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Foundations and Trends® in Technology, Information and Operations Management

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Suggested Citation: Fehmi Tanrisever, Matthew Reindorp, Hande Cetinay and Jan C. Fransoo (2024), "Value of Reverse Factoring under Make-to-Order Production Environments", Foundations and Trends® in Technology, Information and Operations Management: Vol. 18, No. 1, pp 44–83. DOI: 10.1561/0200000114-3.

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Contents

Value of Reverse Factoring under Make-to-Order Production Environments

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ABSTRACT

Reverse factoring has received significant attention as a means for small and medium-sized firms to access capital. In this monograph, we explain the value creation mechanism of reverse factoring and derive the value of reverse factoring contracts for firms in make-to-order (MTO) production environments. Empirical and other theoretical work on reverse factoring exists in research literature, but our model constitutes the first analytic treatment of the problem for a pure MTO setting. We show how the value of reverse factoring results from and is conditioned by (1) the spread in deadweight external financing costs, (2) payment period extensions, (3) volatility in cash flows, (4) working capital policy, and (5) the risk-free interest rate. Thus, in addition to providing managerial insights on value reverse factoring

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Online Appendix available from: http://dx.doi.org/10.1561/0200000114-3_app

contracts, our findings disclose an important relation of these elements to the broader macroeconomic context.

1

Introduction

Since the seminal paper of Modigliani and Miller (1958) it is well known that financial and real investment decisions are separable when capital markets are perfect and there are no frictions, e.g., taxes, transaction and financial distress costs, or information asymmetries. In this ideal case, the source of financing neither affects operating plans nor creates additional value. Capital markets in reality are not perfect, however, and firms face financial constraints and barriers when raising external funds. In particular, capital market frictions may create a significant gap between the costs of internal and external funds, especially for small and medium-sized enterprises (SMEs). As the gap gets larger, SMEs pay a greater external financing premium and are also more likely to under-invest and forgo business opportunities that have positive net present value (Carpenter and Petersen, 2002; Jensen and Meckling, 1976; Myers and Majluf, 1984). This underinvestment can have negative repercussions further along in the economy, since an SME may be a key supplier to a large corporation. We examine here a recent form of financial intermediation that promises to address such problems: so-called "reverse factoring" arrangements, which facilitate information revelation and thus trigger affordable financing for SMEs' working capital.

Firms' interest for reverse factoring started before the financial crisis of 2008. Managers viewed it as a means to extend payment terms to suppliers, without adversely affecting supplier cash flow (Demica, 2007). Post-crisis, extension of payment terms remained as a motivation for large firms to engage in reverse factoring (Milne, 2009), but the importance of supplier cash flow was accentuated. Practitioners' interest for reverse factoring has continued to grow since then. A study conducted by the Supply Chain Financing Community in 2019 found that nearly half of the companies on the payment side of supply chain financing transactions utilized some form of reverse factoring. Moreover, 37% indicated their intention to explore this financial approach further, according to Freedman (2019). As of 2022, the global market size for reverse factoring reached USD 530.8 Billion and is poised for substantial growth, with projections indicating a market size of USD 1,452.1 Billion by 2032 (Acumen, 2023).

As the name suggests, reverse factoring represents a development of conventional factoring. The latter is traditionally a common source of working capital financing for SMEs (Berger and Udell, 2006; Klapper, 2006). In conventional factoring, a firm sells its accounts receivable due from a customer to a third party finance provider, which can be a bank or a specialized factoring company, which later collects the accounts receivable from the customer. The finance provider incorporates various risks and costs when discounting the accounts receivable, including (1) credit risk of the entity that will make the payment (the customer of the selling firm), (2) informational problems about the quality of the accounts receivable such as fraud and mistakes with the billing process, and (3) transaction costs for the collection and monitoring services (Mian and Smith, 1992; Smith, 1987; Smith and Schnucker, 1994). Although conventional factoring can be a significant source of working capital, these risk considerations may in practice lead to large discounts and limit the value of factoring as a source of working capital finance. Reverse factoring provides an alternative solution for SMEs, especially when credit is limited. It reduces costs that result when information about the quality of the receivables is lacking, as well as costs for collection and monitoring services (Klapper, 2006).

In the conventional factoring, the obligor (i.e., the entity that is ultimately to make payment on the account receivable) is not a contractual party to the transaction. The obligor makes no formal guarantee to the factor that the payment will be made. The factoring transaction is based purely on the initiative and information of the borrowing firm. In contrast, a reverse factoring transaction occurs in the context of a contractual agreement between the obligor, the borrowing firm, and the factor. The obligor has an explicit informational role. Instead of communicating only with its SME supplier (the borrowing firm), the obligor registers approval of the latter's invoices on an information system provided by the factor. The terms of the reverse factoring contract entail that, by registering approval on the system, the obligor guarantees that it will remit the corresponding amounts to the bank, after any agreed payment delay, for application to the SME's account. Payment is not in any way contingent on the future actions or financial condition of the SME. After the obligor has registered approval of the invoice, the SME can request early payment and the bank will advance funds at a discount that is based on the obligor's credit risk, rather than the SME's. Reverse factoring serves to mitigate the informational asymmetries (between the SME supplier and the financial market) regarding the SME's assets, reduce transaction costs and enable cheaper financing.

Figure 1.1 depicts the reverse factoring mechanism. It highlights liquidity improvement and/or lower short-term financing costs for the SME, but further consideration shows that similar advantages for the corporation should be possible. Prior to using reverse factoring, the SME's short-term financing expenses are a function of its own cost of external funds and the time that its receivables remain outstanding. If the reduction in the cost of external funds on transactions with the corporation is sufficiently large, the latter may extend the trade credit period (Klapper, 2006), while still leaving some net benefit for the SME. A longer trade credit period entails that the corporation will also realize a reduction in short-term financing needs: net working capital is reduced by an increase of trade liabilities. Although the corporation

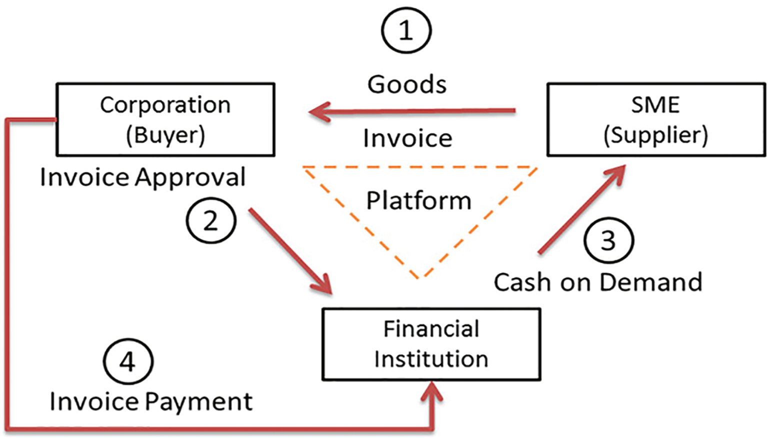

Figure 1.1: Reverse factoring mechanism.

Notes: This shows the structure and sequence of events in a reverse factoring transaction. After the SME supplier (1) meets an order from a corporate customer and issues an invoice, the corporation (2) registers approval of the invoice with the relevant financial institution. If desired, the SME can then (3) expedite cash flow by borrowing against the value of the receivable. At the invoice maturity date, the corporation (4) makes payment to the financial institution, which applies the funds to the account of the supplier.

may, in theory, also consider extracting benefits from reverse factoring by directly asking for payment discounts, payment period extensions appear to be more commonly used in practice by firms (Grüter and Wuttke, 2017; Kouvelis and Xu, 2021; Milne, 2009; Ng, 2013). The main reasons why price discounts are not common in reverse factoring programmes may include informational problems between managers and shareholders about the relative benefit of lowering accounts payables versus reducing procurement costs, and/or transaction costs associated with price agreements, which are usually harder to negotiate compared to payment periods.

In essence, the choice between reverse factoring and conventional external financing (short-term debt) for the SME is a capital structure problem. In a perfect financial market, this choice is irrelevant to firm value because after adjusting for the risk, the cost of these two sources of financing is zero. In other words, the credit arbitrage between these two forms of financing is purely driven by the riskiness of these claims and hence is a mirage in perfect markets. As it is precisely stated by

Hennessy and Whited (2007, p. 1705), "corporate finance is primarily the study of financing frictions. After all, Modigliani and Miller (1958) showed that a CFO can neither create nor destroy value through his financing decisions in a world without such frictions."

In the presence of informational problems, however, external funds become more expensive than internal funds (after adjusting for the risk), and the pecking order theory of finance (Myers and Majluf, 1984) argues that the firms should use the funds in the order of increasing information asymmetry, i.e., first use internal funds, then issue secured debt followed by unsecured debt, and finally resort to equity financing. Consequently, if the payment period is not extended and there are no other costs, the SME will always prefer reverse factoring to conventional external funds (e.g., a bank loan or overdraft). However, the payment period extension creates a trade-off. Although reverse factoring reduces the unit cost of borrowing, any allied payment period extension increases the duration that the SME's receivables remain outstanding and hence increases the need for external funds. In practice this trade-off is not straightforward to evaluate, due to the stochastic nature of business between the firms and the firms' need for external finance. It becomes hard to see how the terms of a reverse factoring contract affect its value. Insight is needed here, as these contracts generally arise through negotiation of the key terms by the involved firms. Fees and any payment period extension are not directly imposable by any one party.

We find that the trade-off between financing cost and payment period extension is further conditioned by the risk-free interest rate, working capital policy and the operating characteristics of the firm. To our knowledge, our work is the first to provide a rigorous analysis of this problem in an MTO (make-to-order) setting with both uncertain demand size and timing.

We consider two MTO business scenarios to investigate the benefit of reverse factoring contracts. First, we model an SME receiving and meeting randomly arriving demand from a corporate customer in a stylistic single period model with costly external financing. In the second model, we add uncertainty about the size of the demand. In both cases, the terms of any reverse factoring arrangement must be agreed at the outset. We assume that the supplier alternatively has access to conventional short-term financing, albeit at a less favorable cost. Our objective is thus to determine the conditions under which the reverse factoring contract will be economically viable and create value for each party. Our work contributes to the literature from the following angles.

First, we quantify the value of reverse factoring contracts to the participants under an MTO business model focusing on pure financing benefits of reverse factoring. We reveal the relevant linkage between (1) the spread of deadweight external financing costs, (2) payment period extensions, (3) the operational characteristics of the firms (in particular, demand volatility) and the implied working capital policy, and (4) the risk-free interest rate. The interrelation of these factors offers a key insight to managers who are going to negotiate the terms of a reverse factoring contract. Not only a greater spread of deadweight external financing costs, but also a greater volatility in demand allows the corporation to increase its payment period while retaining the participation of the SME. We show, however, that the SME's benefits are highly sensitive to the payment period extension: a small increase in payment delay may entail a relatively large decrease in the SME's benefit. Payment period extension thus ultimately proves to be an inefficient strategy when the total benefits of the firms are considered, since it interacts with the operations of the SME and reduces the total available benefits.

Second, we find that SMEs with aggressive working capital polices will have greater incentive to use reverse factoring, and the total benefits for the firms are also larger in this case. The risk-free rate of interest does not influence the total benefits to the firms, but a lower risk-free rate gives the corporation less incentive to offer reverse factoring to the SME. Through a set of numerical analyses, we observe that reverse factoring, under reasonable economic conditions, may yield a value increase of 2–10%.

Third, we show that demand volatility increases the need for external funds, so the benefit of reverse factoring for the SME increases with the variance of demand. Higher demand variance also increases the corporation's maximum benefits, since the payment period can be extended further while retaining the SME's participation. Nonetheless, this exacerbates the inefficiencies resulting from payment period extension. Although the corporation's maximum benefits increase with variance, we find that the maximum extraction ratio of the corporation decreases.

2

Literature Review

Researchers have shown increasing attention in the new millennium to problems at the interface of operations and financial management (Babich and Kouvelis, 2018; Babich *et al.* 2021; Reindorp *et al.*, 2018; Tanrisever *et al.*, 2021; Zhao and Huchzermeier, 2015). Our work is located in a subset of this literature, specifically, among studies that consider problems in supply chain finance. It is also closely related, however, to research streams that traditionally address the elements of our problem, such as small business finance and trade credit.

Full recognition of the financial context is essential for our current study. As we noted in the introduction, reverse factoring can only offer some advantage to firms capital markets – or at least, the market for short-term commercial finance – fail to satisfy the requirements of the famous Modigliani-Miller theorems (Modigliani and Miller, 1958). Where capital markets are imperfect, the source of financing may impact other management decisions within the firm, and ultimately also the ability of firms to create value (Froot *et al.*, 1993; Mayers and Smith, 1982; Smith and Stulz, 1985; Stulz, 1996).

Irrespective of the cause, research on small business finance confirms that the deadweight financing costs faced by large corporations are significantly lower than what their SME suppliers can realize. For instance, Hennessy and Whited (2007) estimate that marginal equity flotation costs for large firms start at 5.0%, while the corresponding figure for small firms is 10.7%; bankruptcy costs amount respectively to 8.4% or 15.1% of capital. Gomes *et al.* (2003), in a general equilibrium asset pricing model, argue that bankruptcy costs of 5% can add 1.2% to the equity premium. As the bankruptcy costs (relative to the firm value) and other capital market frictions such as information asymmetries and transaction costs are usually more severe for SMEs (Cornell and Shapiro, 1988; Erzurumlu *et al.*, 2012; Shane, 2003; Tanrisever *et al.*, 2012), these firms pay a larger deadweight external financing cost compared to their larger counterparts. As these frictions get more severe, access to capital by these small firms can be totally cut.

The existence of such differences is also a key motivation for firms' use of trade credit. Schwartz (1974) provides an early formalization of the financing advantage it provides. When sellers have better access to capital markets than their customers, trade credit allows them to offer better conditions than the customers could obtain through conventional financing. From a different angle, Smith (1987) suggests trade credit as a screening mechanism for suppliers to evaluate a customer's default risk.

Many other studies address the financial and economic foundations of trade credit: see Petersen and Rajan (1994) for a detailed review. Research at the operations-finance interface now complements this knowledge by showing how trade credit may impact supply chain decisions. Gupta and Wang (2009) consider effects on supply chain contracting and inventory management; they find that a base stock policy is still optimal under trade credit, provided the policy itself is adjusted to match the credit terms offered by the supplier. Luo and Shang (2019) study the role of trade credit in a supply chain when defaults are costly. Other have explored the potential of trade credit terms to coordinate the supply chain (Lee and Rhee, 2011; Xiao *et al.*, 2017) or share risk (Yang and Birge, 2018).

While some connection to trade credit is clear, the reverse factoring mechanism is different in several ways, as our analysis will show. A major contrast is evident in the orientation of the parties concerned: the credit provider in reverse factoring is situated downstream in the supply chain, while a typical trade credit arrangement involves a financially constrained small retailer that receives financing from a large supplier. More importantly, a reverse factoring transaction brings no additional risk for the corporation, since it is already obligated to pay the account receivable held by the supplier. In addition, when coupled with an extension of the payment period, reverse factoring entails that the corporation receives additional credit from its supplier, which to some degree will offset the benefit that the latter may realize through a lower external financing cost.

Alongside growth in practitioners' interest for reverse factoring, research on the topic increased significantly in the aftermath of the financial crisis of 2008. Early studies convey high-level managerial assessments (e.g., Seifert and Seifert, 2009) or use financial ratios to calculate the benefits that should result for participants (e.g., Randall and Farris II, 2009). Subsequently, empirical studies (e.g., Wuttke *et al.*, 2013) and simulation-based investigations (e.g., Van der Vliet *et al.*, 2015) appeared. Dello Iacono *et al.* (2015) proposed an initial study of factors affecting firm's adoption of reverse factoring, and this topic has subsequently been examined in multiple different contexts; see, for example, Beka Be Nguema *et al.* (2021), Lampón *et al.* (2021), Phraknoi *et al.* (2022), and Wuttke *et al.* (2019). The most recent contributions in literature explore the credit risks that firms encounter by adopting reverse factoring (Rishehchi Fayyaz *et al.*, 2021), effect on organizational performance (Beka Be Nguema *et al.*, 2022), and the impact on allied concerns such as corporate social responsibility and shared value (Chen *et al.*, 2023). These works are all empirical though, and except Kouvelis and Xu (2021) there is limited work on analytical models exploring the value of reverse factoring. We aim to fill this gap, by integrating reverse factoring with an MTO operating model to reveal the value creation mechanism of reverse factoring and understand how key market factors condition the distribution of this value among the participating firms.

Our research is closely aligned with Kouvelis and Xu (2021), who also aim to establish a theoretical framework for reverse factoring. However, our approach differs from theirs in two key aspects: First, Kouvelis and Xu examine a scenario where reverse factoring is employed for financing long-term investments, demonstrating that RF may *not* be an equilibrium solution depending on firms' returns on free capital. In contrast, our model addresses an alternative scenario where the cost of short-term external funds exceeds the return on free capital in the short term. Consequently, we posit that RF serves as a last-resort external financing option to address urgent capital needs, such as covering rent, labor, or short-term debt.

Secondly, Kouvelis and Xu consider an operational setup where the retailer sets the wholesale price, and a newsvendor-like supplier responds with production quantity and financing decisions (choosing among pure bank financing, recourse factoring, non-recourse factoring, or reverse factoring). In our case, we concentrate on a simplified operational model, specifically a Make-to-Order model, where operational decisions are not contingent on financing models. Therefore, the benefits of reverse factoring in our model are solely derived from cost savings in financing. Within this simplified setting, we are able to derive analytical expressions that clearly link the advantages of reverse factoring to financing costs, payment periods, risk-free interest rates, and demand volatility.

3

Mathematical Model

In this section, we consider an SME supplier that faces stochastic demand arrivals from a corporate buyer. The SME's internal capital is limited and it may need to borrow in order to finance operations and meet current liabilities. We compare the value that the SME obtains from operating under alternative financing scenarios: (1) an initial scenario where the SME uses conventional external financing, versus (2) a scenario where the SME uses reverse factoring.

In both scenarios, the SME has cash reserves of magnitude y at $t = 0$. Pre-existing current liabilities z, such as rents and rates, are due at end of the period, $t = T$. During the period, the firm may generate cash flow from operations, but the timing of cash receipts depends on the timing of demand from the corporation. We assume that demand is realized at a single time point and production is instantaneous. We denote the arrival time of demand by a random variable τ with support $[0, T]$. Demand size ξ is constant and equal to μ (in the next section, demand size will also be stochastic with expectation μ). The stochastic arrival of the demand entails uncertainty in the timing of revenues, which is of significant importance in the presence of payment delays. For example, if a firm receives a sequence of large orders late during the planning period, then it may consume its cash reserves before it starts collecting the revenues associated with these orders. Relative to a case where the orders were received early in the planning period and converted into cash, it is likely to need financing for a longer period of time. Hence, not only the size of the demand is important for the firm, but also the timing, as it influences the timing of cash flows and financing needs. In our case, we provide a single period model in which all demand is realized at a single random time point during the planning period. This is a stylized approach to capture the impact of variable demand arrival times.

Upon arrival of the demand, the SME purchases the required raw materials for cash, creates the final product, and sells it to the corporation on credit. Each unit of the final product is sold for price p_s and incurs a raw material cost c. The demand arrival thus instantaneously reduces the cash reserves of the SME by $c\xi$ and creates an accounts receivable of size $p_s\xi$.

In scenario (1), conventional external financing, the payment delay from the corporation to the SME is l_{ext} time units: payment of the account receivable is due after this delay. To avoid trivial cases, we assume that it is economical to use external funds to meet the demand. Our model also easily extends to the case where the SME is allowed a payment delay when purchasing raw materials. The SME uses its cash reserves and cash generated from operations to meet the current liabilities as they come due. If this internal cash is not sufficient, external funds are received. In addition to any risk premium, the external finance provider charges deadweight costs to the SME, which we denote by b_s. That is, under the risk-neutral measure, external funds to the SME cost b_s per dollar above r_f, the risk-free rate. These deadweight costs may arise from the direct and indirect costs of bankruptcy and financial distress, as well as from transaction costs and informational asymmetries between managers and outside investors (Froot *et al.*, 1993). Thus we denote the total external financing cost paid by the SME in scenario (1) as $r_{\text{ext}} = r_f + b_s$.

We assume the future value of the initial cash reserves are sufficient to cover the fixed costs at the end of the period ($ye^{r_f T} > z$), but less than the fixed costs plus the cost of meeting the order $ye^{r_f T} < z+c\xi$; hence the

SME needs to borrow if the account receivable is not received before the fixed costs are due (this assumption will be relaxed when we discuss the stochastic demand size in Section 4). The corporation has sufficient internal financing and does not need external funds. This assumption is for ease of exposition, and liquidity shocks to the corporation can also be modeled without material effect on our findings. The free cash reserves of both the SME and the corporation earn the risk-free rate. With the conventional financing arrangement of scenario (1), cash inflows and outflows to the SME take place in the following order.

(1) At $t = 0$. SME starts operations with y amount of initial cash reserves (liquid assets).

(2) At $t = \tau$. SME receives the order from the corporation and simultaneously places an order with its supplier for the procurement of raw materials. Raw materials are purchased for cash and are received instantaneously from the supplier of the SME. This reduces the SME's cash reserves to $ye^{r_f \tau} - c\xi$, where $ye^{r_f \tau}$ denotes cash reserves at $t = \tau$, including risk-free earnings, and $c\xi$ is the cost of purchases. For ease of exposition, we assume the SME starts operations with sufficient cash to purchase the raw materials (this assumption will also be relaxed in Section 4). All other expenses are due at the end of the period. The corporation instantaneously receives the final goods from the SME, and sells them to the final customer(s). The transaction creates an account payable for the corporation, which corresponds to an account receivable for the SME.

(3) At $t = T$. Short-term liabilities z of the SME come due (these may include fixed operating expenses, wages, rates, rents, and so forth). This event entails two possible cases.

(3.1) If $\tau + l_{\text{ext}} \leq T$ then the account receivable from the corporation is received no later than the moment when the short-term liabilities are due. Then, cash reserves at the end of period are $y_T = ye^{r_f T} - c\xi e^{r_f (T-\tau)} + p_s \xi e^{r_f (T-\tau-l_{\text{ext}})}$, where $ye^{r_f T} - c\xi e^{r_f (T-\tau)}$ denotes the accumulated cash net of the cost of purchases at $t = T$, and

$p_s \xi e^{r_f(T-\tau-l_{\text{ext}})}$ is the value of the revenues at the end of the period including the risk-free earnings. In this case the SME does not need financing since $ye^{r_f T} > z$ and meeting the order is profitable.

(3.2) If $\tau + l_{\text{ext}} > T$ then the account receivable from the corporation is received after the short-term liabilities are due, the cash reserves at the end of period are $y_T = ye^{r_f T} - c\xi e^{r_f(T-\tau)}$, and this is insufficient to pay z. External funds in the amount of $L(r_f) = z - y_T = z + c\xi e^{r_f(T-\tau)} - ye^{r_f T} > 0$ are received from the bank at a unit cost of r_{ext}, in order to exactly cover the shortage. These external funds are repaid by the SME at time τl_{ext}, i.e., when the SME receives the payment due from the corporation. Due to the credit risk involved in the debt, the uncertain loan repayment is denoted by χ.

(4) At $t = \hat{T} > T + l_{\text{ext}}$. The SME closes its accounts and is liquidated.

The model description and notation are summarized in Figure 3.1.

In scenario (2), the SME uses a reverse factoring arrangement instead of conventional external financing. This entails two differences to the schema of cash flows presented in Figure 3.1. First, the SME may sell its approved invoice (account receivable) to the bank and receive a loan maturing at the end of the payment period. From the bank's perspective this loan is assured by the creditworthiness of the corporation, so the SME incurs deadweight cost of capital $b_o < b_s$ on the transaction. The deadweight cost is smaller because established corporations are, in general, less exposed to capital market frictions than SMEs (Hennessy and Whited, 2007). The bank may also include a surcharge k for the reverse factoring service, so the SME ultimately pays an external financing cost of $r_{\text{rev}} = r_f + b_o + k$ under reverse factoring. We assume, however, that $r_{\text{rev}} < r_{\text{ext}}$. In counterpart to this cheaper financing cost, the second change from scenario (1) is that the corporation may extend the nominal payment period to $l_{\text{rev}} > l_{\text{ext}}$. Thus we characterize a reverse factoring contract by a vector of two parameters: r_{rev}, the reverse factoring financing cost for the SME, and l_{rev}, the reverse factoring payment period of the corporation. The

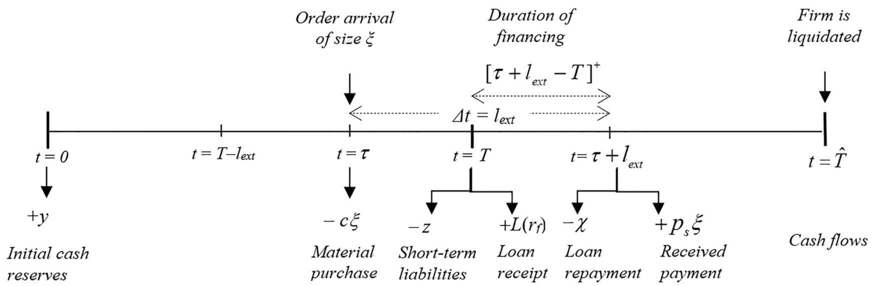

Figure 3.1: Model description and notation.

Notes: Model for the SME with conventional external financing. The SME has cash reserves y at time $t = 0$ and liabilities z due at time $t = T$. Demand of size ξ is received from the corporation at time $\tau < T$. It is always economically feasible to meet demand, but doing so may entail that the SME needs a loan to meet liabilities z at time $t = T$. The loan will be repaid at time $\tau + l_{\text{ext}} > T$, where l_{ext} is the trade credit period that the SME allows the corporation. The SME has unit cost of raw materials c and selling price p_s. The model horizon lies beyond $T + l_{\text{ext}}$, the latest possible moment for payment from the corporation.

SME decides whether to accept the contract $(r_{\text{rev}}, l_{\text{rev}})$ instead of the conventional financing terms $(r_{\text{ext}}, l_{\text{ext}})$.

Reverse factoring can generate value by reducing the deadweight financing costs of the SME. The savings are then shared between the SME and the corporation based on the contracting terms. Both firms are assumed to maximize firm value. Furthermore, we assume that demand risk is diversifiable while the credit risk of the SME is driven by the changes in the value of its assets which is correlated with the market and cannot be fully diversified. Hence, there exists a systematic risk premium for loans issued to the SME.

In our model, the SME's fixed assets are financed by a senior long-term debt that is due to be repaid at the end of the planning period. This senior debt includes covenants which may delay or otherwise restrict the repayment of any junior debts that come due before the end of the period. In particular, these restrictions could be imposed by the senior debtholders if the market value of the fixed assets fell below a certain threshold (*cf.* Leland, 1994; Longstaff and Schwartz, 1995). While we do not explicitly model the value process for the SME's fixed assets, this underlying assumption drives the credit (default) risk of the bank loan and the allied risk premium that the SME must pay to obtain a junior loan. In our case, the current business transaction with the corporate buyer is small relative to the fixed assets of the SME and hence, the credit risk of the SME is solely determined its fixed assets (*cf.* Froot *et al.*, 1993, p. 1637). Relaxing this assumption would only result in marginal insights while significantly limiting analytical tractability. For ease of exposition, we assume that the corporation has negligible default risk. So, the deadweight cost of external funds for the corporation, b_o, is solely driven by transaction costs.

Regarding the bankruptcy process, if the SME goes to bankruptcy, due to a shock to its asset value, it is reorganized and continues to operate under a new ownership structure. That is, we implicitly assume that the SME remains economically viable over time. Bankruptcy reorganization, however, entails that the debt holders may lose some of their claims, so they require a rate of return on their investment that exceeds the risk-free rate. We assume that there exists a risk-neutral measure governing the evolution of the SME's asset value and we discount the value of debt accordingly. In particular, χ denotes the stochastic debt repayment such that

$$\chi = \begin{cases} \text{Face value of debt} & \text{if SME not bankrupt} \\ \text{Value of the debt in reorganization} & \text{if SME bankrupt.} \end{cases}$$

As in Diamond (1989), we define the face value of the loan as the loan principal $L(r_f)$ plus the interest payment (this is not be confused with the face value term in the bond markets). We do not explicitly derive this face value (or equivalently the interest rate on the loan) in our model since it does not feature explicitly in our analysis. Now under the risk-neutral measure (Q-measure) of the asset process, the relationship between the face value and the loan principal is defined by the following fair pricing equation in a competitive market:

$$L(r_f) = \frac{E^Q(\chi)}{e^{r_{\text{ext}}\Delta l_{\text{ext}}}}. \tag{3.1}$$

Note that under the risk neutral measure, the discount factor only includes the risk-free rate and the deadweight financing costs (r_{ext}) since the risk-neutral measure discounts for the systematic risk premium. In particular, (3.1) is the fair pricing equation stating that the loan principal is equal to the expected risk-adjusted loan repayment minus the deadweight cost of the loan. Similar to Froot *et al.* (1993) we take the deadweight costs of financing to be fixed within our model horizon, i.e., the market frictions are constant in the short term.

In what follows, we use a first-order Taylor series approximation when discounting cash flows in the analytical models. Exact results differ only slightly, due to the compounding of interest (exact results are presented in Appendix B). The following propositions describe the benefits and the participation constraints of each party for a given reverse factoring contract. We define $A(T-l) = E_\tau[\tau + l - T]^+$ as the expected duration of borrowing for a generic payment period l. All proofs are included in Appendix A.

Proposition 3.1. With fixed demand size, the reverse factoring contract $v = (r_{\text{rev}}, l_{\text{rev}})$ generates the following benefits for each party.

(i) For the SME, $\pi^{\text{sme}} = b_s A(T - l_{\text{ext}})L - (b_o + k)A(T - l_{\text{rev}})L - p_s \mu r_f (l_{\text{rev}} - l_{\text{ext}})$,

(ii) for the corporation, $\pi^{\text{oem}} = r_f p_s \mu (l_{\text{rev}} - l_{\text{ext}})$,

(iii) for both firms in total, $\pi^{\text{total}} = b_s A(T - l_{\text{ext}})L - (b_o + k)A(T - l_{\text{rev}})L$,

where $L = z + c\mu - y$.

In Proposition 3.1, L is the amount that the SME may need to borrow, excluding the risk-free earnings on the initial cash position y. The SME's benefits are described by three terms: $b_s A(T - l_{\text{ext}})L$, the expected external financing cost of the SME without reverse factoring; $(b_o + k)A(T - l_{\text{rev}})L$, the expected external financing cost with reverse factoring; and $p_s \mu r_f (l_{\text{rev}} - l_{\text{ext}})$, the opportunity cost of reverse factoring, resulting from any payment period extension $l_{\text{rev}} - l_{\text{ext}}$ imposed by the corporation. The SME can only benefit from the reverse factoring contract if the net expected cost of financing decreases under reverse factoring. The corporation collects additional risk-free earnings on the amount of accounts receivable for the duration of the payment period extension. (Recall that the corporation is assumed to have sufficient internal funds and does not need external financing.) Nonetheless, total benefits are independent of the risk-free rate and determined by the spread of external financing cost between the corporation and SME. In particular, when there are no market frictions (b_s, b_o, and k are also zero), reverse factoring creates no value for the supply chain. We also note, however, that calculations based on the nominal spread in interest rates, which does not discount for the systematic risk, can distort these results. Such distortion will generally be to the disadvantage of the more risky supplier, whose benefit will appear greater than it is in the arbitrage-free setting.

The value of reverse factoring to the firms depends on three key market factors: (1) the spread of deadweight cost of capital between the SME and the corporation, (2) the working capital policy (WCP) and operational characteristics of the SME, and (3) the risk-free rate. As the spread of deadweight cost of capital between the parties widens, the SME experiences a larger decrease in its unit external financing cost and benefits more from reverse factoring. The working capital policy determines how often and how much external funding is needed by the SME. It is determined by the initial cash reserves, short-term liabilities and the operational characteristics such as the relative size and the volatility of SME's demand. In particular, an aggressive working capital policy (i.e., lower cash reserves and higher short-term liabilities despite relatively more volatile demand) implies more need for short-term financing and hence more benefits for the SME through reverse factoring. Finally, we see that the opportunity cost of reverse factoring to the SME is increasing (and benefits thus decreasing) with the risk-free rate, and this value is transferred directly to the corporation. The corporation's benefit from reverse factoring is driven by the expected business volume with the SME, the risk-free interest rate, and the payment period extension. The corporation's working capital savings are invested in short-term liquid assets and earn an additional risk-free interest rate for the duration of payment period extension. Table 3.1 summaries the sensitivity of the benefits described in Proposition 3.1 to key parameters.

In what follows, we numerically explore whether the effect of reverse factoring on the firm values is sizable. For the numerical analyses we take time to be measured in years but leave the monetary unit abstract.

Table 3.1: Effect of parameter increases on the benefits of reverse factoring

	l_{ext}	l_{rev}	b_s	b_o	r_f	y
Supplier	↑	↓	↑	↓	↓	↓
Corporation	↓	↑	–	–	↑	–
Total	↑	↓	↑	↓	–	↓

Notes: Effect of parameter increases on the benefits of reverse factoring. All key parameters are included: the length of the payment delay from the corporation to the SME with conventional financing (l_{ext}) or reverse factoring (l_{rev}); the deadweight financing costs for the SME (b_s) and the corporation (b_o); the risk free rate (r_f); and the working capital policy of the SME, reflected by its initial cash reserve (y). The effects for the individual benefits appear in the first two rows, and the combined effect in the third row.

All payment periods are expressed in yearly figures, and financing rates are expressed in fractions of a monetary unit per year. We consider a base case with the following parameters: $p_s = 12$, $c = 10$, $r_f = 0.02$, $b_s = 0.12$, $k = 0.01$, $b_o = 0.01$, $\mu = 100$, $l_{\text{ext}} = 0.3$, $l_{\text{rev}} = l_{\text{ext}} + 0.1$, $z = 1000$, and $y = 1000$. Taking the base case as a medium level, we consider additionally a high and a low level for each key parameter. These cases are used throughout the remainder of the monograph, unless otherwise mentioned. We assume that the demand arrival time is uniformly distributed over a period of one year, i.e., $T = 1$. The results for other plausible demand arrival distributions, such as truncated normal, are qualitatively the same.

Figure 3.2 shows that reverse factoring may have a sizable effect on the firm value. In particular, transaction value may increase by more than 10% for low profit margin SMEs (high c) with aggressive working capital polices (low y) that operate in business environments with long initial payment periods (high l_{ext}) and pay a high cost for external funds (high b_s). In such cases, the SME on average needs to borrow a larger sum of money for a longer period of time and pays a higher cost for these funds. In Northern European countries, payment periods are typically less than 90 days, so value generation from reverse factoring will be lower. In China and Southern European countries such as Spain and Italy, payment periods approach (and even exceed) six months (Hermes, 2012), so value generation will be much greater there, provided contracts are implemented properly. Thus it is no surprise

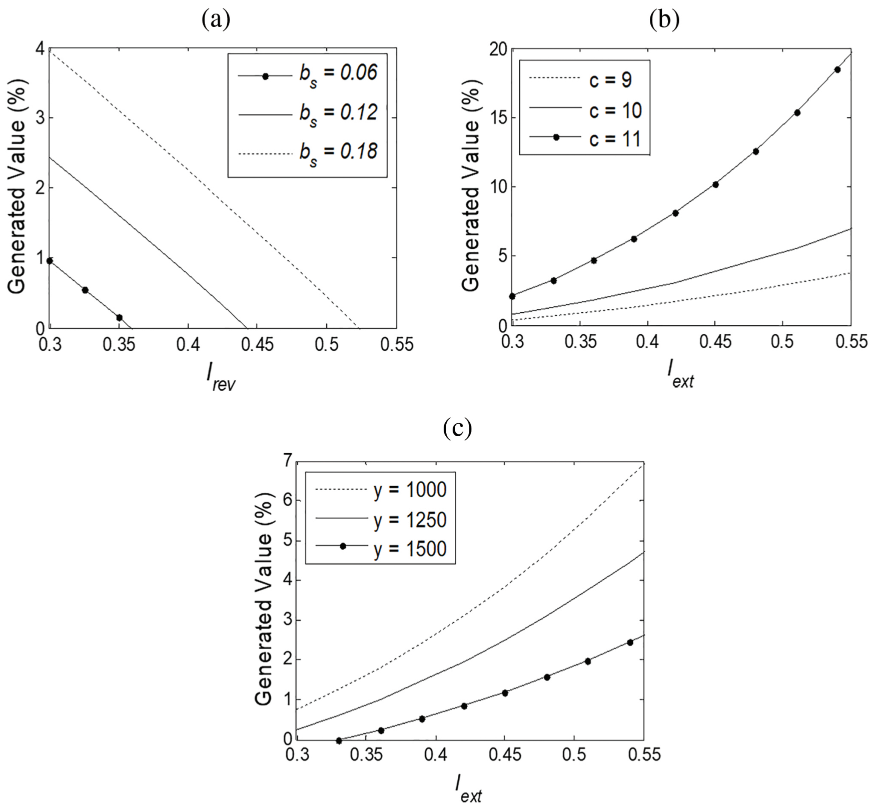

Figure 3.2: Percentage value generation for the SME.

Notes: Under conditions where it is optimal for the SME to use reverse factoring instead of conventional financing, each figure explores the increase in expected value of the transaction with the corporation. All experiments take reverse factoring to entail an increase of 0.1 years in the time the corporation is allowed to pay the SME, i.e., $l_{\text{rev}} = l_{\text{ext}} + 0.1$, where l_{rev} is the payment delay with reverse factoring and l_{ext} is the payment delay with conventional financing. In (a) the increase appears as a function of l_{rev} and b_s, the supplier's deadweight cost of borrowing. In (b) the increase appears as a function of l_{ext} and c, the SME's unit cost of procurement. In (c) the increase appears as a function of l_{ext} and y, the SME's initial cash reserve.

that Santander Group, a Spanish bank, is a leading provider of reverse factoring services. Nonetheless, it is also important to note that the extended payment period l_{rev} quickly reduces the total value generation, as we discussed above.

Next, Proposition 3.2 formalizes the participation constraint, i.e., the break-even condition of each party and the value creation condition for the firms.

Proposition 3.2. With fixed demand size, the following participation constraints apply to the reverse factoring contract $v = (r_{\text{rev}}, l_{\text{rev}})$.

(i) For the SME, $b_s A(T - l_{\text{ext}})L - (b_o + k)A(\tau - l_{\text{rev}})L \geq p_s \mu r_f (l_{\text{rev}} - l_{\text{ext}})$,

(ii) for the corporation, $l_{\text{rev}} \geq l_{\text{ext}}$,

(iii) for both firms in total, $b_s A(T - l_{\text{ext}}) \geq (b_o + k)A(T - l_{\text{rev}})$.

The corporation requires a non-negative payment period extension while the SME's participation constraint is non-trivial, due to the interaction of payment period and financing cost with the operating characteristics and working capital policy. While the bank fee k linearly transfers wealth from the SME to the bank, the payment period extension has a more complex effect on the benefits of the SME. The total effect of the payment period extension is a compound of two distinct sub-effects. First, as the payment period increases, the SME bears the extra cost of financing over a longer time period. Second, with longer payment periods, it is more likely that the SME will deplete its internal cash and need external funds. Together, these sub-effects entail that the specific participation constraint of the SME, when viewed as the maximum deadweight financing cost allowable in the reversed factoring contract $v = (r_{\text{rev}}, l_{\text{rev}})$, is not only a decreasing function of l_{rev}, the payment period under reverse factoring, but also typically strictly convex. This relationship between l_{rev} and r_{rev} is further moderated by the magnitude of the risk-free rate: as r_f increases, the participation constraint becomes more limiting and the SME demands a larger reduction in its cost of external funds. Likewise, the participation constraint is more restrictive when the SME follows a conservative working capital policy, since in this scenario it uses external funds less often, while paying the same opportunity cost for reverse factoring. Finally, it is important to note that when the risk-free rate is positive, the participation constraints of the supply chain and the SME diverge. In

(a) Aggressive working capital $y = 1000$ **(b)** Conservative working capital $y = 1250$

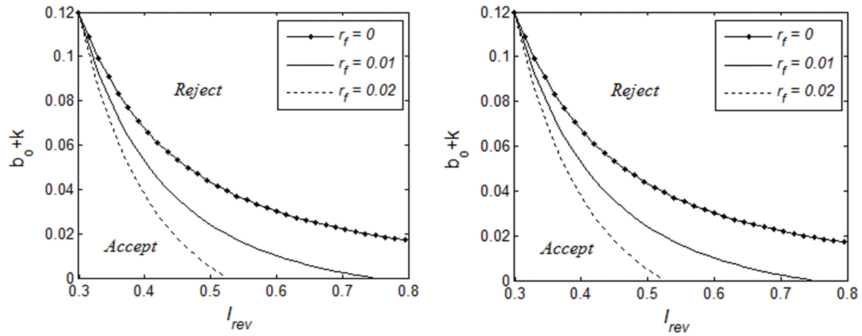

Figure 3.3: Participation constraint for the SME.

Notes: The curves in each subfigure trace the points where the SME is indifferent between using reverse factoring or conventional financing. All experiments again take reverse factoring to entail an increase of 0.1 years in the time that the corporation is allowed to pay invoices to the SME, i.e., $l_{\text{rev}} = l_{\text{rev}} + 0.1$, where l_{rev} is the payment delay with reverse factoring and l_{ext} is the payment delay when the SME uses conventional financing. Each subfigure considers the indifference points at different levels of r_f, the risk free rate. When using reverse factoring, the SME faces a financing rate of $r_{\text{rev}} = r_f + b_o + k$, where b_o is the deadweight financing rate of the corporation and k is the transaction cost rate charged by the financial institution. The results in (a) represent an SME with a more aggressive working capital policy (initial cash reserves y are lower). The results in (b) represent an SME with a more conservative working capital policy.

particular, 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. Figure 3.3 illustrates the preceding discussions of the participation constraint of the SME.

Next, in Proposition 3.3, we describe the optimal reverse factoring contracts for each party and the supply chain.

Proposition 3.3. With fixed demand size, reverse factoring contract $v = (r_{\text{rev}}, l_{\text{rev}})$ maximizes the benefit for each party according to the following respective conditions.

(i) The SME's expected benefit is maximized when

$(r_{\text{rev}} = r_f + b_o, l_{\text{rev}} = l_{\text{ext}})$ and $k = 0$.

The maximum benefit for the SME is $\widehat{\pi}^{\text{sme}} = (b_s - b_o)A(T - l_{\text{ext}})L$.

(ii) The corporation's expected benefit is maximized when

$(r_{\text{rev}} = r_f + b_o, l_{\text{rev}} = l^*_{\text{rev}})$ and $k = 0$.

The maximum benefit for the corporation is $\widehat{\pi}^{\text{oem}} = p\mu r_f(l^*_{\text{rev}} - l_{\text{ext}})$, where l^*_{rev} is the payment period that makes the SME's participation constraint tight, i.e., $b_s A(T - l_{\text{ext}})L - b_o A(T - l^*_{\text{rev}})L = p_s \mu r_f(l^*_{\text{rev}} - l_{\text{ext}})$.

(iii) Total benefit for both firms is maximized when

$(r_{\text{rev}} = r_f + b_o,\ l_{\text{rev}} = l_{\text{ext}})$ and $k = 0$.

The maximum total benefit is $\widehat{\pi}^{\text{total}} = (b_s - b_o)A(T - l_{\text{ext}})L$.

A reverse factoring contract maximizes the SME's benefits when the payment period remains the same and the SME is charged the external financing rate of the corporation (i.e., when there are no bank fees for reverse factoring). The corporation breaks even under this contract and the SME receives all benefits that result from mitigating capital market frictions. This solution also maximizes the total supply chain benefits, which in this case are equal to the total expected savings in deadweight cost of financing. Since the corporation only benefits from an increase in the payment period, the corporation's maximum benefit occurs when the bank fee equals zero and the payment period is increased to the point where the SME breaks even. Nonetheless, Corollary 3.1 below shows that the corporation can at best extract only a fraction of the total benefit.

Corollary 3.1. With fixed demand size, increasing the payment period allows the corporation to extract at most only a fraction of the total benefit, i.e.,

$$\frac{\widehat{\pi}^{\text{oem}}}{\widehat{\pi}^{\text{total}}} = \alpha = \frac{p_s \mu r_f(l^*_{\text{rev}} - l_{\text{ext}})}{(b_s - b_o)A(T - l_{\text{ext}})L} < 1,$$

where α is decreasing in b_s and z, increasing in b_o, r_f and y.

The corporation is unable to realize a maximum benefit equal to the maximum total benefit because of operational interactions that result when the payment period is extended. As discussed above, increasing

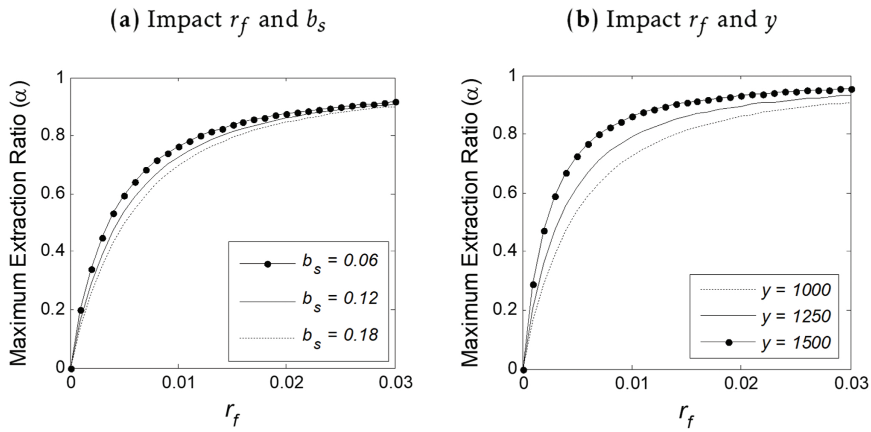

Figure 3.4: Corporation's maximum extraction ratios.

Notes: In (a) the maximum fraction that the corporation can realize is shown as a function of r_f, the risk free rate, and b_s, the deadweight financing cost of the SME. In (b) the maximum fraction that the corporation can realize is shown as a function of r_f, the risk free rate, and y, the initial cash reserves of the SME.

the payment period not only imposes a larger financing period but also increases the chance that the SME will run short of cash due to the arrival of business opportunities during the period. This operational impact entails a non-linear reduction in the SME's benefits, limiting the possibilities for payment period extension. Contracts that do include an extension are thus inefficient, wasting some potential benefit of reverse factoring. Figure 3.4 shows the corporation's maximum extraction ratio α as a function of the risk-free rate, and the SME's deadweight cost of financing and working capital policy.

Proposition 3.1 and Corollary 3.1 show that the maximum benefit fraction that the corporation can individually capture from the reverse factoring contract increases with the risk-free rate. Nevertheless, as the deadweight cost spread increases (holding b_o fixed), the maximum benefits of the corporation grow at a slower rate than the total benefits. The corporation cannot efficiently extract these additional benefits by increasing the payment period, due to the non-linear participation constraint of the SME. Hence α decreases with b_s in Figure 3.4(a). The same reasoning explains the effect of an aggressive working capital policy, seen in Figure 3.4(b).

4

Mathematical Model with Stochastic Demand Size

In this section, we extend our analysis by allowing demand size – as well as demand arrival time – to be stochastic. This shows the impact of demand variability on the results of the previous section. In the analytical derivations, demand size ξ has a general distribution with probability density function $f(.)$, cumulative density function $F(.)$, mean μ, and standard deviation σ. For the numerical studies we take ξ to have a truncated normal distribution. For notational brevity, we use the variables defined in the previous section to denote their analogs here.

Besides the moment when short term liabilities are due, the SME may now also need external financing upon demand realization, if internal cash is too little to procure all raw materials needed to meet the corporation's order. Nonetheless, we maintain the assumption that the discounted value of the SME's account receivable is always greater than any cash shortage that the SME experiences when the short term liabilities are due. This allows us to directly compare the reverse factoring and external financing options. (Allowing the firm to use external financing to cover any shortages in excess of the account receivable is possible but does not generate additional insights.) We find that the main results from the preceding analysis apply in the present case. Proposition 4.1 describes the benefit to each party.

Proposition 4.1. With stochastic demand size and timing, the reverse factoring contract $v = (r_{\text{rev}}, l_{\text{rev}})$ generates the following benefits for each party.

(i) For the SME, $\pi^{\text{sme}} = b_s H(l_{\text{ext}}) - (b_o + k)H(l_{\text{rev}}) - p_s \mu r_f (l_{\text{rev}} - l_{\text{ext}})$,

(ii) for the corporation, $\pi^{\text{oem}} = p_s \mu r_f (l_{\text{rev}} - l_{\text{ext}})$,

(iii) for both firms in total, $\pi^{\text{total}} = b_s H(l_{\text{ext}}) - (b_o + k)H(l_{\text{rev}})$,

where

$$\begin{aligned}
H(l) &= E_{\xi,\tau}[(z + c\xi - y)\Delta l I_{\Omega_1(l)} + ((c\xi - y)l + z\Delta l)I_{\Omega_2(l)} \\
&\quad + (c\xi - y)l I_{\Omega_3(l)}], \\
\Delta l &= \tau + l - T, \\
\Omega_1(l) &= \{\xi, \tau \colon \xi \le y(1 + r_f \tau)/c, \xi \ge (y(1 + r_f T) - z)/ \\
&\qquad (c(1 + r_f(T - \tau))), \tau \ge T - l\}, \\
\Omega_2(l) &= \{\xi, \tau \colon \xi \ge y(1 + r_f \tau)/c, \tau \ge T - l\}, \\
\Omega_3(l) &= \{\xi, \tau \colon \xi \ge y(1 + r_f \tau)/c, \tau \le T - l\}, \text{ for } l = l_{\text{ext}} \text{ and } l_{\text{rev}}.
\end{aligned}$$

Proposition 4.1 is analogous to Proposition 3.1, but the expected financing requirement has a different form, given by $H(.)$, which represents both the borrowing amount and the duration of borrowing. In this case, borrowing amount and duration are not separable. In particular, with stochastic demand size, there are three possible cases where financing occurs. These cases correspond to the sets $\Omega_i(l)$, $1 \le i \le 3$, that partition the space of outcomes for demand size and timing.

The set relations are illustrated in Figure 4.1. If $(\xi, \tau) \in \Omega_1(l)$ then the initial cash reserves are sufficient to procure all needed raw materials but the cash position at end of the period is not enough to pay for the fixed cost. Hence the SME only borrows to finance the fixed cost at the end of the period. If $(\xi, \tau) \in \Omega_2(l)$ then, in addition to financing the fixed expenses at the end of the period, the SME needs to borrow to finance the purchase of raw materials. This represents the case that

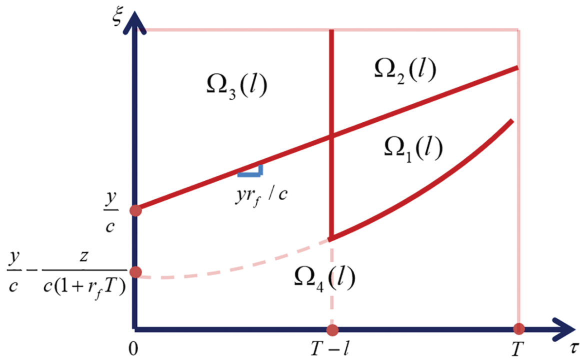

Figure 4.1: Financing needs for the SME.

Notes: This figure illustrates partitions in the space of outcomes for demand size (ξ) and timing (τ) that correspond to different financing needs for the SME. Sets $\Omega_i(l)$, $1 \leq i \leq 3$, are cases where external financing is needed, either via conventional borrowing or via reverse factoring. Set $\Omega_4(l)$ is the complementary case.

the firm receives a very large demand close to the payment of the fixed expenses. In the third case, when $(\xi, \tau) \in \Omega_3(l)$ the firm again receives a large demand, but revenue from this demand is collected before the fixed costs are due. Hence in this case the firm only borrows to finance the purchase of raw material. Note that since the production and sales are instantaneous, the resulting account receivable can be used to finance the purchase of raw materials (in practice this can be accomplished through a bridge loan which is repaid once the account receivable is created). The complementary region $\Omega_4(l)$ represents the case that the SME conducts operations without a shortage of internal funds.

The other results from Section 3 hold here with slight modifications, but analytical tractability is limited. Propositions 3.2 and 3.3 and Corollary 3.1 still hold with financing needs $A(.)L$ replaced by $H(.)$, defined in Proposition 4.1; and l^*_{rev} is defined as the positive value which makes the SME's participation constraint tight, i.e., $b_s H(l_{\text{ext}}) - (b_o)H(l^*_{\text{rev}}) = r_f p_s \mu(l^*_{\text{rev}} - l_{\text{ext}})$ when $k = 0$. Next we provide a set of numerical analyses to illustrate the effect of demand size volatility. For these analyses, we use the base case from Section 3 and examine three cases for volatility of demand size: $\sigma \in \{0, 10, 20\}$.

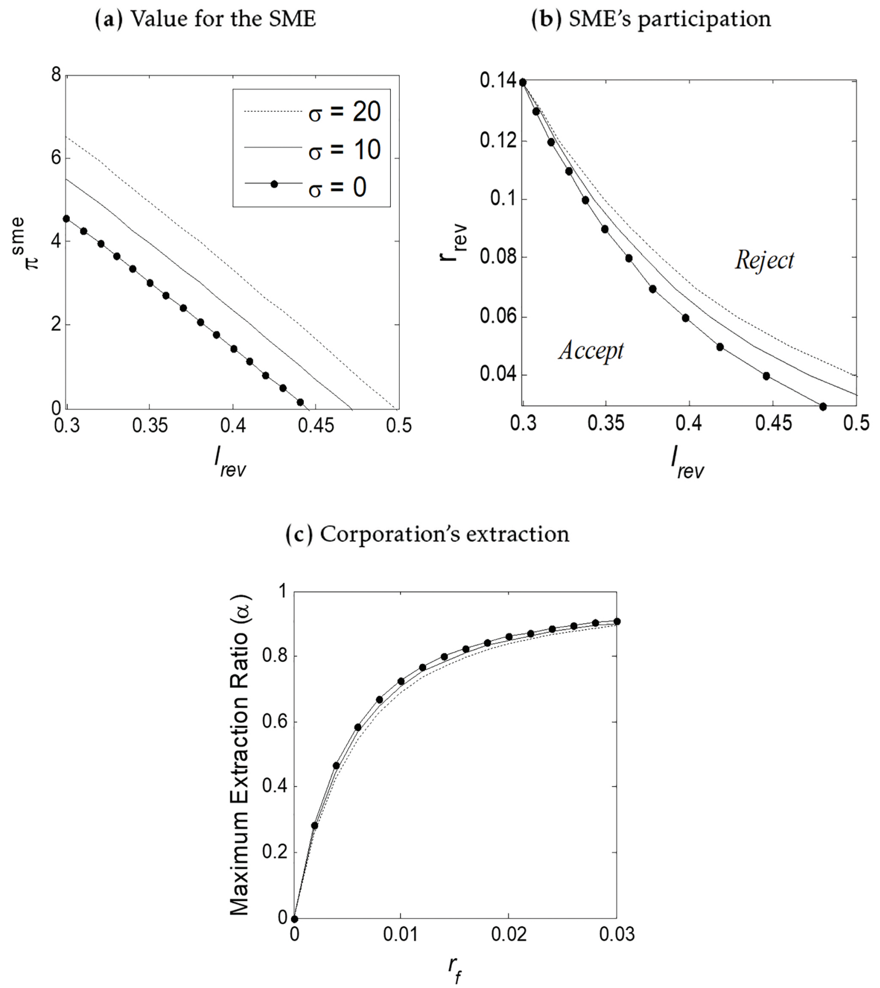

Figure 4.2: Effect of demand size volatility.

Notes: (a) shows the impact of demand volatility on the value of reverse factoring for the SME. The payment period l_{rev} required by reverse factoring is also varied. (b) shows how demand volatility affects the decision of the SME to use reverse factoring. Again the payment period l_{rev} required by reverse factoring is varied, along with the financing rate r_{rev} that the SME can access in reverse factoring. (c) shows how demand volatility affects the maximum extraction level of the corporation, at different levels of r_f.

Volatility in demand size increases the need for external funds, so the benefit of reverse factoring for the SME increases with the variance of demand size, as illustrated by Figure 4.2(a). Figure 4.2(b) shows that this leads to an expansion of the SME's participation region. Higher demand variance also increases the corporation's maximum benefits, since the payment period can be extended further while retaining the SME's participation. Nonetheless, this exacerbates the inefficiencies resulting from payment period extension. Although the corporation's maximum benefits increase with variance, Figure 4.2(c) shows that the maximum extraction ratio of the corporation decreases, since the total benefits increase faster.

5

Conclusions

The recent credit crisis emphasized the need for and the value of close financial and operational collaboration between the corporations and their SME business partners. In this monograph, we explore a particular form of intra-chain collaboration, reverse factoring, which many businesses see not only as an important element in their strategy for recovery from the recent credit crisis, but also as a means for generating more value during usual economic conditions. Reverse factoring entails that firms collaborate on financing arrangements, in order to improve the efficiency of their transactions, reduce costs, and obviate operational roadblocks.

This research reveals the value creation mechanism of reverse factoring and explains how this value is conditioned by key market factors. Our analysis of reverse factoring contracts links their potential for value creation to (1) the spread of external financing costs between the corporation and the SME, (2) the payment period extension, (3) the operational characteristics of the SME (in particular, demand volatility and the implied working capital policy), and (4) the risk-free interest rate. The interrelation of these factors constitutes a key insight for the firms when negotiating the terms of a reverse factoring contract.

Firms should assess their deadweight external financing cost, working capital policy, and the risk-free interest rate to value reverse factoring agreements. Reverse factoring is most beneficial when the spread in deadweight financing costs is high, nominal payment periods are long, the demand volatility is high, and the SME employs an aggressive working capital policy. The risk-free interest rate does not impact the total value generation, but it significantly influences the individual benefits of the corporation and the SME. A low risk-free interest rate may even create a disincentive to the establishment of reverse factoring contracts, since the benefits to the corporation may be less than the present value of the practical implementation costs of reverse factoring (e.g., legal contracting, training programs, information technology, etc.).

Corporations should be cautious about the effects of payment period extension on an SME's operations and the potential for value creation. A small increase in payment delay may entail a relatively large decrease in SME's benefit from reverse factoring. Payment period extension thus ultimately proves to be an inefficient strategy, since it interacts with the operations of the SME and reduces the total benefits available to the firms. While SME managers must clearly be careful not to agree to a value-destroying contract, corporate managers should also be cautious not to hurt their SME partners through a poorly-arranged reverse factoring contract. Contracts with long payment period extensions may benefit the corporation in the short term, but may in the long term adversely affect the financing of the SME and endanger the supply lines of the corporation.

We consider a single period stylized model of trade between a supplier and a corporate customer. Our analysis can be extended to a multi-period setup with parties continuously engaging in trade over time. Numerically, we have observed that a multi-period model qualitatively results in similar managerial insights while the analytical tractability is significantly limited. Our analysis suggests several other related directions for exploration. For instance, a game-theoretic extension could examine the negotiation process between the involved parties and reveal the equilibrium reverse factoring contract. It would be also interesting to explore reverse factoring in an international setting in the presence of exchange and interest rate risks.

Our analysis should enable firms to design more efficient reverse factoring contracts and further optimize their operational and financial benefits. The results provide managers with guidance that could facilitate access to working capital and increase the financial efficiency of their business. This leads to cost savings, which in return yield further profits for the participants and help ensure the survival of the business relations.

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