ahead of the buyer's general unsecured creditors, the seller is still behind the buyer's secured creditors who have security interests in the goods. For example, it is common for a bank loan to use the buyer's floating inventory as collateral. In this case, the bank holds a secured interest on the inventory and thus the seller cannot use the inventory reclamation right defined under U.C.C. or Section 546(c).

Another statute trade creditors could use to reclaim their goods is the Chapter 11 Critical Vendor Motion. This motion grants a subset of trade creditors high priority for trade credit on all goods sold within 90 days before the debtor files for Chapter 11 bankruptcy. Note that although this motion allows a longer reclamation period than U.C.C. and Section 546(c) allow, it has two limitations. First, to qualify for this rule, the vendor has to be selected by the purchaser and to be approved by the judge. Second, this right does not apply to Chapter 7 bankruptcies, which most small firms use. BAPCAP reclamations, however, can be used in both Chapter 7 and Chapter 11 bankruptcies.

Finally, among legal scholars, it is agreed that the strongest reclamation right the supplier could enjoy is Section 503(b)(9) of BAPCPA. According to this statute, trade creditors who provided goods to a distressed debtor within 20 days before the commencement of a bankruptcy case are entitled to an *administrative priority* equal to the value of the goods sold. In bankruptcy, administrative priority is the highest preference afforded to an unsecured claim. This statute serves the direct motivation of this chapter, as we are interested in whether trade credit should have high or low priority when the buyer defaults.

After summarizing how priorities are treated in practice, we introduce some notation that we use in this chapter and link them to priorities in practice as mentioned above. We consider two types of financial claims: a bank loan and trade credit. A *bank loan contract* includes the *market value* B and the face value L_b. A *trade credit contract* consists of the *wholesale (credit) price* w, which is due when demand is realized, and *the line of trade credit* $\bar{L}_s$, that is, the maximum amount of trade credit the supplier is willing to extend.

Further, we assume that upon default, the payoffs of different parties (creditors and the debtor) only depend on the total value of the debtor, but not on the value of specific assets held by the debtor. Given this assumption, let y be the total value of the retailer before paying any claims; what the creditors receive should only be a function of y. Correspondingly, we define *default thresholds* θ_b (for bank loan) and θ_s (for trade credit) as: when $y < \theta_b$, the bank loan defaults; when $y < \theta_s$, trade credit defaults. An *allocation rule* ($l_b(y)$ for the bank loan and $l_s(y)$ for trade credit) governs how the bank and the trade creditor are paid off when default occurs. By definition, the allocation rule needs to satisfy: $\forall y < \theta_b$, $l_b(y) < L_b$, and $\forall y \geq \theta_b$, $l_b(y) = L_b$; $\forall y < \theta_s$, $l_s(y) < L_s$, and $\forall y \geq \theta_s$, $l_s(y) = L_s$. Given this definition, a bank loan in a perfectly competitive market breaks even; that is,

$$B = \int_0^{\theta_b} l_b(y) dF(y) + L_b \bar{F}(L_b). \tag{1}$$

Clearly, different priority rules are reflected in the allocation rules $l_b(y)$ and $l_s(y)$, and lead to different L_b and L_s. We use $L_t = L_b + L_s$ to represent the total liability.

Depending on the magnitude of θ_b and θ_s, we focus on three representative cases: trade credit is senior to the bank loan ($\theta_b > \theta_s$); the bank loan is senior to trade credit ($\theta_b < \theta_s$); and the bank loan and trade credit have equal seniority ($\theta_s = \theta_b$).

0.3 Priority Rules and Demand Risk Sharing

Based on the above formulation of priority rules, we first focus on how priority influence trade credit in the presence of only demand risk. We extend the model by considering a non-demand risk in the next section.

Consider a “selling to a newsvendor" model similar to Yang and Birge (2018). Both the supplier and retailer are risk-neutral. The retailer is financially constrained, with only initial capital K for investment and relies on external financing if K is insufficient. The time horizon is divided into two periods. In the first period, the supplier announces the wholesale price w and the line of credit $\bar{L}_s$. For tractability, we confine our discussion to net-term trade credit terms. The retailer responds with the order quantity x. The supplier incurs unit production cost c and delivers the x units of goods to the retailer. The retailer has capital K at the end of the first period. To finance his inventory, the retailer borrows B from a bank, with a face value L_b, and pays part of the order by cash. In the second period, the retailer sells the inventory at retail price $p = 1$. Let ξ be the demand realized during the second period. Assume ξ has a cumulative distribution function $F()$, with density function $f()$, and failure rate $h()$, which is assumed to be increasing. At the end of the second period, the revenue $\min(x, \xi)$ is realized and unsold inventory has no salvage value. When $\min(x, \xi) \geq L_b + L_s$, the retailer pays off both claims and keeps the rest. Otherwise, some obligation is partially paid off, with the amounts depending on the priority arrangement.

0.3.1 Trade Credit Limit under Exogenous Wholesale Price

In the first scenario, we assume the wholesale price w offered by the supplier is exogenous, and the only decision the supplier can make is to determine the line of trade credit.[1] To highlight the impact of priority, we first establish two benchmarks where he retailer uses only one source

[1]The exogenous wholesale price assumption is reasonable under a few circumstances. First, the wholesale price may be determined by market competition. Second, certain regulation, such as the Robinson-Patman Act and franchise laws, prohibit price discrimination. Finally, in practice, the wholesale price and line of credit may be determined by different departments within a company. In addition, we extend the model to the endogenous wholesale price case in Section 0.3.2.

of external financing: only bank loan, and only trade credit. Under the case when only a bank loan is available, as there is no source of financial friction, not surprisingly, the retailer orders $\bar{F}^{-1}(w)$, the same amount as when he has sufficient capital, reassuring the validity of the M-M irrelevance result under this setting.[2]

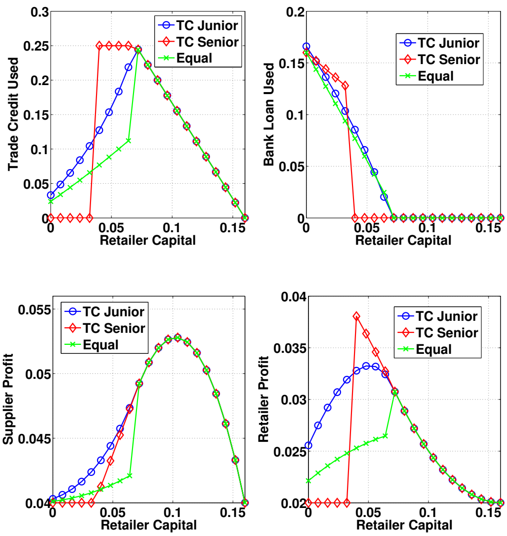
In the second benchmark, when only trade credit is available to the retailer, we find that with trade credit limit $\bar{L}_s$ as the only lever, the supplier sets $\bar{L}_s^* = \bar{F}^{-1}\left(\frac{c}{w}\right)$, which allows the supplier's marginal cost c to match the marginal revenue $w\bar{F}(\bar{L}_s^*)$ when the retailer uses up all trade credit offered. In response, the retailer's decision and the supply chain performance follow a threshold structure: when the retailer's capital K is sufficiently small, the retailer uses up all credit offered, and both the order quantity and the supplier's profit increase in K. However, for larger K, the retailer does not use up all trade credit offered, and both order quantity and supplier profit decreases in K. Furthermore, at the threshold K that separate these two scenarios, the retailer's order quantity is $\bar{F}^{-1}(c)$, allowing the chain to be coordinated. This threshold K also allows the supplier to achieve the highest profit under the exogenously given w.

With these two benchmarks, we analyze the three main scenarios where the retailer has access to both bank loan and trade credit to highlight the impact of priority rules on trade credit usage and supply chain performance. The findings are summarized in Figure 1.

Our result shows that when trade credit is senior to the bank loan (*TC Senior*), when the retailer's financial constraint is tight (small K), the supplier does not offer trade credit, and the retailer uses only the bank loan, and the chain behaves exactly the same as the bank loan only benchmark. However, as K increases, the supplier offers the same trade credit limit as the trade credit only scenario. The reason behind is the following. When trade credit is senior, if the retailer adopts both trade credit and bank loan, the retailer's marginal cost is determined by the bank loan, and hence remains at w. Consequently, the retailer's order quantity is the same as the bank loan only benchmark, completely

[2] We refer the readers to Yang and Birge (2011) for the detailed derivation of this result and the following ones in this chapter.

Figure 1: Comparison of Trade Credit, Bank Loan Usage, and Profit Allocation under Different Priority Rules



Parameters: $c = 0.6$, $w = 0.8$, and $\xi \sim$ Uniform[0, 1].

eliminating the risk-sharing role of trade credit. Thus, in order to use trade credit as a risk-sharing tool, the supplier needs to offer sufficient trade credit in order to meet the entire financing need of the retailer, and this inevitably erodes the supplier's profit margin. As a result, the supplier only offers trade credit when the retailer's financing need is low.

When trade credit is junior to the bank loan (*TC Junior*), this priority change does not influence trade credit usage and supply chain performance when the retailer's financing need is low (high K). In this region, the retailer only uses trade credit. However, when trade credit is junior, the supplier extends retailers over a larger range of K, and it also allows the retailer to use both trade credit and bank loan for small K. This is because when trade credit is junior, the retailer's marginal cost is determined by $w\bar{F}(\bar{L}_s)$, whether the retailer uses bank loan or not. Thus, for the retailer with high financing need, the supplier could reduce the trade credit limit and induce the retailer to adopt bank loan without changing the retailer's marginal cost, which in turn determines the order quantity and supply chain performance. As a result, the supplier's profit is also higher under this scenario than the one when trade credit is junior. That said, when the retailer's capital K is in the medium range, the retailer receives less trade credit, and uses a bank loan as a substitute. As a result, the total amount of financing received by the retailer is smaller than that in the scenario when trade credit is senior, and it also results in lower retailer profit and supply chain efficiency.

Relating this result to the recent change in the bankruptcy law, that is, the introduction of Section 503(b)(9), we find that when trade credit is junior, the supplier is universally better off. However, trade credit with high priority has its own advantages. First, for a certain interval, that is, for $K \in (\kappa_n^{ts}, \kappa_u^{ts})$, trade credit with high priority can improve chain efficiency. Second, trade credit with high priority is easy to implement as it only requires knowing whether the retailer's cash position is above or below the threshold κ_n^{ts}, while the line of trade credit when trade credit is junior depends on the exact value of K.

Finally, as Figure 1 reveals, when trade credit and the bank loan have equal seniority (*Equal*), the supplier is willing to extend the least amount of trade credit among these three scenarios, and the chain efficiency and profits of different parties are the lowest as well.

0.3.2 The Optimal Trade Credit Contract

After focusing on the supplier's decision on trade credit limit, we relax the constraint on exogenous wholesale price and study the optimal trade credit when the supplier has the freedom to choose both the (credit) wholesale price w and the line of credit $\bar{L}_s$. In this case, we find that regardless of priority rules, the supplier offers unlimited trade credit with net terms. The retailer only uses trade credit. Put differently, in the presence of a single demand risk, when the supplier can jointly determine credit price and quantity, priority rules become irrelevant. The result is intuitive: first, compared with other priority rules, for each fixed w, trade credit being a low priority claim allows the supplier to earn the highest profit. Second, when w is in the supplier's control, the maximum line of trade credit she is willing to extend is $\bar{F}^{-1}(c)$, which corresponds to charging $w = 1$ and offering trade credit that is sufficient even for a retailer with $K = 0$. As such, the retailer solely relies on trade credit for financing inventory, deeming priority rules irrelevant.

Finally, we note that the above conclusion is solely from the perspective of the supplier, who is modeled as the Stackelberg leader in the game. However, granting suppliers with pricing powers is not necessarily optimal from a supply chain perspective. In fact, when suppliers are forced to supply at a low wholesale price, which alleviates double marginalization, total supply chain efficiency can be improved.

0.4 Trade Credit and Priority in the Presence of Multiple Risks

The last section concludes with a strong result that when the retailer faces only demand risk and the supplier has control of the wholesale price, priority rules become irrelevant and the supplier is willing to offer unlimited trade credit under net terms; hence, she becomes the sole creditor of the retailer.

Reality, however, is more complicated. In addition to procuring inventory from the supplier, he may invest in other risky projects, or face other uncertainties such as lawsuits and marketing campaigns. To model this situation, we introduce another risk embedded in an additional (generic) project. In this case, as this project requires a positive initial investment, and suppliers only lend in kind, trade credit provided by the supplier is insufficient for both inventory and the initial investment of the generic project. In this case, unlike the scenario where the supplier is the sole creditor, the retailer may have to borrow from more than one creditor, and priorities become unavoidable. Specifically, we expand the above model by assuming that before the supply contract, the retailer makes a decision whether to invest in a generic long-term project. If yes, he borrows a bank loan to finance this project. Following the retailer's investment decision, the supplier proposes a supply contract as discussed in the previous section. This generic project is paid off at the same time that demand is realized. Both the investment payoff and demand are assumed to follow a binary distribution. The joint distribution and associated payoffs are summarized in Table 1. In this table, σ represents the state of the world, where l is short for low, and h

is short for high. And the correlation between the generic project payoff and demand is reflected in $\epsilon \in [-1/4, 1/4]$. Note that given these payoffs, the generic project is always risky; that is, when the low state happens, the investment cannot be (fully) recovered. Further, although we show most examples assuming an exogenous wholesale price, an endogenous wholesale price does not change the qualitative insights. Based on this model, we use a series of examples to illustrate the interaction between the two risks. Without loss of generality, we assume the retailer's initial capital $K = 0$ and wholesale (credit) price is exogenously given.

Table 1: Joint Distribution of Investment Payoff and Demand

σ	Probability	Demand	Investment Payoff
hh	$1/4 + \epsilon$	2	V
hl	$1/4 - \epsilon$	2	0
lh	$1/4 - \epsilon$	1	V
ll	$1/4 + \epsilon$	1	0

Payoff Correlation. As discussed above, one concern about having another risk is that it will blur the correlation between the realized demand and the retailer's total payoff. To illustrate this concern, consider the following example. Let $V = 1$, $I = 0.4$, $c = 0.4$, $w = 0.9$. When examined independently, the generic project has a positive NPV of 0.1, and thus is worth investing. Similarly, when the inventory decision is considered independently, the supplier's optimal decision is to offer unlimited trade credit and the retailer orders two units. The corresponding profits are: $\pi_s = 0.5(1) + 0.5(1.8) - 2(0.4) = 0.6$, and $\pi_r = 0.1$. When not offering trade credit, the supplier's profit is $\pi_s = w - c = 0.5$.

Now consider the case when both investment decisions are made jointly. Suppose trade credit is junior and the supplier still offers unlimited trade credit. From the retailer's perspective, if he orders one unit, his profit $\pi_r(1) = (0.25 + \epsilon)(0.7 + 0) + (0.25 - \epsilon)(0.7 + 0) = 0.35$, and the supplier's profit $\pi_s(1) = 0.35$. Note that in this case, both parties' profits are independent of the correlation ϵ.

When ordering two units, the retailer's profit $\pi_r(2) = (0.25 +$

$\epsilon)(0.8) = 0.2+0.8\epsilon$. Similarly, and the supplier's profit $\pi_s(2) = 0.6-0.8\epsilon$. Note that when ϵ increases, the supplier's profit decreases, while the retailer's profit increases. Intuitively, this is because that as a creditor, the supplier prefers a smoother payoff, while the retailer, who is the equityholder, prefers a more volatile one. However, for the supplier to extract more profits, the retailer's incentive constraint needs to be satisfied; that is, $\pi_r(2) > \pi_r(1) = 0.35$. However, in this case, $\pi_s(2) < 0.8-0.35 = 0.45$, which is smaller than what the supplier makes when she offers no trade credit. This reveals that by including another project, the retailer can take advantage of the supplier by taking both the trade credit offered by the latter and a cheaper bank loan, and consequently make a greater profit. Anticipating this, the supplier does not offer trade credit at all.

On the other hand, when trade credit has high priority, while the supplier is willing to offer trade credit, the chain behaves exactly as when no trade credit is offered, as the retailer has no incentive to order two units and trade credit is riskless.

Over-investing. So far, all examples show situations that, when considered separately, the generic project is worth investing, that is, it has a positive net present value (NPV). Next, we use the following case to examine the impact of priority on trade credit when the generic project independently has a negative NPV. Let $\epsilon = 0$, $V = 1$ and $I = 0.7$. When evaluated independently, the retailer should not invest in this project, which has a NPV of -0.2. However, suppose the supplier offers the same contract under the base case ($w = 0.9$, unlimited credit), the retailer's optimal strategy is to invest in this project, order one unit from the the supplier, and makes a total profit 0.2. The supplier, however, only makes a profit of 0.3. Therefore, under this circumstance, the supplier's optimal strategy is not to offer trade credit at all.

Debt overhang. As we mention in the model setting, as demand risk is normally short-term relative to the generic project, the payoff of the latter may be revealed (noisily) before the supplier proposes the supply contract. Obtaining information about the project's status, the supplier can subsequently incorporate this information into credit extension decisions. For example, when the supplier finds the company is in bad shape, she may refuse to extend trade credit if she can only hold a junior claim. In finance, a closely related phenomenon is *debt overhang* (Myers, 1977), which means that highly levered companies may opt out of some valuable investment opportunities because those opportunities may not benefit the equityholder. In a similar vein, we show how the interaction of a long-term debt (used for a long-term investment) and a short-term debt (trade credit) influences trade credit usage and the retailer's investment decisions.

Consider the above expanded model with $V = 1$, and $I = 0.8$, which the retailer can finance using a bank loan. Assume $\epsilon = 0.25$, i.e., demand and the project payoff are perfectly positively correlated. Further, at time 1, the retailer receives a signal of the payoff of the project before making the inventory decision. With 90% probability, the signal is good, that is, the payoff of the project is 1; and with 10% probability, the signal is bad (the payoff of the project is 0). The signal is observable to every party, and it is 90% accurate; that is, when the signal is good, with 90% probability, the demand and project payoff is high, with 10% low. When the signal is bad, with 90% probability, the demand and project payoff is low, and with 10% high. For demand, $c = 0.4$, $w = 0.9$.

Under this setting, first consider the scenario when trade credit has low priority. Clearly, when the signal is bad, the supplier should not offer any trade credit. Anticipating this situation, however, the retailer should borrow a bank loan at time 0 with $B = I + w = 1.7$, which leads to $L_b = 1.85$. Thus, when the signal is good, it is optimal for the supplier to extend trade credit in spite of low priority. Conditional on the good signal, the supplier's profit is $90\%(0.9) + 0.9 - 2(0.4) = 0.91$, and the retailer's profit is $90\%(0.25) = 0.225$. Therefore, the unconditional profit for the supplier is $90\%(0.91) + 10\%(0.5) = 0.869$, and the retailer's profit is $90\%(0.225) + 1\%(0.15) = 0.204$.

On the other hand, if trade credit has high priority, it is easy to show that the supplier's profit is 0.5, as she can only sell one unit regardless of the signal. The retailer's profit is $0.02 + 0.1 = 0.12$, which is dominated by the case when trade credit has low priority.

This example shows another advantage of trade credit as the low priority claim. It allows the supplier to use trade credit as a risk-sharing mechanism only when facing a good signal. In response, the retailer should borrow a larger bank loan and carry some cash in the first period.

As all of the above examples show, even in the presence of other risks, granting low priority to trade credit does not create any efficiency loss for the chain. It is true that under certain circumstances, the supplier does not extend trade credit unless trade credit has high priority. However, in such cases, in anticipation of the supplier's decision, the retailer could increase his cash holding by borrowing a larger amount from the bank. With this in mind, when the retailer has multiple creditors, compared with the case when trade credit has high priority, trade credit with low priority improves chain efficiency and the supplier's profit, confirming the result we obtained when there is only demand risk.

0.5 Conclusion and Future Research

Focusing on how priority rules between trade credit and bank loan influence trade credit usage and supply chain efficiency, this chapter finds that under the risk-sharing role of trade credit, assigning trade credit with low priority in general leads to higher supply chain efficiency. At the same time, it is important for the supplier to adjust the credit price and quantity by considering other non-demand risks the retailer faces.

The paper is not without limitations. First, our current conclusion relies on the assumption of no distress costs, net-terms trade credit, and risk-neutral players. However, if suppliers are significantly more risk-averse than banks, assigning trade credit with high priority can be advantageous. Second, it is worth noting that the risk-sharing role of trade credit is just one of the many theories that may explain trade credit. Even though we show that granting trade credit with low priority is generally more efficient through its purpose in risk-sharing, we cannot conclude that for the other purposes that trade credit serves, higher priority would not benefit the supply chain. For example, if suppliers can better recover the value from unsold inventory than banks, then trade credit as a high priority claim could be optimal. Finally, further empirical analysis, such as using the adoption of BAPCPA as a natural example, should also be promising.

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