



Article

Supply Chain Finance: Designing Supplier Monitoring Incentives for Bank-Financed Retailer Inventory

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Abstract

Bank-funded supply chain finance can support retailers' inventory purchases, but compensating core suppliers for hidden monitoring effort can reduce lending profits. This study examines how banks should design monitoring incentives for core suppliers that sell inventory to cash-constrained retailers. The contribution of the three-party principal-agent model is to link supplier trading earnings, the retailer's order and borrowing response, and the bank's default recovery. Least-cost supplier contracts are derived under participation, incentive and payment-floor constraints, and illustrative financing offers are compared on nested grids. The illustrative results show that baseline financing supports larger retailer orders and higher retailer profits than self-financing, while low monitoring effort is preferred because the additional recovery from high effort is outweighed by its incentive cost. Lower effort costs and more informative signals can make high effort preferable without increasing retailer orders. A common minimum supplier payment reduces bank profitability and, when sufficiently high in the tested scenarios, leads to no financing. These illustrative grid findings support assessing monitoring's recovery gains against incentive costs and retailer responses; they do not establish a continuous-offer equilibrium.

Keywords: supply chain finance; inventory financing; supplier monitoring; credit risk; incentive contract; principal-agent theory; cash-constrained retailers

1. Introduction

Small and medium-sized enterprises (SMEs) often have limited collateral and credit histories and are informationally opaque to external lenders (Berger & Udell, 2006; Onkundi et al., 2023), which can raise borrowing costs and restrict credit access. Financially constrained SMEs may be unable to order or produce optimally, increasing supply chain vulnerability and reducing supply chain performance (Qiao & Zhao, 2023; Randall & Farris, 2009). Supply chain finance (SCF) uses collaborative financing arrangements to improve participants' working capital (Pfohl & Gomm, 2009; Wuttke et al., 2013b). Here, a bank finances SME retailers' purchases from a core supplier that provides transaction information and monitors their activities. This creates an incentive problem because the bank relies on monitoring effort it cannot directly observe.

Financial constraints also shape choices about vertical integration, understood as bringing successive stages of production or distribution under common ownership. Although integration can mitigate contracting problems, financing the associated asset investment



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may itself be difficult for a capital-constrained SME (Acemoglu et al., 2009). This creates a reason to consider staged or partial integration alongside contractual alternatives. Long-term supply agreements can help safeguard relationship-specific investments without common ownership (Joskow, 1987), while leasing can provide access to productive assets without an outright purchase (Berger & Udell, 2006). These arrangements address different needs from the transaction-based working-capital finance examined here: funding retailers' purchases does not necessarily fund the assets needed for integration or eliminate lenders' informational concerns. SCF may therefore need to be complemented by asset financing and durable supply agreements when firms seek to expand.

Banks are key SCF solution providers (Wuttke et al., 2016; Wuttke et al., 2013b; Yan et al., 2016). Their collaboration with core suppliers can align financial, physical and information flows (Gelsomino et al., 2016; Silvestro & Lustrato, 2014). In the cases motivating this study (Appendix A), the bank relied on core suppliers' transaction information to assess retailers and manage credit risk. Obtaining this information depends on the core suppliers' willingness to verify transactions, share data and monitor retailers. The contracting problem is therefore how to reward observable information sharing so that a core supplier undertakes costly monitoring when the bank cannot directly observe its effort.

This study is motivated by four SCF projects in which a Chinese bank collaborated with core suppliers to finance SME retailers (Appendix A). The core suppliers helped retailers obtain bank loans rather than extending trade credit themselves. They supplied trading and transaction information for the bank's credit assessments and lending decisions. These cases identify a practical contracting problem: how can the bank encourage costly monitoring and information sharing when it cannot directly observe the core supplier's effort?

In these projects, the bank verified retailers' orders with the core suppliers and disbursed loan funds directly to the core suppliers. The core suppliers were responsible for monitoring retailers' operations and payments and coordinating physical flows. Bank managers reported that the core suppliers were reluctant to commit resources because these tasks were costly and could complicate operations, while the bank found the effort difficult to observe. To support these activities, the bank offered simplified SCF decision procedures, marketing support and investment in information systems.

The central issue is whether incentives can make monitoring worthwhile for the core supplier while preserving the bank's economic rationale for financing retailers. A contract must provide sufficient value for the core supplier to participate and make costly monitoring preferable to low effort. The bank, in turn, must assess the cost of these incentives against the expected return from the financed transactions. A further difficulty arises when the core supplier requires a minimum level of support regardless of the information-sharing outcome. These requirements raise a specific question: under what conditions can the bank induce monitoring when effort is unobservable, information sharing is an imperfect signal of that effort, and the core supplier can decline participation?

The remainder of the paper is organised as follows. Section 2 reviews the relevant literature and states the research purpose. Section 3 sets out the three-party model and numerical methodology. Section 4 reports the illustrative financing outcomes and sensitivity analyses. Section 5 discusses the findings in relation to previous research and outlines the study's limitations. Section 6 concludes with the main findings, managerial implications and directions for future research.

2. Literature Review

The literature relevant to this study concerns how financing constraints, information asymmetry, and contractual incentives affect coordination among banks, core suppliers, and SMEs. The review is organised around three questions: how financing arrangements interact with supply chain operations; how information sharing and interfirm relationships support SCF implementation; and how contracts allocate monitoring responsibilities and incentives. Together, these perspectives provide a basis for assessing how existing research addresses the bank's reliance on a core supplier's costly, unobservable effort and for specifying the research purpose.

Research on the operations–finance interface examines how financing conditions shape production, inventory, and investment decisions. Buzacott and Zhang (2004) link available financing to firms' assets and liabilities and show how bank financing affects production and inventory decisions. Protopappa-Sieke and Seifert (2010) show that working-capital restrictions and upstream and downstream payment delays affect order quantities and create trade-offs between operational and financial performance. These studies establish that financing and the transactions it supports are interdependent. Zhao and Huchzermeier (2015) develop an integrated risk-management framework that identifies conditions under which operational and financial decisions should be coordinated. Marchi et al. (2016) examine joint financing of uncertain production-capacity investment in a supplier–buyer relationship, showing that sharing investment and outcome uncertainty can benefit both parties. Taken together, these contributions explain how financing arrangements influence operating decisions and the gains from coordination. The present study builds on this operational perspective by examining the bank's compensation of a core supplier for unobservable monitoring effort, using information sharing as the observable contracting signal.

Payment timing and trade-credit terms connect working-capital constraints with operational decisions. Gupta and Dutta (2011) model the scheduling of supplier payments subject to downstream cash receipts and penalties for late payment, identifying the computational difficulty of coordinating these flows. Kouvelis and Zhao (2012) analyse supplier trade credit and bank financing when both supply chain parties face capital constraints and bankruptcy risk; under their stated assumptions, an optimally structured trade-credit contract induces the retailer to prefer supplier financing and improves supply chain efficiency. Yang and Birge (2018) show how trade credit shares demand risk between the retailer and supplier: their model predicts trade credit alone for financially stronger retailers and a combination of trade credit and bank loans when retailer cash is low. These studies link payment terms, financing channels and demand-risk allocation. In the present model, the wholesale price is fixed, the supplier receives payment before retail sales, and retailer inventory is funded by bank borrowing and the retailer's own working capital. The bank separately compensates the supplier for monitoring. The contract analysis therefore concerns monitoring incentives within this financing arrangement; payment scheduling and the choice of trade-credit portfolios remain outside the model.

Case-based research highlights the importance of information sharing and interfirm coordination for SCF implementation and adoption. For example, Randall and Farris (2009) show that supply chain financial management techniques (i.e., cash-to-cash and shared weighted average cost of capital) can reduce the financial costs experienced by a supply chain. Blackman et al. (2013) analyse Motorola's financial supply chain management strategy. They find that Motorola collaborates with its supply chain partners to align physical product, information systems, and financial flows, and that sharing financial data with suppliers can generate cost savings for Motorola and its suppliers. Wuttke et al. (2013b) distinguish pre-shipment SCF, which can improve upstream working capital, from post-shipment SCF, which can strengthen the buying firm's working

capital position; their findings also link more effective risk reduction to internal and external integration. Wuttke et al. (2013a) further show that SCF adoption by buying firms is interrelated with adoption by their suppliers. More recently, Yin et al. (2025) examine purchase order finance involving three banks and a Chinese core manufacturer, identifying aligned objectives, information and resource sharing, and coordinated decisions as features of their collaboration. Together, these studies establish the importance of coordination in SCF practice. Building on this evidence, the present study examines how a bank can motivate the core supplier's costly monitoring effort when that effort cannot be directly observed.

Digital information capabilities provide a further link between supply chain operations and financing. Using survey data from 307 Chinese manufacturing firms, Yu et al. (2021) find that big data analytics capability is positively associated with internal SCF integration, which mediates its relationship with integration with customers and suppliers. Their results also identify a moderating role for a data-driven culture, indicating that organisational conditions matter alongside technological capability. J. Li et al. (2022) organise research on financial technology at the operations–finance interface and link firms' operational capabilities to investors' financing considerations. More recently, Ronchini et al. (2024), drawing on ten case studies of SCF providers, identify applications of artificial intelligence in credit assessment, fraud detection, and supplier onboarding, together with implementation challenges. Taken together, this literature suggests that technology-supported information processing and organisational arrangements jointly shape SCF implementation. For the present study, these findings motivate attention to how information is generated and shared. The model takes the information environment as given and examines the core supplier's incentives to exert monitoring effort within it, treating observable information sharing as an imperfect signal of that effort.

Blockchain-based SCF research examines the design of systems for sharing transaction and credit information. Wu et al. (2023) analyse trade-offs among security, operating costs, and efficiency in a financial-institution-dominated SCF system. Zheng et al. (2022) propose a blockchain-based credit-information-sharing model that incorporates access control, privacy protection, and traceability. These studies concern how information is processed and shared. For incentive-contract design, a separate question is whether the observed information reveals the core supplier's costly monitoring effort. A technical system that records or transmits transactions does not, by itself, establish that this effort is observable or contractible. The present model therefore treats information sharing as an imperfect signal and focuses on compensation for hidden effort, while leaving the choice and design of the information technology outside its scope.

Empirical research connects information and governance conditions with financing outcomes. Using matched loan applications and contracts, Kirschenmann (2016) finds greater loan-size rationing for opaque small firms at the start of bank relationships, with rationing declining over successive loans. Hu (2025) reports shorter cash conversion cycles among Chinese listed SMEs following implementation of the Regulations on Ensuring Payment to SMEs, linking payment policy with liquidity. S. Li and Xu (2025), using Chinese listed-company data, find that SCF participation is associated with greater earnings management, particularly among private firms, while information transparency and stronger internal controls help constrain manipulation. Zhang and Liu (2026) report lower credit risk associated with blockchain-enabled SCF among Chinese listed e-commerce SMEs and identify information transparency and contract enforcement as channels. These findings indicate that financing outcomes depend on information quality, institutional arrangements and governance, rather than access to funds alone. The present model isolates one contractual mechanism within this broader context: supplier monitoring improves the

bank's recovery after retailer default at given financing terms, and the bank compares that recovery gain with the cost of inducing effort. The empirical studies provide context for this mechanism; testing the contract model's predictions remains a separate task.

The financing instrument determines which participant's credit risk and working-capital needs an SCF arrangement addresses. Gelsomino et al. (2016) distinguish financial-institution solutions centred on payables and receivables from a broader supply chain perspective that also includes inventory and working-capital optimisation. Klapper (2006) explains that factoring provides finance through the sale of suppliers' receivables and that reverse factoring can alleviate supplier informational opacity when eligible receivables are owed by high-quality buyers. The inventory-financing arrangement examined here addresses a different transaction stage: an SME retailer borrows to purchase goods, while the core supplier receives the wholesale payment before retail demand is realised. The bank consequently relies on the supplier's transaction knowledge and monitoring to recover proceeds if the retailer defaults. This distinction locates the model's contribution in monitoring incentives for retailer inventory finance; reverse factoring and the core supplier's own default risk remain outside its scope.

Research on financing providers examines how funding arrangements, operational control, and risk allocation affect supply chain performance. Pfohl and Gomm (2009) develop a conceptual framework and mathematical model for optimising financing costs across supply chain participants. Lee and Rhee (2011) show that combining trade credit with a markdown allowance can coordinate a retailer's inventory decisions when financing is costly. Chen and Cai (2011) compare bank financing with integrated logistics and financing by a third-party logistics (3PL) firm, showing how combining these services can improve supply chain profits. Silvestro and Lustrato (2014) examine two international banks and identify their contributions to coordination, collaboration, information sharing, and visibility between buyers and suppliers. Yan et al. (2016) explicitly model a bank as the leader in a financing game involving a manufacturer and a capital-constrained retailer. Their partial credit guarantee contract combines bank lending with a manufacturer's guarantee and can coordinate the supply chain under a suitable guarantee coefficient. These studies recognise active roles for financing providers and explain how financing terms and operational relationships affect coordination. The present study focuses on a specific contractual responsibility within this setting: the bank compensates a core supplier for costly, unobservable monitoring of financed retailers. This focus requires participation and effort incentives to be examined alongside the bank's expected return from financing.

Monitoring costs and the allocation of repayment obligations also influence financing arrangements. Bi and Yang (2022) compare bank lending and trade credit when banks and suppliers incur fixed and variable monitoring costs, showing that financing choices depend on retailer wealth and the monitoring costs of the two providers. Bi et al. (2022) examine debt-shared bank financing, in which a supplier assumes part of a retailer's loan repayment obligation, and show how retailer wealth shapes financing and inventory outcomes. Zha et al. (2024) compare retailer-sponsored bank financing with advance payments for capital-constrained suppliers and identify opposing supplier and retailer preferences for these arrangements. These studies provide benchmarks for examining who supplies funds, who bears repayment obligations and who incurs monitoring costs. The present study focuses on the bank's information-contingent compensation of a core supplier for hidden monitoring effort, accounting for the supplier's trading margin and the retailer's financing response. Its contract analysis therefore complements financing-mode and debt-sharing comparisons by examining the payments required to make delegated monitoring incentive compatible.

Recent research shows how financing terms and contractual information can shape credit-risk management. Wang and Cai (2024) examine bank loan limits and loan insurance, identifying conditions under which supplier pricing and insurance purchase can benefit both supply chain parties. Sun et al. (2024) analyse default-risk controls in a supplier–retailer relationship and show that a portfolio of trade credit and equity vendor financing can support channel coordination while meeting the firms’ risk-management objectives. In the broader bank-lending literature, Elkamhi et al. (2023) show that signal quality affects the use and strictness of financial maintenance covenants; the relationship between signal quality and covenant strictness need not be monotonic. Together, these studies identify financing portfolios, insurance, and information-contingent restrictions as distinct mechanisms for managing risk, with implications that depend on the contract and information structure. The present study examines a complementary contractual choice: how a bank compensates a core supplier for monitoring the transactions underlying retailer finance, subject to the supplier’s participation and effort incentives.

Recent studies distinguish several information mechanisms in financing decisions. Huang et al. (2024) compare bank and online-platform financing for a supplier serving a capital-sufficient buyer, accounting for differences in supplier assessment and the providers’ probabilities of quitting. When neither provider quits, the buyer earns more under bank financing while the supplier earns more under platform financing. Zhao (2025) shows that demand-information acquisition costs and disclosure rules affect a capital-constrained retailer’s financing choice; the retailer is more willing to acquire accurate information under external financing than under trade credit. X. Li et al. (2025) model bank–equity investor co-operation and show how sharing retailer risk information can improve financing decisions when banks and retailers have different risk attitudes. These studies examine financier assessments, retailer demand knowledge and information exchange between financiers. In the present model, the demand distribution and contract primitives are public, while the supplier’s monitoring effort is hidden and influences a verifiable information signal. The analysis determines the compensation needed to induce that effort and compares its cost with the bank’s expected recovery gain, connecting information production incentives to the financing decision.

Contract theory provides a basis for analysing the bank’s delegation of costly, unobservable monitoring to the core supplier. Holmström (1979) establishes conditions under which imperfect information about an agent’s action can improve a contract based on the realised payoff alone. Grossman and Hart (1983) develop a framework for determining the cost of inducing an action and using that cost to evaluate the principal’s choice of action. Participation and incentive compatibility impose distinct requirements: the agent must obtain sufficient expected utility to accept the contract and must prefer the intended action to available alternatives (Laffont & Martimort, 2002). In the SCF setting studied here, the bank finances an SME retailer and relies on the supplier to monitor the underlying supply chain transactions. Information shared about ordering, delivery, and payment provides an observable basis for compensation, while the supplier’s monitoring effort remains hidden. The contract must therefore balance the cost of inducing monitoring against the bank’s expected financing return. This application builds on established moral-hazard theory and locates the incentive problem in the allocation of monitoring responsibilities within a bank–supplier–retailer financing arrangement.

The reviewed literature links SCF performance to the coordination of operational and financial decisions, the organisation of financing relationships, and the quality of shared information. It also shows that risk-management benefits depend on the design of financing and contractual arrangements. These findings motivate analysis of how banks use the supplier’s access to supply chain transactions when the effort required to

monitor those transactions is costly and unobservable. The purpose of this study is to characterise bank–supplier incentive contracts for monitoring transactions underlying loans to financially constrained retailers, and to examine how participation requirements, effort costs, information signals, and a minimum compensation requirement shape the payments needed to induce high effort.

Analytical proposition 1 (information signals): at a fixed financed order and lending rate, consider a feasible least-cost contract that induces high monitoring effort, with binding supplier participation and incentive constraints and a nonbinding minimum payment requirement. Holding the remaining parameters fixed, a higher probability of high information sharing under high effort reduces the high-information payment and increases the low-information payment. A higher probability of high information sharing under low effort has the opposite effects. These comparisons apply while the same constraints remain binding and the contract remains feasible.

Analytical proposition 2 (effort costs): under the conditions of Analytical proposition 1, and holding the remaining parameters fixed, an increase in the cost of high monitoring effort raises the high-information payment and lowers the low-information payment. An increase in the cost of low monitoring effort lowers the high-information payment and raises the low-information payment. These comparisons apply at a fixed financed order and lending rate, while participation and incentive compatibility remain binding, the minimum payment requirement remains nonbinding, and the contract remains feasible.

Analytical proposition 3 (participation and minimum payments): at a fixed financed order and lending rate, holding the remaining parameters fixed, a higher reservation utility raises both payments when supplier participation and incentive compatibility bind and the minimum payment requirement is nonbinding. A common minimum payment in both information states leaves the zero-floor contract unchanged if it does not exceed that contract's low-information payment. Above this threshold, both payments increase: the low-information payment equals the minimum, and the high-information payment adjusts to maintain incentive compatibility. In this latter regime, incentive compatibility and the low-information payment floor bind, while participation is slack and the supplier receives expected net utility above its reservation level. These conclusions apply to feasible contracts that induce high monitoring effort.

3. Methods

This study combines case evidence with analytical modelling. Four SCF projects involving a Chinese bank, core suppliers, and SME retailers provide the institutional context. We use the case evidence to identify the financing relationships, transaction-monitoring responsibilities, and information-sharing arrangements that motivate the model. We adapt the hidden-action contracting frameworks of [Holmström \(1979\)](#) and [Grossman and Hart \(1983\)](#) by including supplier trading earnings, the retailer's order and borrowing response, and information-dependent recovery of transaction proceeds. At a fixed order and lending rate, we minimise supplier monitoring payments subject to participation, incentive compatibility and the applicable payment floor. Theorem 1 derives the contract under non-negative payments; Theorem 2 introduces a common positive floor. Their proofs and comparative statics establish the three analytical propositions under the stated feasibility and binding-constraint conditions. We then incorporate the least-cost contracts for both effort levels into the bank's financing decision, allowing the retailer to choose its order or self-finance. Section 3.2 specifies the numerical procedure, and Section 4 reports illustrative financing outcomes. The propositions are assessed through mathematical derivation rather than statistical hypothesis tests. The case evidence motivates the model's

assumptions; the numerical parameter values are illustrative rather than estimates obtained from the case data.

The four projects involve home-appliance and beverage manufacturers and their SME retailers. Interviews were conducted with senior managers from the bank and core suppliers, and each interview lasted approximately one hour. Bank managers were asked about customer selection, credit approval, interest-rate and credit-limit decisions, loan collection, and credit-risk control. Core-supplier managers discussed retailers' financing needs, information sharing with the bank, and supply chain management practices. The evidence also included observations from site visits and internal documents and presentations from the bank and core suppliers. The appendix reports the project profiles and interview topics.

3.1. Model Setting

The financing arrangement involves a bank, a core supplier (hereafter, the supplier), and a financially constrained SME retailer. The bank offers an interest rate, a credit limit, and an order-contingent monitoring contract. The retailer chooses its order quantity and whether to borrow. For an accepted transaction, the retailer contributes its working capital and the bank pays the loan directly to the supplier. The supplier fulfils the order, earns the wholesale margin, and chooses its monitoring effort. Sales proceeds are realised after delivery, and the retailer repays subject to limited liability. We assume that verifiable transaction information improves the bank's recovery of transaction assets in default. The model jointly determines the retailer's order, the supplier's monitoring effort, and the bank's lending and incentive decisions.

Let q denote the retailer's order quantity, w the wholesale price, k the supplier's unit production cost, and B the retailer's non-negative available working capital. Let P denote the retail selling price and X non-negative random demand. We assume that the selling price exceeds the wholesale price, which exceeds the non-negative production cost. Unsold goods have a non-negative unit salvage value below the wholesale price. Prices, production cost, working capital, and the demand distribution are common knowledge. For tractability, demand is independent of the supplier's information-sharing outcome. This assumption isolates the effect of monitoring on the recovery of transaction assets in default.

For a financed order with $wq > B$, the retailer contributes its available working capital B and borrows $L = wq - B$. The bank transfers L directly to the supplier, which receives the purchase price wq from the combined payments. Let $i \geq 0$ denote the loan interest rate and $\downarrow > 0$ the credit limit offered by the bank. An admissible financed order satisfies $0 < L \leq \downarrow$. The promised repayment at the end of the selling period is $D = (1 + i)L$; actual repayment depends on realised transaction proceeds and the default recovery rules specified below.

Let v_s denote the unit salvage value of unsold goods, with $0 \leq v_s < w$. The cash generated by an order q after demand X is realised is $V(q, X) = P\min\{q, X\} + v_s(q - X)^+$, where $z^+ = \max\{z, 0\}$. The first term is sales revenue and the second is the salvage value of unsold inventory. These proceeds are measured before loan repayment and represent the transaction assets available for debt service and, in default, recovery.

We assume that the retailer is risk-neutral and that the bank's recovery is limited to the assets of the financed transaction. For an admissible financed order, the retailer's expected profit is $\Pi_R(q; i) = E_X[(V(q, X) - D)^+] - B$, where the expectation is taken over demand and $D = (1 + i)(wq - B)$. The positive-part term represents the retailer's residual cash after repayment, while B is its initial working-capital contribution. If transaction proceeds fall short of the promised repayment, the retailer receives no residual cash but loses the funds it invested.

Without bank financing, the retailer can choose an order q_0 satisfying $0 \leq q_0 \leq \frac{B}{w}$ and retain any unspent working capital. Its maximum expected profit under self-financing is

$\Pi_R^0 = \max_{0 \leq q_0 \leq \frac{B}{w}} \{E_X[V(q_0, X)] - wq_0\}$. This profit is measured relative to its initial working capital, so only the amount spent on inventory is deducted. Because ordering nothing is feasible, the outside-option profit is non-negative. A financed order is acceptable to the retailer only if $\Pi_R(q; i) \geq \Pi_R^0$; otherwise, it prefers self-financing.

Given a bank offer $(i, \downarrow)$, the retailer chooses a financed order from $\frac{B}{w} < q \leq \frac{B+\downarrow}{w}$ to maximise its expected profit. Whenever the maximum is attained, its optimal financed order satisfies $q^*(i, \downarrow) \in \arg \max_{\frac{B}{w} < q \leq \frac{B+\downarrow}{w}} \Pi_R(q; i)$. This response is implemented only if

$\Pi_R(q^*(i, \downarrow); i) \geq \Pi_R^0$. To make the response unambiguous, we select the largest profit-maximising financed order when several exist and assume that the retailer accepts financing when indifferent between financing and self-financing. If the financed maximum is not attained or the participation condition fails, the retailer takes its self-financing option. These tie-breaking rules are imposed for a determinate model response.

Let ρ_L and ρ_H denote the fractions of transaction proceeds that the bank can recover in default under the low and high verifiable information states, respectively, with $0 \leq \rho_L \leq \rho_H \leq 1$. Conditional on state $j \in \{L, H\}$, the bank's realised receipt is $R_j(q, X; i) = D$ if $V(q, X) \geq D$, and $R_j(q, X; i) = \rho_j V(q, X)$ if $V(q, X) < D$. Thus, the promised repayment is received in solvent states, while default recovery depends on the transaction's available proceeds and information state. The unrecovered share in default represents tracing, enforcement or liquidation losses and is not paid to the retailer. The recovery fractions are modelling assumptions rather than estimates from the interviews.

The supplier receives the wholesale payment before retail demand is realised. Its operating margin on a financed order is $M(q) = (w - k)q$, which is determined by the retailer's chosen quantity and is separate from the bank's monitoring incentive. Under the assumed payment arrangement, this margin is not exposed to the retailer's subsequent repayment outcome. Once the order is fixed, the margin is the same under either monitoring effort level. It therefore does not by itself provide an incentive to exert high effort; that incentive must come from the bank's state-contingent monitoring payment.

The supplier chooses an unobservable monitoring effort level e to oversee the financed transactions and monitor the retailer. Effort takes two values: low effort e_L and high effort e_H . We assume that high monitoring effort is more costly than low effort and increases the probability of high information sharing with the bank. We assume that the observable and verifiable information-sharing outcome u takes two values: u_L (i.e., a low degree of information sharing) and u_H (i.e., a high degree of information sharing), with $u_H - u_L \equiv \Delta u > 0$. The bank uses this transaction information to assess and monitor the retailer's financing; its expected return from the financed transaction, before paying the supplier's incentive, is $s(u)$. Monitoring effort affects the probability of each information-sharing outcome. The bank cannot observe effort directly, so the incentive contract conditions payment on the verifiable information-sharing outcome. Let p_{HH} be the probability that the degree of information sharing is high (u_H) given the supplier's high effort level (e_H), where $0 < p_{HH} < 1$. Then, the probability that the degree of information sharing is low (u_L) given the supplier's high effort level (e_H) is calculated as $p_{LH} = 1 - p_{HH}$. Let p_{HL} be the probability that the degree of information sharing is high (u_H) given the supplier's low effort level (e_L) where $0 < p_{HL} < 1$. Then, the probability that the degree of information sharing is low (u_L) given the supplier's low effort level (e_L) is calculated as $p_{LL} = 1 - p_{HL}$. We assume that high monitoring effort makes high information sharing more likely than low effort. Accordingly, higher monitoring effort e shifts the distribution of information sharing upward in the sense of first-order stochastic dominance, i.e., $\Pr(u_e > \hat{u})$ is weakly increasing in monitoring effort e for every fixed threshold $\hat{u}$ (Bunn, 1984). For the two information outcomes, we impose $p_{HH} > p_{HL}$, with $p_{HH} - p_{HL} \equiv \Delta p > 0$.

Let $r_f \geq 0$ denote the bank's given funding rate over the financing period. For each verifiable information state $j \in \{L, H\}$, define its conditional expected net return before the monitoring payment as $s(u_j; q, i) = E_X[R_j(q, X; i)] - (1 + r_f)L(q)$. The expectation is taken over demand at a fixed financed order and lending rate, using the receipt function defined above. The funding term includes both repayment of the loan principal and its funding interest; the supplier's monitoring payment is deducted separately. Thus, information sharing affects the bank's return through recovery of proceeds from defaulted financed transactions. In the conditional incentive-design problem below, q and i are fixed and $s(u_j)$ abbreviates $s(u_j; q, i)$.

Before the supplier chooses its monitoring effort, the bank offers it an incentive contract $\{t(u_L), t(u_H)\}$. Let $t_j \equiv t(u_j)$ denote the bank's cost of providing the incentive to the supplier when the information-sharing outcome u_j is observed, for $j = L, H$. The bank is assumed to be risk-neutral, with conditional expected net return $y_j = s(u_j) - t_j$ for $j = L, H$. The supplier is assumed to be risk-averse, with an increasing and strictly concave utility function $A(M(q) + t_j)$, i.e., $A' > 0$ and $A'' < 0$, and $A(0) = 0$. Concavity represents aversion to uncertainty in the total transaction payoff, comprising operating margin and the monitoring payment. The monitoring incentive is modelled as a monetary transfer payable by the bank even if the retailer defaults. If the supplier exerts an effort level $e \in \{e_L, e_H\}$ in monitoring the financed transactions and the retailer, it incurs an effort cost of $c(e)$, measured in utility units. The cost function is assumed to be increasing and convex in e , i.e., $c' > 0$ and $c'' > 0$. For $e \in \{e_L, e_H\}$, define the supplier's monitoring effort cost as $c(e_L) = c_L$ and $c(e_H) = c_H$, with $c_H - c_L \equiv \Delta c > 0$. The supplier's expected utility net of effort cost must be at least its reservation utility a_0 . This reservation utility represents its best alternative to the financed transaction, including any available self-financed sales, and is treated as given. Thus, the supplier's participation constraint (PC) is written as follows:

$$\Pr(u_H|e)A(M(q) + t_H) + (1 - \Pr(u_H|e))A(M(q) + t_L) - c(e) \geq a_0 \quad (1)$$

Because the bank cannot observe or verify the supplier's effort, it cannot contract directly on effort. For a fixed financed order q , the incentive-compatibility constraint (IC) requires the effort induced by the contract to maximise the supplier's expected utility net of effort cost over the two available effort levels; $\tilde{e}$ denotes a candidate effort in the maximisation below:

$$e \in \arg \max_{\tilde{e} \in \{e_L, e_H\}} \left\{ \Pr(u_H|\tilde{e})A(M(q) + t_H) + (1 - \Pr(u_H|\tilde{e}))A(M(q) + t_L) - c(\tilde{e}) \right\} \quad (2)$$

To induce high monitoring effort e_H , the incentive-compatibility condition in Equation (2) requires that the supplier's expected utility from high effort be at least as large as that from low effort:

$$p_{HH}A(M(q) + t_H) + (1 - p_{HH})A(M(q) + t_L) - c_H \geq p_{HL}A(M(q) + t_H) + (1 - p_{HL})A(M(q) + t_L) - c_L \quad (3)$$

For an intended effort level e , let $p_e = p_{HH}$ when $e = e_H$ and $p_e = p_{HL}$ when $e = e_L$. At a fixed financed order and lending rate, the bank's expected profit after paying the supplier is $\Pi_B^e(q, i; t_L, t_H) = p_e[s(u_H; q, i) - t_H] + (1 - p_e)[s(u_L; q, i) - t_L]$. Here, the payments are the values of the bank's committed order-contingent schedule at q . This profit combines the information-state probabilities induced by monitoring, receipts net of funding costs, and the bank's expected monitoring payments. The bank evaluates lending offers using the retailer's order response $q^*(i, \uparrow)$ and requires supplier participation and incentive compatibility for the intended effort. The bank can decline financing, obtaining a normalised profit of zero.

At a fixed financed order q and lending rate i , the bank conditions incentives on the verifiable information-sharing outcome. An incentive-feasible contract (Laffont & Martimort, 2002) must satisfy both PC (1) and IC (3) to induce high effort. We restrict the payments to $t_H, t_L \geq 0$ and assume that the supplier follows the contract's recommended effort when indifferent between the two effort levels. In Model 1, Y denotes the bank's realised net return; its conditional expectation under high effort equals the profit defined above. Because q and i are fixed, maximising expected net return is equivalent to minimising the bank's expected monitoring payment. The resulting conditional high-effort problem is as follows:

$$\begin{aligned} \max_{\{t_H, t_L\}} E(Y|e_H) &= p_{HH}(s(u_H) - t_H) + (1 - p_{HH})(s(u_L) - t_L) \\ \text{s.t.} \quad &p_{HH}A(M(q) + t_H) + (1 - p_{HH})A(M(q) + t_L) - c_H \geq a_0 \\ &p_{HH}A(M(q) + t_H) + (1 - p_{HH})A(M(q) + t_L) - c_H \geq p_{HL}A(M(q) + t_H) + (1 - p_{HL})A(M(q) + t_L) - c_L \end{aligned} \quad (\text{Model 1})$$

Theorem 1. For a fixed financed order q and lending rate i , suppose the bank seeks to implement high effort under the non-negative-payment and effort-indifference assumptions above. Let $h = A^{-1}$ and $d = \frac{\Delta c}{\Delta p}$, and define $b_L = a_0 + c_H - p_{HH}d$, $z_L^* = \max\{b_L, A(M(q))\}$ and $z_H^* = z_L^* + d$. Provided the two optimal utility levels are attainable for non-negative payments, the unique contract that minimises the bank's expected monitoring payment is as follows:

$$\hat{t}_H = h(z_H^*) - M(q), \hat{t}_L = h(z_L^*) - M(q) \quad (4)$$

Proof. Define $A_H = A(M(q) + t_H)$ and $A_L = A(M(q) + t_L)$. Because the utility function is strictly increasing, these relations can be inverted to give $t_H = h(A_H) - M(q)$ and $t_L = h(A_L) - M(q)$. Subtracting the operating margin recovers the monitoring payment from the total monetary payoff. Non-negative payments require $A_H, A_L \geq A(M(q))$. Model 1 can then be written in terms of the utility levels as follows:

$$\begin{aligned} \max_{\{A_H, A_L\}} E(Y|e_H) &= p_{HH}(s(u_H) - h(A_H) + M(q)) + (1 - p_{HH})(s(u_L) - h(A_L) + M(q)) \\ \text{s.t.} \quad &p_{HH}A_H + (1 - p_{HH})A_L - c_H \geq a_0 \\ &p_{HH}A_H + (1 - p_{HH})A_L - c_H \geq p_{HL}A_H + (1 - p_{HL})A_L - c_L \end{aligned}$$

Let $p = p_{HH}$, $\delta = A_H - A_L$ and $\mu = p A_H + (1 - p)A_L$. The supplier's expected monitoring payment is $C(\mu, \delta) = p h(\mu + (1 - p)\delta) + (1 - p)h(\mu - p\delta) - M(q)$. Incentive compatibility requires $\delta \geq d$, and participation requires $\mu \geq a_0 + c_H$. With $\delta \geq d > 0$, non-negative payments are equivalent to $\mu \geq A(M(q)) + p\delta$. Since h is increasing and strictly convex, this cost increases strictly with μ and with a positive δ on its feasible domain. The smallest admissible mean, $\max\{a_0 + c_H, A(M(q)) + p\delta\}$, is nondecreasing in δ . Under the attainability condition in Theorem 1, the unique minimum therefore occurs at $\delta^* = d$ and $\mu^* = \max\{a_0 + c_H, A(M(q)) + pd\}$. Hence, the optimal total utility levels are as follows:

$$z_L^* = \max\{a_0 + c_H - p_{HH}d, A(M(q))\}, \quad z_H^* = z_L^* + d \quad (5)$$

Since $d > 0$, $z_H^* > z_L^*$, and the strictly increasing inverse utility function gives $\hat{t}_H > \hat{t}_L \geq 0$. If $b_L > A(M(q))$, participation and incentive compatibility bind and both monitoring payments are positive. If $b_L < A(M(q))$, the low-state payment is zero, incentive compatibility binds, and participation is slack. At $b_L = A(M(q))$, participation, incentive compatibility and the low-state payment bound all bind. Recovering the transfers as $\hat{t}_j = h(z_j^*) - M(q)$, $j \in \{H, L\}$, yields Equation (4). Strict convexity of the expected payment in the attainable

utility pair ensures uniqueness. Under the assumed recommendation-following rule at effort indifference, the contract implements high effort. This completes the proof. $\square$

Remark 1. Holding the financed order, lending rate, effort costs and signal probabilities fixed, both optimal monitoring payments are weakly increasing in the supplier's reservation utility a_0 while the contract remains feasible. Define the threshold $a_0^{\text{crit}} = A(M(q)) - c_H + p_{HH}d$. For $a_0 < a_0^{\text{crit}}$, the low-state payment bound binds and participation is slack; increases in reservation utility that remain below this threshold leave both payments unchanged. For $a_0 > a_0^{\text{crit}}$, participation and incentive compatibility bind; a higher reservation utility raises both optimal total utility levels by the same amount, so both payments increase strictly. At $a_0 = a_0^{\text{crit}}$, participation, incentive compatibility and the low-state payment bound all bind. Equal increases in utility need not imply equal increases in monetary payments.

High-effort signal probability: under the conditions of Theorem 1, hold the financed order, lending rate, reservation utility, effort costs and low-effort signal probability fixed. As p_{HH} increases, the high-state payment $\hat{t}_H$ decreases strictly and the low-state payment $\hat{t}_L$ is weakly increasing. The low-state payment increases strictly when participation binds and the payment floor is nonbinding; it remains zero when the floor continues to bind. These conclusions apply over feasible changes with $0 < p_{HL} < p_{HH} < 1$ and allow a change in which constraint binds. They qualify the high-effort probability result in Analytical proposition 1.

Low-effort signal probability: under the conditions of Theorem 1, hold the financed order, lending rate, reservation utility, effort costs and high-effort signal probability fixed. As p_{HL} increases, the high-state payment $\hat{t}_H$ increases strictly and the low-state payment $\hat{t}_L$ is weakly decreasing. The low-state payment decreases strictly when participation binds and the payment floor is nonbinding; it remains zero when the floor continues to bind. These conclusions apply over feasible changes with $0 < p_{HL} < p_{HH} < 1$ and allow a change in which constraint binds. They qualify the low-effort probability result in Analytical proposition 1.

High-effort cost: under the conditions of Theorem 1, hold the financed order, lending rate, reservation utility, low-effort cost and signal probabilities fixed. As c_H increases, the high-state payment $\hat{t}_H$ increases strictly and the low-state payment $\hat{t}_L$ is weakly decreasing. The low-state payment decreases strictly when participation binds and the payment floor is nonbinding; it remains zero when the floor continues to bind. These conclusions apply over feasible changes with $c_H > c_L$ and allow a change in which constraint binds. They qualify the high-effort cost result in Analytical proposition 2.

Low-effort cost: under the conditions of Theorem 1, hold the financed order, lending rate, reservation utility, high-effort cost and signal probabilities fixed. As c_L increases, the high-state payment $\hat{t}_H$ decreases strictly and the low-state payment $\hat{t}_L$ is weakly increasing. The low-state payment increases strictly when participation binds and the payment floor is nonbinding; it remains zero when the floor continues to bind. These conclusions apply over feasible changes with $c_H > c_L$ and allow a change in which constraint binds. They qualify the low-effort cost result in Analytical proposition 2.

Proof. We differentiate the optimal total utility levels z_H^* and z_L^* in Equation (5), holding the financed order, lending rate and all other parameters fixed. The formulas below distinguish a nonbinding low-state payment floor, $b_L > A(M(q))$, from a binding floor with slack participation, $b_L < A(M(q))$. At $b_L = A(M(q))$, the applicable responses are given by the

one-sided derivatives of the two adjoining regimes. Differentiating with respect to p_{HH} gives the following:

$$\frac{\partial z_H^*}{\partial p_{HH}} = \begin{cases} -\frac{\Delta c(1-p_{HL})}{(\Delta p)^2} < 0 & b_L > A(M(q)), \\ -\frac{\Delta c}{(\Delta p)^2} < 0 & b_L < A(M(q)). \end{cases}$$

$$\frac{\partial z_L^*}{\partial p_{HH}} = \begin{cases} \frac{\Delta c p_{HL}}{(\Delta p)^2} > 0 & b_L > A(M(q)), \\ 0 & b_L < A(M(q)). \end{cases}$$

Holding the financed order, lending rate and all other parameters fixed, we next differentiate the optimal total utility levels z_H^* and z_L^* in Equation (5) with respect to p_{HL} . Using the same regime definitions and one-sided boundary convention gives the following:

$$\frac{\partial z_H^*}{\partial p_{HL}} = \begin{cases} \frac{\Delta c(1-p_{HH})}{(\Delta p)^2} > 0 & b_L > A(M(q)), \\ \frac{\Delta c}{(\Delta p)^2} > 0 & b_L < A(M(q)). \end{cases}$$

$$\frac{\partial z_L^*}{\partial p_{HL}} = \begin{cases} -\frac{\Delta c p_{HH}}{(\Delta p)^2} < 0 & b_L > A(M(q)), \\ 0 & b_L < A(M(q)). \end{cases}$$

Holding the financed order, lending rate, reservation utility, low-effort cost and signal probabilities fixed, we differentiate the optimal total utility levels z_H^* and z_L^* in Equation (5) with respect to c_H . Using the same regime definitions and one-sided boundary convention gives the following:

$$\frac{\partial z_H^*}{\partial c_H} = \begin{cases} \frac{1-p_{HL}}{\Delta p} > 0 & b_L > A(M(q)), \\ \frac{1}{\Delta p} > 0 & b_L < A(M(q)). \end{cases}$$

$$\frac{\partial z_L^*}{\partial c_H} = \begin{cases} -\frac{p_{HL}}{\Delta p} < 0 & b_L > A(M(q)), \\ 0 & b_L < A(M(q)). \end{cases}$$

Holding the financed order, lending rate, reservation utility, high-effort cost and signal probabilities fixed, we differentiate the optimal total utility levels z_H^* and z_L^* in Equation (5) with respect to c_L . Using the same regime definitions and one-sided boundary convention gives the following:

$$\frac{\partial z_H^*}{\partial c_L} = \begin{cases} -\frac{1-p_{HH}}{\Delta p} < 0 & b_L > A(M(q)), \\ -\frac{1}{\Delta p} < 0 & b_L < A(M(q)). \end{cases}$$

$$\frac{\partial z_L^*}{\partial c_L} = \begin{cases} \frac{p_{HH}}{\Delta p} > 0 & b_L > A(M(q)), \\ 0 & b_L < A(M(q)). \end{cases}$$

Since the optimal monitoring payments in Equation (4) satisfy $\hat{t}_j = h(z_j^*) - M(q)$, $j \in \{H, L\}$, holding the financed order fixed keeps $M(q)$ constant. The strictly increasing inverse utility function h therefore preserves the direction of each optimal total utility response. The high-state payment responds strictly in the directions established above in both regimes. The low-state payment responds strictly when the floor is nonbinding and remains zero while the floor binds, so its overall response is weakly monotone. The two regimes yield the same optimal utility and payment levels at $b_L = A(M(q))$; the comparisons therefore also apply across feasible regime switches. This completes the proof of the four conditional comparative-static statements above. $\square$

At a fixed financed order q and lending rate i , suppose that the supplier requires an agreed minimum monetary payment $v > 0$ from the bank in each verifiable information state as a condition for accepting a high-effort monitoring contract, so $t_H \geq v$ and $t_L \geq v$. This floor applies to the monitoring transfer and is separate from the supplier's operating margin and reservation utility. Model 2 uses the same payment-enforcement and effort-indifference assumptions as Model 1. Because q and i are fixed, maximising the bank's conditional expected profit under high effort is equivalent to minimising its expected monitoring payment. The resulting conditional problem, including the payment floors, is as follows:

$$\max_{\{t_H, t_L\}} E(Y|e_H) = p_{HH}(s(u_H) - t_H) + (1 - p_{HH})(s(u_L) - t_L) \quad (\text{Model 2})$$

$$\text{s.t. } p_{HH}A(M(q) + t_H) + (1 - p_{HH})A(M(q) + t_L) - c_H \geq a_0 \quad (\text{PC})$$

$$p_{HH}A(M(q) + t_H) + (1 - p_{HH})A(M(q) + t_L) - c_H \geq p_{HL}A(M(q) + t_H) + (1 - p_{HL})A(M(q) + t_L) - c_L \quad (\text{IC})$$

$$t_H \geq v$$

$$t_L \geq v$$

Theorem 2. For a fixed financed order q and lending rate i and an agreed minimum monitoring payment $v > 0$, let $z_{L,v}^* = \max\{b_L, A(M(q) + v)\}$ and $z_{H,v}^* = z_{L,v}^* + d$, where b_L and d are defined in Theorem 1. Provided these utility levels are attainable with payments at least v , the unique contract $\{\tilde{t}_H, \tilde{t}_L\}$ that minimises the bank's expected monitoring payment and implements high effort under the assumptions above is characterised by the following cases:

- If $0 < v < \hat{t}_L$, where $\hat{t}_L$ is the Model 1 low-state payment in Equation (4), the minimum-payment constraints are nonbinding. Participation and incentive compatibility bind, and the contract is unchanged: $\tilde{t}_H = \hat{t}_H$ and $\tilde{t}_L = \hat{t}_L$;
- If $v \geq \hat{t}_L$, the low-state payment equals v and incentive compatibility binds. Participation binds at $v = \hat{t}_L > 0$ and is slack when $v > \hat{t}_L$. The high-state payment strictly exceeds v , so its payment floor is nonbinding. The contract is as follows:

$$\tilde{t}_H = h(A(M(q) + v) + d) - M(q), \quad \tilde{t}_L = v. \quad (6)$$

Proof. Define $A_H = A(M(q) + t_H)$ and $A_L = A(M(q) + t_L)$. Because the utility function is strictly increasing, the corresponding monitoring transfers are $t_H = h(A_H) - M(q)$ and $t_L = h(A_L) - M(q)$. At fixed q and i , maximising the bank's conditional expected profit under high effort is equivalent to minimising its expected monitoring payment. The minimum-payment problem can therefore be written in utility levels, restricted to the attainable range of the utility function, as follows:

$$\begin{aligned} \min_{A_H, A_L} & [p_{HH}h(A_H) + (1 - p_{HH})h(A_L) - M(q)] \\ \text{s.t. } & p_{HH}A_H + (1 - p_{HH})A_L - c_H \geq a_0 \quad (\text{PC}') \\ & p_{HH}A_H + (1 - p_{HH})A_L - c_H \geq p_{HL}A_H + (1 - p_{HL})A_L - c_L \quad (\text{IC}') \\ & A_H \geq A(M(q) + v) \\ & A_L \geq A(M(q) + v) \end{aligned}$$

Let $p = p_{HH}$, $\delta = A_H - A_L$, $\mu = p A_H + (1 - p)A_L$, and $m_v = A(M(q) + v)$. The supplier's IC' requires $\delta \geq d > 0$, while PC' requires $\mu \geq a_0 + c_H$. Since $A_H > A_L$, the high-state floor follows from the low-state floor. For each feasible δ , PC' and the low-state floor imply $\mu \geq \max\{a_0 + c_H, m_v + p\delta\}$. The expected monitoring payment is strictly increasing in μ ; at a fixed μ , it is strictly increasing in positive δ , because h is strictly increasing and strictly convex and both probability weights are positive. The minimum admissible μ is

nondecreasing in δ . Thus the unique optimum has $\delta = d$ and $\mu = \max\{a_0 + c_H, m_v + pd\}$, provided the resulting utility pair is attainable. Consequently, IC' binds and $A_L = z_{L,v}^* = \max\{b_L, m_v\}$, with $A_H = z_{H,v}^* = z_{L,v}^* + d$. PC' binds when $b_L \geq m_v$ and is slack when $b_L < m_v$. The low-state payment floor binds when $b_L \leq m_v$, and the high-state floor is strictly slack. Recovering the monitoring transfers as $\tilde{t}_j = h(z_{j,v}^*) - M(q)$, for $j \in \{H, L\}$, yields the stated cases and Equation (6), including the equality boundary. This proves the conditional minimum-payment result.

For a fixed financed order q and lending rate i , the bank must compare high effort with a least-cost low-effort contract. For this comparison, impose the same payment floor in both effort regimes: $f = 0$ in Model 1 and $f = v$ in Model 2, with $t_H, t_L \geq f$. The unique minimum-payment contract implementing low effort is $t_H = t_L = \tau_L(q; f)$, where $\tau_L(q; f) = h(\max\{a_0 + c_L, A(M(q) + f)\}) - M(q)$, provided the utility level inside h is attainable. To see this, participation requires the supplier's expected total utility before effort cost to be at least $a_0 + c_L$, and the payment floor requires each state's total utility to be at least $A(M(q) + f)$. Jensen's inequality for the strictly convex inverse utility function therefore bounds the expected monitoring payment below by $\tau_L(q; f)$. The constant payment attains this bound, satisfies participation and the payment floor, and makes low effort strictly preferable because $c_L < c_H$. Strict convexity and positive state probabilities ensure uniqueness. The bank's corresponding expected monitoring cost is $K_L(q; f) = \tau_L(q; f)$.

Let $t_j^H(q; f)$ denote the least-cost high-effort payment from Theorem 1 when $f = 0$ and Theorem 2 when $f = v$, for $j \in \{H, L\}$. Define $K_H(q; f) = p_{HH}t_H^H(q; f) + (1 - p_{HH})t_L^H(q; f)$, with $K_L(q; f) = \tau_L(q; f)$ as derived above. After substituting the relevant payment schedule, the bank's expected profit is $\Pi_{B,f}^e(q, i) = p_e s(u_H; q, i) + (1 - p_e)s(u_L; q, i) - K_e(q; f)$, using the effort probabilities and net receipt functions already defined, with the monitoring cost indexed by the intended effort regime. Take O to be a specified bounded set of admissible non-negative interest-rate and credit-limit pairs; its bounds are model inputs. Let F_f contain triples $(i, \downarrow, e)$ with $(i, \downarrow) \in O$ and $e \in \{e_L, e_H\}$ for which the retailer's financed best response is attained and satisfies participation, and the committed supplier contract is attainable and satisfies participation, incentive compatibility and the common payment floor at every order permitted by the credit limit. The

bank's value is $W_B(f) = \max \left\{ 0, \sup_{(i, \downarrow, e) \in F_f} \Pi_{B,f}^e(q^*(i, \downarrow), i) \right\}$, with $\sup \emptyset = -\infty$. An attained positive inner supremum determines the bank's chosen financing offer and effort regime. If the inner value is nonpositive, the bank chooses no financing; an unattained positive supremum is a limiting value and does not establish an equilibrium. This formulation makes the bank anticipate both the retailer's order response and the supplier's induced monitoring effort.

A continuous-offer financing equilibrium requires a feasible bank offer and intended effort regime that attain the bank's greatest profit over all admissible offers in the specified domain, together with the retailer's optimal order and the supplier's optimal participation and effort decisions under the stated tie-breaking rules. Solving the supplier's conditional contracting problem establishes the least-cost payments for a given order and effort regime, but does not establish this global optimality of the bank's offer. Restricting the bank's choice to a finite grid excludes deviations to offers between grid points. Consequently, a grid-selected offer can be optimal among the tested offers while a feasible untested offer yields a higher bank profit. Likewise, selecting no financing on a grid establishes only that none of the tested feasible offers is strictly profitable; a continuous-offer no-financing equilibrium requires that no feasible offer anywhere in the specified domain yields positive profit. If the continuous-offer profit supremum is positive but unattained, no feasible offer realises that value, so it cannot be reported as a financing equilibrium.

At a fixed financed order q , lending rate i and common payment floor f , define $V_D(q, i) = E_X[V(q, X)\mathbf{1}_{\{V(q, X) < D(q, i)\}}]$; the expected transaction proceeds in default. The receipt functions coincide in solvent states, while their difference in default is $(\rho_H - \rho_L)V(q, X)$. Funding costs also coincide at these financing terms. Hence, whenever both effort regimes are feasible, $\Pi_{B,f}^{e_H}(q, i) - \Pi_{B,f}^{e_L}(q, i) = \Delta p(\rho_H - \rho_L)V_D(q, i) - [K_H(q; f) - K_L(q; f)]$. The bank therefore weakly prefers high effort at these terms exactly when $\Delta p(\rho_H - \rho_L)V_D(q, i) \geq K_H(q; f) - K_L(q; f)$. The left-hand side is the additional expected default recovery generated by monitoring, and the right-hand side is its additional implementation cost. High effort requires a strictly positive utility spread; strict convexity of h and Jensen's inequality therefore imply $K_H(q; f) > K_L(q; f)$ under the common floor. If $\rho_H = \rho_L$ or $V_D(q, i) = 0$, low effort is strictly preferred at these financing terms. This conditional comparison does not by itself establish that lending is profitable or that an offer is an equilibrium: retailer participation, feasibility of the committed supplier schedule, and the bank's offer optimisation and no-financing option must also be satisfied.

Consider an increase in the high-information recovery rate from ρ_H to ρ'_H , with $\rho_L \leq \rho_H \leq \rho'_H \leq 1$, holding the offer domain, payment floor and all other model primitives fixed. For each feasible offer and intended effort regime, the retailer's response $q = q^*(i, \uparrow)$, the supplier's implementation costs and the feasible set F_f remain unchanged because these objects do not depend on the recovery rate. Making the recovery-rate argument explicit, the change in bank profit at the same offer is $\Pi_{B,f}^e(q, i; \rho'_H) - \Pi_{B,f}^e(q, i; \rho_H) = p_e(\rho'_H - \rho_H)V_D(q, i) \geq 0$. Thus, every strictly profitable feasible offer at the original recovery rate remains strictly profitable at the higher rate, and the bank's value satisfies $W_B(f; \rho'_H) \geq W_B(f; \rho_H)$. Improved recovery in high-information states can therefore expand the set of profitable financing options and weakly increase the bank's value. This result does not establish a universal change in the chosen interest rate, credit limit, order quantity or monitoring effort, since the bank may select a different offer or effort regime. A financing equilibrium still requires an attained positive optimum under the offer-selection rule stated above. $\square$

3.2. Numerical Analysis

The numerical analysis uses the three-party model to examine the interaction between retailer financing, supplier monitoring and bank profitability. For each candidate interest rate and credit limit, we solve the retailer's constrained order problem, compare its maximum expected profit with the self-financing outside option, and apply the order-selection and participation rules specified above. For each admissible financed response, we evaluate both monitoring regimes using their respective least-cost contracts, checking supplier participation, incentive compatibility and the common payment floor at every order permitted by the credit limit. Bank profit is calculated from expected solvent repayment and information-dependent default recovery, less funding repayment and expected monitoring payments. Numerical maximisation over the specified bounded offer domain provides candidate financing offers, which are compared with the zero-profit no-financing option. Finite-grid outcomes are treated as numerical approximations and do not by themselves establish an equilibrium of the continuous-offer game. Sensitivity comparisons distinguish changes in monitoring contracts at fixed financing terms from changes in the bank's selected offer and effort regime.

For a transparent numerical illustration, we use normalised monetary units and a three-point demand distribution: demand is 0.5, 2 or 4 units with probabilities 0.3, 0.4 and 0.3, respectively. The retail price is 2, the wholesale price is 1, the unit production cost is 0.7, the retailer's initial cash is 0.2, the unit salvage value is 0.1, and the bank's funding rate is 0.02. The supplier's utility is the square root of its total monetary payoff before effort cost;

its reservation utility is 0.5, and its high- and low-effort costs are 0.12 and 0.02, respectively, measured in utility units. The probability of a high-information signal is 0.8 under high effort and 0.3 under low effort. Default recovery rates are 0.8 in the high-information state and 0.2 in the low-information state. We compare Model 1's zero payment floor with Model 2's common minimum monitoring payment of 0.5, applied to both effort regimes. In both models, the bank's offer domain allows interest rates from 0 to 1 and credit limits from 0 to 3.8. These bounds are scenario inputs, and the parameter values are illustrative assumptions rather than estimates from the case study.

All demand expectations are evaluated as finite probability-weighted sums. Between demand-support points, the retailer's expected equity payoff is convex in the order quantity; its largest attained maximiser is therefore found by checking the order-cap endpoint and all feasible demand-support points. The excluded lower-endpoint limit is also evaluated to detect an unattained supremum. The self-financing optimum is calculated from its two endpoints and feasible demand-support points. Exact rational comparisons determine retailer-profit rankings and repayment states; states in which transaction proceeds equal promised repayment are classified as solvent. Bank receipt and funding amounts are evaluated from exact rational primitives. Under the square-root utility specification, the closed-form supplier utility targets are attainable throughout the permitted order interval, so the committed schedules satisfy participation, incentive compatibility and the common payment floor at every permitted order. Monitoring costs are evaluated in double precision, with effort-specific grid-maximising candidates independently checked using 50-digit decimal arithmetic. The interest-rate and credit-limit grid steps initially equal 0.01 and 0.05, respectively, and are refined to 0.005 and 0.025, then 0.0025 and 0.0125. Each grid compares the best feasible bank profit across both effort regimes with the zero-profit no-financing option. Successive grid values assess numerical stability; agreement provides neither an error bound on the continuous-offer value nor proof of an equilibrium.

Under the three-point demand specification, changes in a financing offer can alter the retailer's selected order, its decision to accept financing, or the repayment status of a demand state. The bank's profit after these responses therefore need not be continuous in the offer, and bounded offer ranges alone do not guarantee that its supremum is attained. For example, the representative offer in Table 1 makes the retailer indifferent between orders of 0.5 and 2 units; the reported order of 2 follows the specified tie-breaking rule. Evaluating this offer does not rule out more profitable nearby offers. Nested grid refinement expands the set of tested offers, but identical maximum profits on two successive grids can still overlook a profitable offer between their grid points. Thus, stability at the reported resolutions does not establish convergence to the continuous-offer value. Establishing a continuous-offer equilibrium would require verification that no feasible off-grid deviation improves the bank's profit and that its optimum is attained. To claim an approximate equilibrium instead, one would need a quantified bound on the profit gain available from untested deviations; no such bound is established here.

Table 1. Illustrative finest-grid financing outcomes and monitoring-effort comparison.

Outcome	Model 1	Model 2
Common monitoring-payment floor	0	0.5
Selected monitoring effort	Low effort	Low effort
Representative interest rate	0.875	0.875
Representative credit limit	1.8	1.8
Retailer order quantity	2	2
Retailer loan	1.8	1.8
Retailer expected profit	0.2375	0.2375

Table 1. *Cont.*

Outcome	Model 1	Model 2
Retailer self-financing profit	0.2000	0.2000
Default probability	0.3	0.3
Selected bank profit	0.6576	0.1576
Best high-effort financing profit	0.4812	−0.1065
Additional high-effort default recovery	0.1035	0.1035
Additional high-effort implementation cost	0.2799	0.3676

Notes: monetary amounts are in normalised units. Profits and incremental amounts are reported to four decimal places. Interest is for one model period. The representative credit limit is the smallest sufficient limit among tied grid maxima. High-effort increments are evaluated at the representative financing terms. The reported best profits and representative offers refer to the finest tested grid. Offers between its points remain untested, so neither global optimality over the continuous-offer domain nor a continuous-offer equilibrium is established (see Section 3.2).

4. Results

For feasible least-cost high-effort contracts, the mathematical derivations establish the three analytical propositions under their stated conditions. For Analytical proposition 1, the comparative statics following Theorem 1 show that increasing the probability of high information sharing under high effort lowers the high-information payment and raises the low-information payment; increasing this probability under low effort reverses these effects. For Analytical proposition 2, increasing high-effort cost raises the high-information payment and lowers the low-information payment, whereas increasing low-effort cost reverses these effects. These comparisons hold at a fixed financed order and lending rate, with other parameters fixed, binding participation and incentive constraints, and a nonbinding payment floor. For Analytical proposition 3, higher reservation utility raises both payments in this regime. Theorem 2 establishes that a common floor leaves the zero-floor contract unchanged until it exceeds the baseline low-information payment; above that threshold, the low-information floor and incentive constraint bind, while participation becomes slack. The numerical results below compare effort levels and financing offers with retailer responses; they illustrate financing choices rather than statistically test the propositions.

On the finest offer grid, low monitoring effort yields the highest bank profit in both baseline models. A representative best offer has a model-period interest rate of 0.875 and a credit limit of 1.8. Orders of 0.5 and 2 units give the retailer the same expected profit of 0.2375, exceeding its self-financing profit of 0.2; the specified largest-order rule therefore selects 2 units and a loan of 1.8. Default occurs only when demand is 0.5, with probability 0.3. Bank profit is 0.6576 in Model 1 and 0.1576 in Model 2, so the common payment floor of 0.5 reduces bank profit by 0.5 while financing terms and the order remain unchanged in this scenario. At these terms, high effort adds 0.1035 in expected default recovery but increases implementation cost by 0.2799 in Model 1 and 0.3676 in Model 2, making low effort preferable. The greatest financing profits under high effort on the same grid are 0.4812 and −0.1065, respectively. Both selected low-effort offers yield positive bank profit and dominate the no-financing option. These bank values agree between the last two grid refinements. The findings describe illustrative grid outcomes and do not establish a continuous-offer equilibrium or universal changes in orders or interest rates.

To assess the joint effect of monitoring cost and the common payment floor, shown in Table 2, we vary the supplier's high-effort cost across 0.045, 0.07, 0.12 and 0.17 utility units, holding its low-effort cost at 0.02, and examine payment floors of 0, 0.25, 0.5 and 0.75 in normalised monetary units. All other baseline parameters and offer bounds remain fixed. For each of the 16 scenarios, we repeat the three nested offer grids, recompute the

least-cost contracts for both efforts and compare their greatest feasible bank profits with the no-financing value of zero. On the finest grid, high effort is selected at a high-effort cost of 0.045 and floors of 0, 0.25 and 0.5, yielding bank profits of 0.6971, 0.4353 and 0.1752, respectively. At high-effort costs of 0.07, 0.12 and 0.17, low effort is selected at these same floors, yielding bank profits of 0.6576, 0.4076 and 0.1576, respectively. Each profitable scenario has a representative interest rate of 0.875, credit limit of 1.8, retailer order of 2 and retailer profit of 0.2375. At a floor of 0.75, neither effort regime yields profitable financing anywhere on the finest grid for any tested high-effort cost, so the bank chooses no financing and the retailer self-finances. The bank values agree between the last two grid refinements in every scenario. These illustrative grid outcomes show that an increase in high-effort cost can induce a switch to low effort; they do not establish that the bank must always increase its chosen monitoring payments or that a continuous-offer equilibrium exists.

Table 2. Sensitivity of financing and monitoring outcomes to high-effort cost and the common payment floor.

High-Effort Cost	Payment Floor	Selected Regime	Bank Value	Expected Monitoring Payment	Retailer Order
0.045	0	High effort	0.6971	0.0640	2
0.045	0.25	High effort	0.4353	0.3258	2
0.045	0.5	High effort	0.1752	0.5859	2
0.045	0.75	No financing	0.0000	—	0.2
0.07	0	Low effort	0.6576	0.0000	2
0.07	0.25	Low effort	0.4076	0.2500	2
0.07	0.5	Low effort	0.1576	0.5000	2
0.07	0.75	No financing	0.0000	—	0.2
0.12	0	Low effort	0.6576	0.0000	2
0.12	0.25	Low effort	0.4076	0.2500	2
0.12	0.5	Low effort	0.1576	0.5000	2
0.12	0.75	No financing	0.0000	—	0.2
0.17	0	Low effort	0.6576	0.0000	2
0.17	0.25	Low effort	0.4076	0.2500	2
0.17	0.5	Low effort	0.1576	0.5000	2
0.17	0.75	No financing	0.0000	—	0.2

Notes: high-effort costs are in utility units; payment floors, bank values and monitoring payments are in normalised monetary units. Expected monitoring payment is the bank's expected supplier transfer under the selected effort. Each financed scenario has a representative model-period interest rate of 0.875, credit limit and loan of 1.8, retailer profit of 0.2375 and default probability of 0.3. Under no financing, the retailer orders 0.2 using its own cash and earns 0.2; indicates no monitoring contract. Bank value includes the zero-profit no-financing option. The zero floor corresponds to Model 1 and positive floors to Model 2. All selected regimes and bank values are conditional on the finest tested offer grid. In particular, "No financing" means that neither effort regime yields strictly positive bank profit at any feasible tested offer; it does not rule out profitable offers between grid points. These results therefore do not establish a continuous-offer equilibrium or the exact payment floor at which financing ceases in the continuous-offer model (see Section 3.2).

Finally, shown in Table 3, we examine the joint effect of signal informativeness and the common payment floor, comparing the baseline high-effort cost of 0.12 with the lower cost of 0.045 considered above. For each cost, the probability of a high information-sharing signal under high effort takes the values 0.5, 0.6, 0.7, 0.8 and 0.9, while its probability under low effort remains 0.3; payment floors are 0 and 0.5. All other baseline parameters and offer bounds remain fixed. We reoptimise both effort regimes and financing offers on the three nested grids for each of the 20 scenarios. At the baseline high-effort cost, low effort is selected at every tested signal probability, with bank values of 0.6576 under the zero floor and 0.1576 under the positive floor. At a high-effort cost of 0.045 and zero floor, low effort

is selected at probabilities 0.5 and 0.6, whereas high effort is selected at 0.7, 0.8 and 0.9, yielding bank values of 0.6699, 0.6971 and 0.7221, respectively. With the positive floor, high effort is selected only at 0.8 and 0.9, yielding bank values of 0.1752 and 0.2016; low effort is selected at the other tested probabilities. All 20 scenarios support profitable financing, with a representative interest rate of 0.875, credit limit of 1.8, retailer order of 2 and retailer profit of 0.2375. Bank values agree between the last two grid refinements. These results show that improved signal informativeness can make high effort worthwhile when its cost is sufficiently low, while the common floor changes the observed switching pattern. The tested probabilities do not establish continuous switching thresholds or a continuous-offer equilibrium. A negative profit under high effort alone is insufficient to justify no financing when low-effort financing remains profitable.

Table 3. Sensitivity of financing and monitoring outcomes to signal informativeness and the common payment floor.

High-Effort Cost	High-Effort Signal Probability	Payment Floor	Selected Effort	Bank Value	Expected Monitoring Payment	Retailer Order
0.12	0.5	0	Low effort	0.6576	0.0000	2
0.12	0.5	0.5	Low effort	0.1576	0.5000	2
0.12	0.6	0	Low effort	0.6576	0.0000	2
0.12	0.6	0.5	Low effort	0.1576	0.5000	2
0.12	0.7	0	Low effort	0.6576	0.0000	2
0.12	0.7	0.5	Low effort	0.1576	0.5000	2
0.12	0.8	0	Low effort	0.6576	0.0000	2
0.12	0.8	0.5	Low effort	0.1576	0.5000	2
0.12	0.9	0	Low effort	0.6576	0.0000	2
0.12	0.9	0.5	Low effort	0.1576	0.5000	2
0.045	0.5	0	Low effort	0.6576	0.0000	2
0.045	0.5	0.5	Low effort	0.1576	0.5000	2
0.045	0.6	0	Low effort	0.6576	0.0000	2
0.045	0.6	0.5	Low effort	0.1576	0.5000	2
0.045	0.7	0	High effort	0.6699	0.0705	2
0.045	0.7	0.5	Low effort	0.1576	0.5000	2
0.045	0.8	0	High effort	0.6971	0.0640	2
0.045	0.8	0.5	High effort	0.1752	0.5859	2
0.045	0.9	0	High effort	0.7221	0.0597	2
0.045	0.9	0.5	High effort	0.2016	0.5802	2

Notes: high-effort costs are in utility units; payment floors, bank values and monitoring payments are in normalised monetary units. High-effort signal probability is the probability of a high information-sharing signal conditional on high effort; the corresponding low-effort probability is fixed at 0.3. Expected monitoring payment is the bank's expected supplier transfer under the selected effort. All other baseline parameters and offer bounds remain fixed. Every scenario supports profitable financing, with a representative model-period interest rate of 0.875, credit limit and loan of 1.8, retailer profit of 0.2375 and default probability of 0.3. The zero floor corresponds to Model 1 and the positive floor to Model 2. Bank values are reported to four decimal places and include the zero-profit no-financing option. The reported effort choices maximise bank profit over the finest tested offer grid at each listed signal probability. The discrete signal comparisons do not locate exact switching thresholds, and profitable deviations to untested financing offers have not been ruled out. These outcomes therefore do not establish a continuous-offer equilibrium (see Section 3.2).

5. Discussion

The three-party framework explains how supplier monitoring and retailer financing jointly shape the bank's contract choice. Information sharing affects the bank's expected recovery following retailer default, while the retailer's cash constraint and the supplier's wholesale margin enter borrowing needs and compensation requirements. The analytical

contracts identify the least-cost supplier payments conditional on an order, effort regime and common payment floor; the reported financing offers are selected from bounded numerical grids after participation and feasibility checks. In the baseline, the additional recovery generated by high effort is smaller than its additional implementation cost, so low-effort financing is selected. At the lower high-effort cost, the signal comparisons show switches to high effort without changes in retailer orders. The payment-floor comparisons also identify scenarios in which no tested offer yields positive bank profit under either effort regime, so the grid-based procedure selects self-financing. These outcomes illustrate why monitoring incentives, credit provision and the no-financing alternative must be evaluated together. Positive profits from feasible tested offers establish that profitable financing is available in those scenarios, but do not establish that the selected offers maximise profit over the continuous domain. Conversely, a zero grid value does not rule out profitable untested offers. The reported regime switches therefore describe comparisons among tested offers and parameter values, rather than verified comparative statics of a continuous-offer equilibrium. These numerical illustrations are not empirical estimates of the motivating case.

The reservation-utility result has a conditional interpretation. Grossman and Hart (1983) evaluate the cost of inducing an action subject to participation and incentive constraints. In our financing setting, the supplier's trading margin contributes to the utility entering those constraints, so monitoring transfers supplement earnings from the financed sale. Holding the financed order, lending rate, effort costs, signal probabilities and payment floor fixed, the least-cost high-effort payments are weakly increasing in supplier reservation utility while the contract remains feasible. They rise strictly when participation binds and remain unchanged while a binding low-state payment floor leaves participation slack. Thus, stronger outside opportunities do not necessarily require higher monitoring payments; the response depends on the active constraint. The reservation utility represents the supplier's specified outside option; a financial-service unit or an independent ability to finance retailers does not by itself determine its numerical value. Managers therefore need to assess the supplier's relevant outside opportunity together with its trade margin and contractual payment bounds. These conditional payment comparisons do not imply that the bank will retain high effort, leave financing terms unchanged or continue lending after reoptimising its offer.

Information sharing has two roles in the model: it signals the supplier's unobserved monitoring effort and determines the bank's recovery fraction following retailer default. Holmström (1979) establishes conditions under which imperfect information improves contracts based on realised payoffs alone. Our results apply this incentive-contract perspective to transaction monitoring within a three-party financing arrangement. In Model 1, at a fixed financed order and lending rate, with all other primitives held constant and feasibility maintained, an increase in the probability of a high information-sharing signal under high effort strictly lowers the high-state payment and weakly raises the low-state payment; an increase in that probability under low effort has the opposite effects. The low-state payment remains zero while its floor binds. These are conditional payment comparisons, and the signal probabilities describe information given effort rather than effort given information. The numerical results additionally compare the bank's effort choices: higher high-effort signal probabilities induce switches to high effort at the lower tested effort cost, while the baseline-cost scenarios retain low effort and retailer orders remain unchanged. Yu et al. (2021) find that big data analytics capability is positively associated with internal SCF integration. Our analysis addresses a complementary contractual question: whether the available signal makes costly monitoring worthwhile. System integration alone does not establish effort observability or

identify the model's effort-conditioned probabilities. Estimating those probabilities and linking observed signals to default recovery requires empirical identification beyond the illustrative calculations reported here.

The effort-cost results distinguish conditional high-effort contracts from the bank's choice of effort regime. In Model 1, holding the financed order, lending rate, reservation utility, signal probabilities and the other effort cost fixed, a higher high-effort cost strictly raises the high-state payment and weakly lowers the low-state payment while implementation remains feasible. A higher low-effort cost has the opposite effects; the low-state payment remains zero while its floor binds. The cost comparisons in Table 2 also allow the bank to reoptimise both effort and financing terms. When the high-effort cost increases from 0.045 to 0.07, with the low-effort cost fixed at 0.02, the selected regime switches from high to low effort at each tested payment floor of 0, 0.25 and 0.5. At the zero floor, the selected expected monitoring payment falls from 0.0640 to zero, illustrating why a rise in effort cost need not increase the payment under the bank's chosen regime. Monitoring costs enter supplier utility; the model does not estimate how information-system integration, managerial capability or retailer relationships change these costs, nor does it account for upfront technology investment. Managers therefore need to assess both the cost of implementing effort and the additional default recovery it generates. Yan et al. (2016) show that a suitable manufacturer credit guarantee can achieve channel coordination in a bank-financed, capital-constrained supply chain. Our model examines supplier monitoring that affects recovery following retailer default. Its bank-optimal monitoring choices do not establish channel coordination, which would require a separate comparison with the integrated supply chain's objective.

The payment floor is an agreed minimum monetary monitoring transfer to the supplier in each verifiable information state. It is separate from the supplier's trading margin, reservation utility and the credit available to the retailer. At a fixed financed order and lending rate, Theorem 2 identifies the Model 1 low-state payment as the threshold for changes in the high-effort contract. If the positive floor is no higher than that payment, the contract is unchanged. If the floor exceeds it, the low-state payment equals the floor and the high-state payment increases to preserve the utility spread required by incentive compatibility, provided the resulting utility pair is attainable. Supplier participation is then slack, while incentive compatibility binds. This threshold depends on the financed order and the other contract primitives; it is not a universal monetary amount. Model 2 also imposes the same floor on the low-effort contract, so the bank must compare both effort regimes and the no-financing option. At the baseline high-effort cost in Table 2, increasing the floor from zero to 0.5 lowers the selected bank value from 0.6576 to 0.1576, while low effort and a retailer order of 2 are retained. At a floor of 0.75, neither effort regime supports profitable financing on the finest grid at any tested high-effort cost, and the retailer self-finances. These comparisons concern the tested grids and do not establish a continuous-offer financing threshold. The motivating case's marketing support and retailer credit facilities do not identify a monetary monitoring-payment floor; incorporating those provisions would require separate modelling of their obligations and costs. The bank therefore needs to evaluate supplier payment commitments together with retailer financing terms and the profitability of the resulting arrangement.

Several assumptions delimit the interpretation of these results. The framework describes a single-period inventory-purchase loan to a cash-constrained retailer, so its conclusions should be assessed within that financing structure. Supplier effort and the verifiable information signal each have two states, and demand is independent of the signal. Monitoring affects recovery following retailer default; at fixed financing terms, it does not change demand or the occurrence of default. More general effort and signal spaces, joint

demand–information distributions and repeated lending would require extending both the supplier’s incentive problem and the bank’s financing decision. Wholesale and retail prices are fixed, the supplier’s own default risk is not modelled, and monitoring payments are assumed enforceable even after retailer default. Future models could examine endogenous prices, supplier creditworthiness, limited payment enforcement and the upfront investment required for information-system integration. The current model addresses hidden monitoring effort with publicly known primitives; pre-loan private information and screening could be added to examine adverse selection alongside post-loan moral hazard. The numerical parameters are illustrative and do not estimate the motivating case’s costs, signal probabilities or recovery rates. Agreement between the last two grid refinements demonstrates stability of the reported comparisons at those resolutions, without providing an approximation-error bound or proving that a continuous-offer optimum is attained. Further work should establish conditions for attainment and compute bounds on numerical approximation error. Empirical validation would also require transaction and repayment data that identify effort-conditioned signal probabilities, monitoring costs and default recovery, together with tests of how well the resulting contracts predict financing and monitoring choices.

6. Conclusions

This study examined when bank-funded inventory purchases should be accompanied by incentive payments for a core supplier’s monitoring of a cash-constrained retailer. Its contribution is to connect the retailer’s order and borrowing response with supplier trading earnings, hidden monitoring effort and the bank’s recovery after default in one three-party framework. The analysis identifies the least-cost supplier payments conditional on an order and effort regime, then embeds these payments in the bank’s financing decision with participation requirements, a common payment floor and a no-financing alternative. A feasible high-effort contract alone does not justify lending: the bank must assess its recovery benefit and implementation cost together with the retailer’s response and the profitability of available financing offers.

In the illustrative calculations, the finest grid selects low-effort financing in the baseline, with a retailer order of 2 and expected retailer profit of 0.2375; self-financing yields an order of 0.2 and profit of 0.2. The bank earns 0.6576 with no monitoring-payment floor and 0.1576 with a common floor of 0.5. At the baseline financing terms, the additional implementation cost exceeds the recovery benefit from high effort in both models, so the bank prefers low monitoring effort. Reducing the high-effort cost from 0.12 to 0.045 utility units, with the remaining baseline parameters fixed, leads to high-effort selection at the zero floor and a bank profit of 0.6971, while the retailer order remains 2. The signal comparisons also produce switches to high effort at the lower cost as the tested high-effort signal probability increases. A floor of 0.75 eliminates profitable financing on the finest grid at all four tested high-effort costs. These outcomes describe the specified numerical scenarios and grids; they do not establish universal effort choices or a continuous-offer equilibrium.

The managerial implication is to evaluate supplier incentives together with the retailer’s loan and order decisions. Within the model, a bank needs to account for the supplier’s trading earnings and outside option, specify verifiable information states and relate monitoring compensation to the resulting recovery benefit. A payment floor should enter the comparison of both effort regimes and the profitability of financing. The analysis therefore supports examining contractual commitments jointly; it does not establish that higher payments or more monitoring improve all participants’ outcomes. Future empirical work should combine transaction and repayment records with credible measures of monitoring effort to estimate the signal and recovery mechanisms and test the contract

predictions. Theoretical extensions should address supplier creditworthiness, private information before lending and investment in information integration, while establishing conditions for continuous-offer attainment and bounds on numerical approximation error.

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Appendix A. Case Study

	Project A	Project B	Project C	Project D
Core supplier	Home-appliance manufacturer A	Home-appliance manufacturer A	Beverage manufacturer A	Beverage manufacturer B
SCF customer	Retailer	Retailer	Retailer	Retailer
Line of credit	5 million RMB or above	1 to 5 million RMB	1 to 5 million RMB	1 to 5 million RMB
Interviewees	Two senior managers of the bank in charge of project A Four senior managers of the core supplier	Two senior managers of the bank in charge of project B Four senior managers of the core supplier	One senior manager of the bank in charge of project C	One senior manager of the bank in charge of project D
Data collection	Each interview lasted about one hour. The research team asked senior bank managers about the design and implementation of SCF projects. The questions addressed how the bank identified customers and determined interest rates and credit limits before lending; the key steps in credit approval; how it collected loan repayments after entering into an SCF agreement; the issues it considered most important; and how it identified and controlled credit risk. The team also asked senior managers of the core suppliers about the extent of their information sharing with the bank, their ability to identify and meet retailers' financing needs, the issues they considered most important in SCF projects, and their supply chain management processes and practices. The study also drew on observations from site visits and internal materials from the bank and the core suppliers, including documents and presentations.			

Comments from the bank's managers

Bank managers stated that they would select retailers with higher sales revenue, stable sales growth over a longer period, and a longer history of transactions with the core supplier. In some cases, they would also select retailers with a fixed operating location to assess their business capacity.

Bank managers stated that they would verify order information with the core supplier in detail and disburse the SCF loan directly to it. They would require the core supplier to take responsibility for logistics and monitoring. If a retailer breached the SCF contract, the core supplier would be responsible for coordinating efforts to resolve the problem.

Bank managers regarded integration of the bank's and the core supplier's information systems as a prerequisite for implementing SCF projects. In their view, this was the only way to provide effective information support for implementation.

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