

A Model of Supplier Finance

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Supplier Finance (SF)

- ▶ Supplier finance (supply chain finance or reverse factoring) is enabled by advances in digital finance.
 - ▶ a buyer firm offers suppliers an early payment program
 - ▶ tailored liquidity support for suppliers
- ▶ SF gained traction among many large buyer firms.
 - ▶ Retailers: Walmart, Alibaba, JD.com, Carrefour, etc.
 - ▶ Manufacturers: GE, Lenovo, Philips, Sony, Samsung, etc.
- ▶ Market size of SF
 - ▶ The global SF market was estimated at \$1.8 trillion (2021).
 - ▶ It was growing at annual rates of 15% – 20% (2019–2024).

The Co-op Partners with PrimeRevenue to Protect Suppliers Amid Economic Volatility



NEWS

tags: [Supplier Perspective](#), [Supply Chain Finance](#)



By [PrimeRevenue](#) • Published August 11, 2020 • 4 minute read

UK's sixth largest food retailer makes strategic transition to PrimeRevenue platform

Atlanta, GA – Manchester, UK, August 11, 2020 – PrimeRevenue, the leading platform for working capital finance solutions, and The Co-operative Group, today announce a new supply chain finance partnership. Barclays Bank PLC, who introduced The Co-op to PrimeRevenue, will be providing funding on the supply chain finance programme followed by other financial institutions as the programme grows.

Co-op has made the strategic decision to partner with PrimeRevenue for its new supply chain finance offering. Fueled by a highly challenging business climate heightened by the pandemic, the company aims to offer suppliers a simple method of early payment to help with their cash flow without having a detrimental impact to Co-op's own cash position. This is particularly relevant in the current environment where the old adage "cash is king" has never been truer.

How does supplier finance work?

1. Co-op launches a supplier finance program (collaborates with a fintech company called PrimeRevenue):
 - ▶ Co-op *selects suppliers* into the program;
 - ▶ Co-op *delays payment* to participating suppliers.
2. Once joining the program, suppliers can opt to
 - ▶ Hold invoices to maturity;
 - ▶ Sell unpaid invoices to Co-op for **early payment**.
3. Co-op pays the full invoice amount at maturity.

Three puzzling facts of supplier finance

1. Divergence in Adoptions: Why do many leading buyer firms choose not to adopt SF?
 - ▶ Aldi, IKEA, Costco, Amazon, etc.
2. Trade Credit Extensions: Why do SF require suppliers to give more trade credit to the larger, capital-rich buyer firm?
 - ▶ A central theme in the trade credit literature.
3. Selective Inclusion: Why do buyer firms offer SF only to a selected set of suppliers?
 - ▶ Access is usually only by invitation.

Related literature

- ▶ Supply Chain Finance:
 - ▶ Tunca & Zhu (2017); Kouvelis & Xu (2021)
 - ▶ One buyer firm with many suppliers
- ▶ Multi-product intermediaries:
 - ▶ Rhodes, Watanabe & Zhou (2021)
 - ▶ Liquidity provision and intermediaries' retail advantages
- ▶ Banking and Money (Diamond-Dybvig model)
 - ▶ Heterogeneous suppliers and selective inclusion
- ▶ Trade credit
 - ▶ Petersen & Rajan (1997); Burkart & Ellingsen (2004); Cunat (2007); Nocke & Thanassoulis (2014)
 - ▶ Reallocation of trade credit among suppliers

The Model

Agents

- ▶ A mass of suppliers:
- ▶ A mass of consumers:
- ▶ One intermediary (buyer-firm):

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- ▶ A mass of suppliers:
 - ▶ Each produces a unique and indivisible good
 - ▶ Constant marginal costs, $c \in [\underline{c}, \bar{c}]$, differ among suppliers
 - ▶ c is publicly observable
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 - ▶ There is a *numeraire* good (used as a payment)

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Trade and liquidity shocks

- ▶ Suppliers can trade directly with consumers
 - ▶ each supplier can meet all consumers, trade bilaterally
 - ▶ trade surplus is split equally: $p - c = (u - c)/2$
 - ▶ this particular solution does not matter for our results

Trade and liquidity shocks

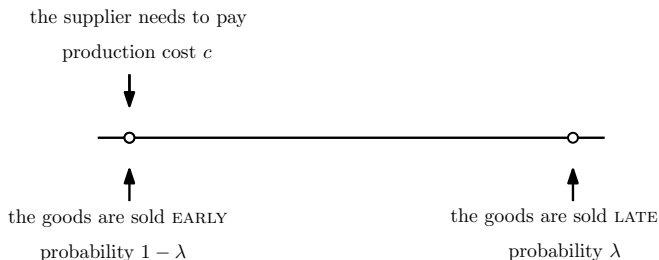
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- ▶ Suppliers (with no endowment) face no liquidity issue in a frictionless world
 - ▶ retail revenue can be used to cover production costs c
- ▶ Supplier's liquidity issue matters when:
 - ▶ disparity exists in the timing between production and trade.
 - ▶ a liquidity shock prevents suppliers from using retail revenue to cover production costs.



- ▶ There are two sub-periods: *early* and *late*.
 - ▶ Production is possible only in the *early* sub-period.
 - ▶ Suppliers may match with consumers *early or late*.
- ▶ With probability $1 - \lambda$: a supplier matches with consumers early, c can be covered using revenue
- ▶ With probability λ : a supplier matches with consumers late c can not be covered using revenue (i.e., **liquidity shock**)

Interpret liquidity shocks from retail technologies

No trade occurs because of limited retail technologies possessed by suppliers.

- ▶ Display/advertisement: Consumers buy only after inspection & Display can be early or late
- ▶ Delivery/inventory : Consumers pay only after delivery & Delivery can be early or late
- ▶ Production-to-Order: Order and payment by consumers could occur early if communicated well

Ex ante heterogeneity of suppliers

- Each supplier is indexed by

$$(\lambda, c) \in \Omega = [0, 1] \times [\underline{c}, \bar{c}],$$

λ is the probability of liquidity shock, c is marginal cost;
 (λ, c) follows C.D.F. $G(\lambda, c)$, publicly observable.

The intermediary selects suppliers into one of the modes:

1. Middleman mode (M), pure middleman
2. Finance mode (F), middleman and liquidity provider

Middleman mode (M)

- ▶ The intermediary sells on behalf of suppliers
 - ▶ Intermediary's probability of a liquidity shock: $m\lambda$
 - ▶ $m < 1$: intermediary's matching advantage over the original suppliers (Rubinstein and Wolinsky 1987)
- ▶ The intermediary gives TILI offers to selected suppliers:
 - ▶ c needs to be covered by the supplier himself
 - ▶ Transfer $f_M(\lambda, c)$ immediately after consumers pay
 - ▶ f_M compensates suppliers direct selling value $(1 - \lambda)(u - c)/2$.
- ▶ Supplier (λ, c) contributes profits:

$$\begin{aligned}\pi_m(\lambda, c) &= \underbrace{(1 - m)\lambda(u - c)/2}_{\equiv (1 - m\lambda)\frac{u - c}{2} - (1 - \lambda)\frac{u - c}{2}} > 0 \text{ (since } m < 1\text{)}\end{aligned}$$

Finance mode (F)

- ▶ The intermediary sells on behalf of suppliers **and** provides liquidity.
- ▶ Intermediary gives TILI offers to selected suppliers:
 - ▶ Transfer a reward $f_F(\lambda, c)$ at the end of the period
 - ▶ Costs c are covered by intermediary at the time of production
- ▶ Supplier (λ, c) contributes profit:

$$\pi_F(\lambda, c) = \lambda(u - c)/2 - k$$

$k > 0$: per-seller cost of early payment program;

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and contributes liquidity (at the time of production):

$$\theta_F(\lambda, c) = (1 - m\lambda)p - c = (1 - m\lambda)(u + c)/2 - c$$

Intermediary's problem

- The intermediary selects suppliers into two modes:

$$\max_{q(\cdot) \in \{0,1\}} \int_{\Omega} \left((1 - q(\lambda, c)) \pi_M(\lambda, c) + q(\lambda, c) \pi_F(\lambda, c) \right) dG$$

subject to the liquidity constraint:

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- ▶ The object is equivalent to

$$\max_{q(\cdot)} \int_{\Omega} \left(\pi_M(\lambda, c) + q(\lambda, c) \Delta \pi(\lambda, c) \right) dG,$$

where $\Delta \pi(\cdot) = \pi_F(\cdot) - \pi_M(\cdot)$.

Profit-maximizing selection policy

- ▶ The intermediary's problem can be solved using the Lagrangian:

$$\mathcal{L} = \int_{\Omega} \left[\pi_M(\cdot) + q(\cdot) \left(\Delta\pi(\cdot) + \mu\theta_F(\cdot) \right) \right] dG(\lambda, c)$$

- ▶ $\mu \geq 0$: The shadow value of liquidity
- ▶ The optimal selection rule is:

$$q(\lambda, c, \mu) = \begin{cases} 1 & \text{if } \Delta\pi(\lambda, c) + \mu\theta_F(\lambda, c) \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

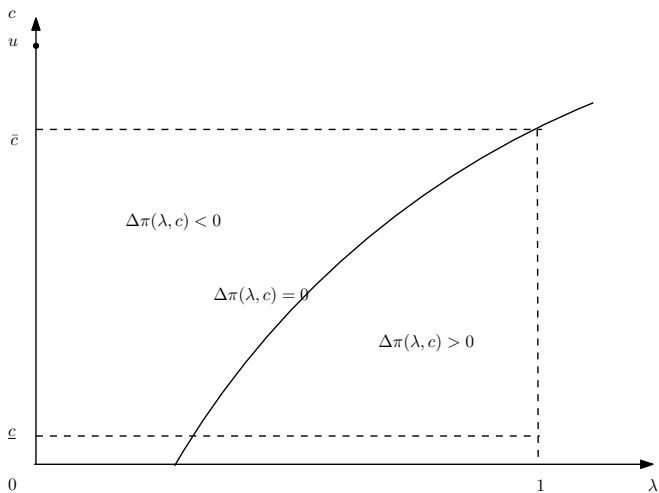


Figure: Incremental profit $\Delta\pi \equiv \pi_F - \pi_M$

$$\Delta\pi(\lambda, c) = m\lambda(u - c)/2 - k$$

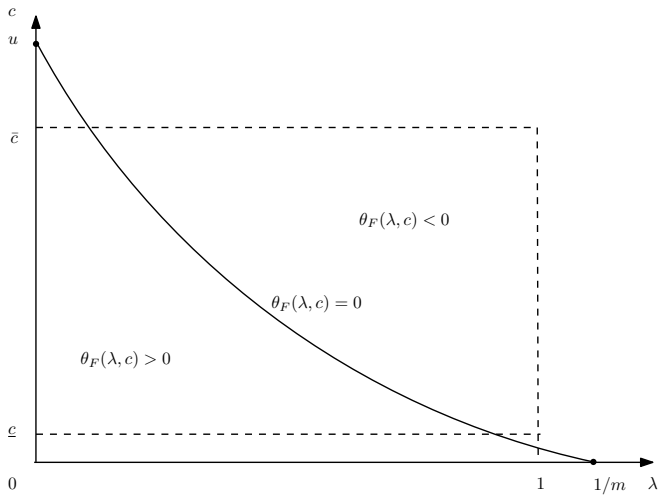


Figure: Liquidity $\theta_F(\lambda, c)$

$$\theta_F(\lambda, c) = (1 - m\lambda)(u + c)/2 - c$$

Proposition (Profit-based liquidity cross-subsidization)

The intermediary optimally selects suppliers from three regions

- ▶ *Region A: positive profit and positive liquidity contributions*

$$\Delta\pi(\lambda, c) \geq 0, \quad \theta_F(\lambda, c) \geq 0$$

- ▶ *Region B: positive profit and negative liquidity*

$$\Delta\pi(\lambda, c) > 0, \quad \theta_F(\lambda, c) < 0, \quad \underbrace{-\pi/\theta_F}_{\text{returns}} \geq \mu$$

- ▶ *Region C: negative profit and positive liquidity*

$$\Delta\pi(\lambda, c) < 0, \quad \theta_F(\lambda, c) > 0, \quad \underbrace{-\pi/\theta_F}_{\text{costs}} \leq \mu$$

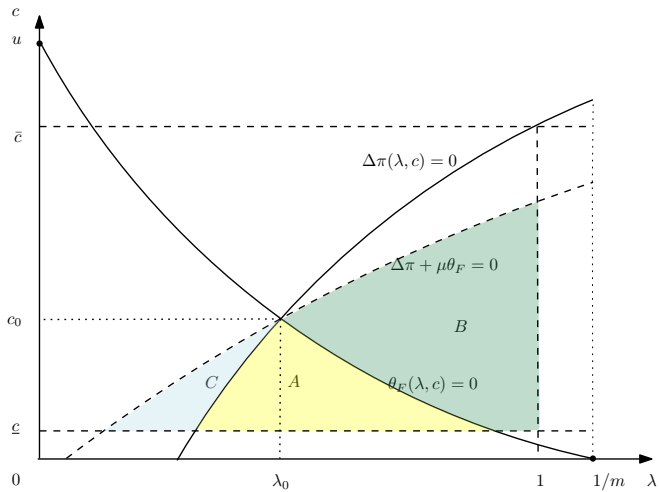


Figure: Profit-based liquidity cross-subsidization

Proposition

Supplier finance is active whenever $\Delta\pi(1, \underline{c}) < 0$, or

$$k/m < (u - \underline{c})/2.$$

When supplier finance is active, suppliers are selected and liquidity is cross-subsidized ($\mu > 0$).

Intuitions:

- ▶ Smaller k : less costly fintech.
- ▶ Larger m : lower inventory turnover.
- ▶ This proposition answers all three puzzles
(1) adoption, (2) trade credit extension, (3) selective inclusion.

Generalizing supplier outside options

- ▶ Suppose suppliers have a direct selling value of $w(\lambda, c)$ assuming $w(\lambda, c) < (1 - m\lambda)(u - c)/2$
- ▶ We have

$$\Delta\pi(\lambda, c) = m\lambda(u - c)/2 - k,$$

since

$$\pi_F(\lambda, c) = (u - c)/2 - w(\lambda, c) - k,$$

$$\pi_M(\lambda, c) = (1 - m\lambda)(u - c)/2 - w(\lambda, c).$$

Endogenous liquidity holdings L

Determination of μ

The liquidity constraint determines $\mu = \mu(L)$:

$$\int_{\Omega} q(\lambda, c, \mu) \theta_F(\lambda, c) dG + L = 0$$

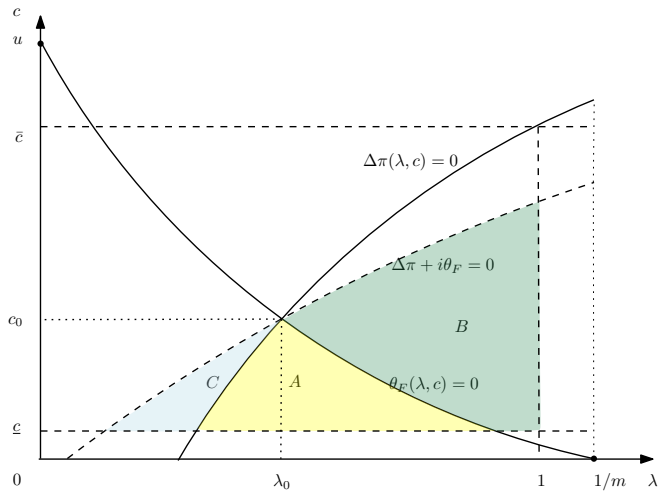
- ▶ $\mu(L) = 0$: liquidity does not matter for selecting suppliers; selection is solely based on $\Delta\pi(\lambda, c)$
- ▶ $\mu(L) > 0$: liquidity cross-subsidization, strictly decreases in L
- ▶ $\mu(0)$: the liquidity value at $L = 0$, or shadow price of the first marginal unit of liquidity

Endogenous L

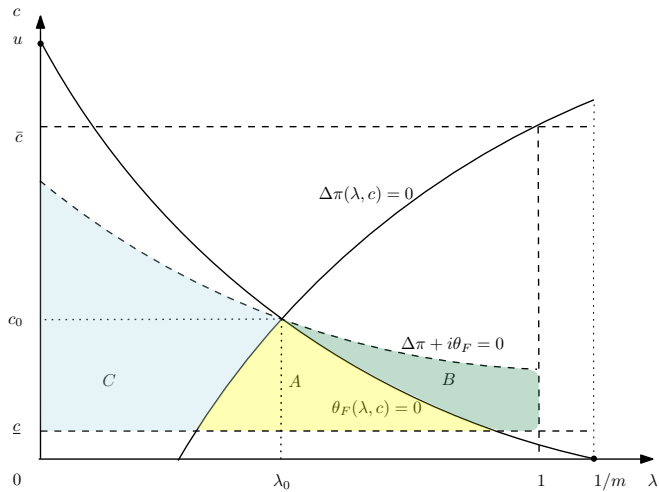
- ▶ Suppose the intermediary faces a liquidity cost in the money market i (nominal interest rate).
- ▶ The intermediary's liquidity holdings $L \geq 0$, which is strictly decreasing in $i \in (0, \mu(0))$, satisfying:

$$\begin{cases} \mu(L) = i & \text{if } i < \mu(0); \\ L = 0 & \text{if } i \geq \mu(0). \end{cases}$$

- ▶ The equilibrium liquidity value $\mu = \min\{\mu(0), i\}$ is jointly shaped by
 - ▶ Richness of suppliers' liquidity: $\mu(0)$
 - ▶ Cost of outside market liquidity: i



Positively-sloped selection curve



Negatively-sloped selection curve

Welfare

Welfare

- ▶ Incremental total surplus for finance:

$$\Delta v(\lambda, c) = m\lambda(u - c) - k.$$

- ▶ A planner subjected to liquidity shocks will adopt liquidity cross-subsidization.
- ▶ Social welfare can increase when funding cost i is higher.

When $i = 0$

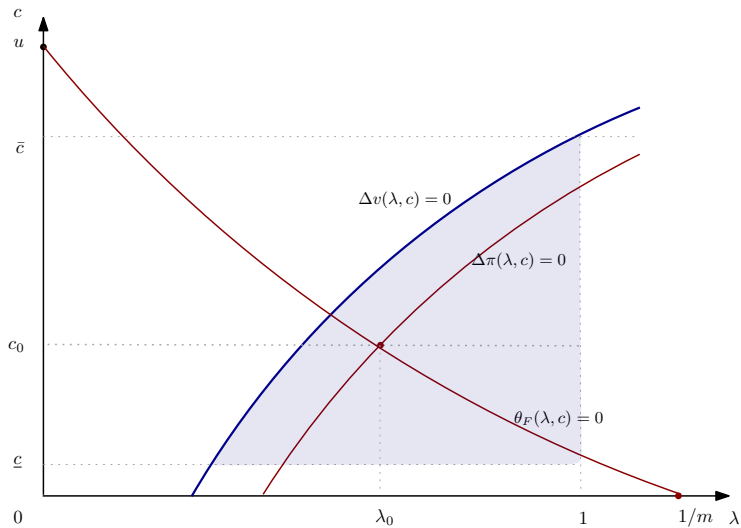


Figure: Supplier finance is welfare improving

When $i > 0$

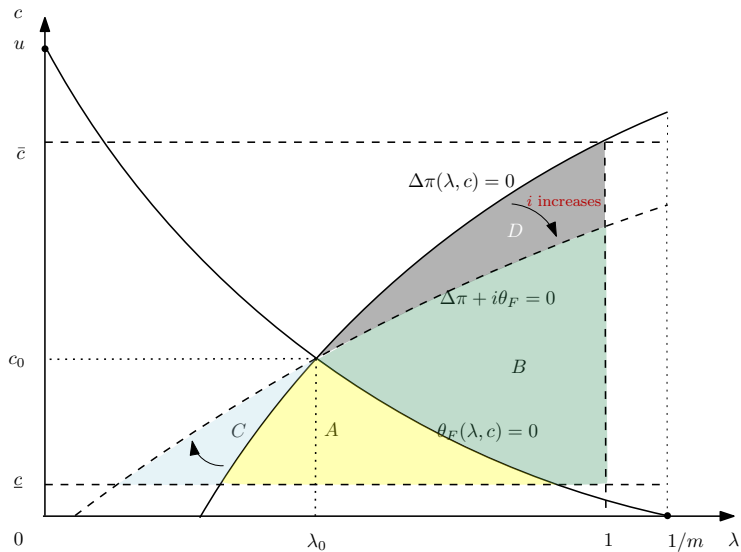


Figure: Marginal suppliers as i increases from $i = 0$

When $i > 0$

Proposition (Non-zero external funding rates)

Suppose $\mu(0) > 0$, and (λ, c) follows a uniform distribution.

There exists $m^ > 0$ and $k^* > 0$ such that if $m < m^*$ or $k < k^*$, marginally increasing i from $i = 0$ improves welfare.*

Intuition:x

- ▶ As i increases, finance mode excludes suppliers with positive $\Delta\pi(\lambda, c)$ and includes suppliers with positive $\theta(\lambda, c)$
- ▶ Trading volume increases when C is sufficiently higher than D
- ▶ Graphically, if either m or k is sufficiently small, D is also sufficiently small

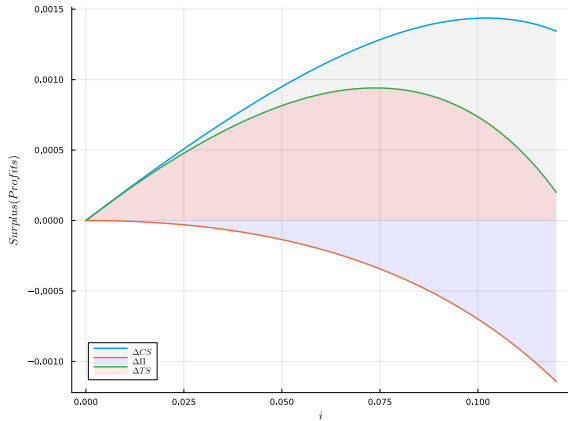


Figure: Welfare is non-monotonic in i under uniform distribution of (λ, c)

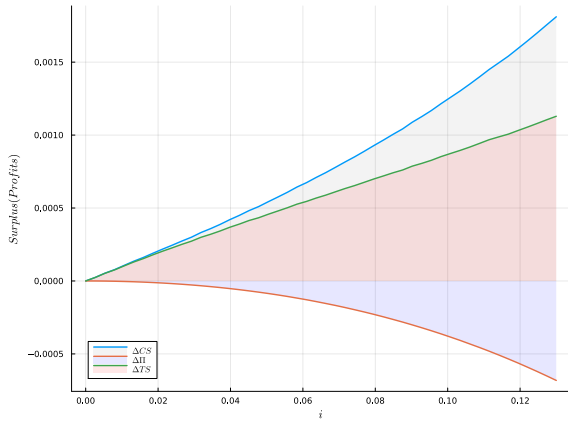
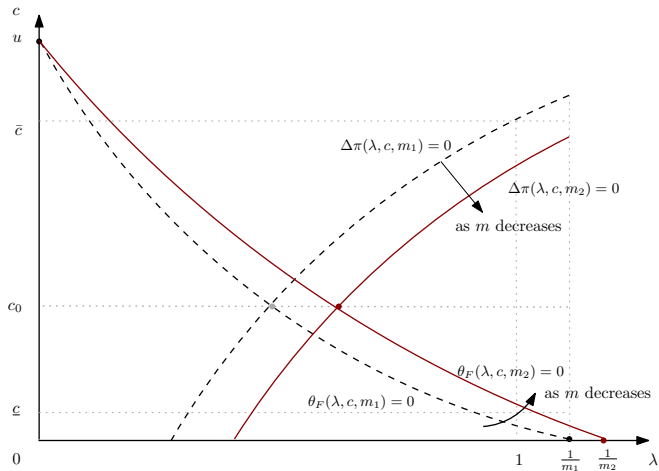


Figure: Welfare increases in i under Beta distributions of λ and c

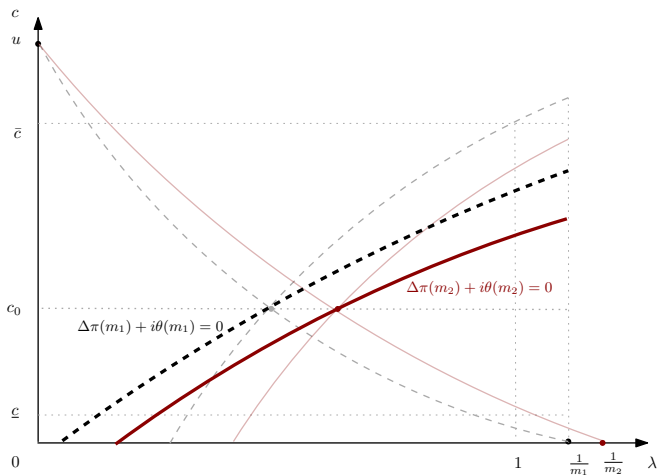
Matching efficiency and liquidity provision



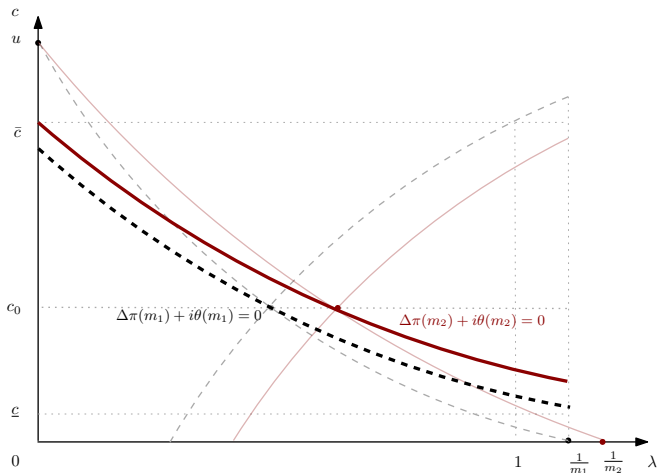
Effects of changes in matching efficiency m :

$$\Delta\pi(\lambda, c) = m\lambda(u - c)/2 - k$$

$$\theta_F(\lambda, c) = (1 - m\lambda)(u + c)/2 - c$$

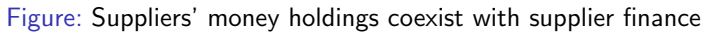


- If the selection curve is upward-sloping, SF shrinks as m decreases from m_1 to m_2 (matching efficiency improves)



- If the selection curve is downward-sloping, SF expands as m decreases m_1 to m_2 (matching efficiency improves)

Suppliers' access to money market



Proposition

Suppose $\lambda_0 < 1$, $\underline{c} > 0$, $i < \frac{k\bar{\lambda}}{mu\bar{\lambda}-2k}$, and suppliers face money market rate i^s . There exist thresholds $i < \underline{i}^s < \bar{i}^s \equiv \frac{(u-\underline{c})\bar{\lambda}}{2\underline{c}}$ such that:

- ▶ If $i^s \leq \underline{i}^s$, suppliers with $c \leq c^s(\lambda, i^s)$ hold money for liquidity, and supplier finance stays inactive.
- ▶ If $i^s \geq \bar{i}^s$, no supplier holds money, and supplier finance is activated for some suppliers.
- ▶ If $i^s \in (\underline{i}^s, \bar{i}^s)$, suppliers with $c \leq c^s(\lambda, i^s)$ have money, while supplier finance activates for other suppliers.

Manufacturing supplier finance

Manufacturing supplier finance

- ▶ A manufacturer (M) produces final goods using homogeneous intermediate goods sourced from suppliers.
- ▶ Suppliers are indexed by (λ, c) . Each can produce at most one unit of intermediate goods.
 - ▶ With prob λ , the supplier does not have liquidity to buy the required inputs.
- ▶ Let I be the total amount of intermediate goods, and impose a linear production function $Q(I) = I$.
- ▶ In retail market, price is normalized to one. A fraction α consumers purchase the final goods in early subperiod, and $1 - \alpha$ purchase in late subperiod.

- ▶ M sources intermediate goods from two channels.
- ▶ **Wholesale market:** with prob $1 - \lambda$, the supplier can produce and show in wholesale market, price is $w(c)$.

$$\pi_W(\lambda, c) = (1 - \lambda)(1 - w(c)),$$

$$\theta_W(\lambda, c) = (1 - \lambda)(\alpha - w(c)).$$

- ▶ **Supplier finance:** c is financed, the supplier produces & delivers for sure; M pays $f(\lambda, c)$ to the supplier in late subperiod.

$$\pi_F(\lambda, c) = 1 - c - (1 - \lambda)(w(c) - c) - k,$$

$$\theta_F(\lambda, c) = \alpha - \lambda c.$$

- The manufacturer's problem is to choose $q(\cdot) \in \{0, 1\}$ to maximize:

$$\int_{\Omega} \left(q(\lambda, c) \pi_F(\lambda, c) + (1 - q(\lambda, c)) \pi_W(\lambda, c) \right) dG,$$

subject to the liquidity constraint:

$$\int_{\Omega} \left(q(\lambda, c) \theta_F(\lambda, c) + (1 - q(\lambda, c)) \theta_W(\lambda, c) \right) dG + L \geq 0.$$

- $q(\cdot) = 1$ if and only if

$$\Delta\pi + \mu\Delta\theta \geq 0.$$

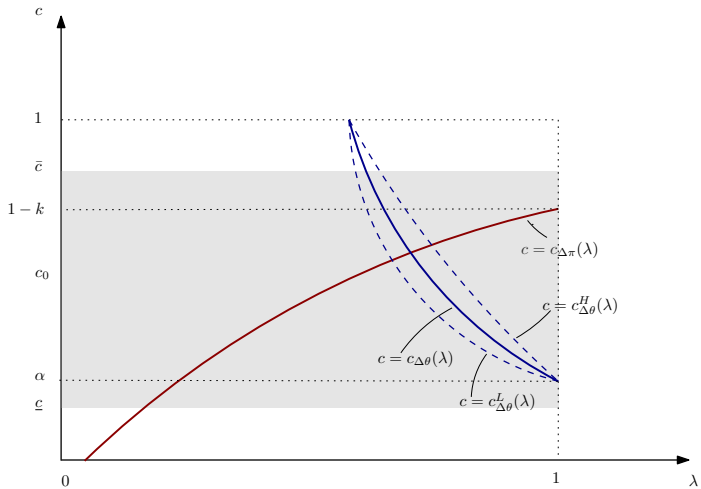


Figure: Manufacturer financing selection under linear production function

Policy implications: sleeping risks

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MARKETS

Supply-Chain Finance Is New Risk in Crisis

Experts say the economic slowdown could expose weak spots in the arrangements



A “sleeping risk” on the books of U.S. businesses could be awakened by the pandemic, as the sudden cash crunch exposes a hidden type of financing that makes balance sheets look better, credit-rating firms are warning.

- ▶ Rising funding costs may trigger widespread supplier bankruptcies and substantial declines in output.
 - ▶ The buyer firm can respond to rising external funding costs by relying more on trade credit of suppliers.
 - ▶ The internal liquidity pool serves as a buffer against funding cost pressures.

Policy implications: window dressing

- ▶ Buyer firms tend to record payment obligations as accounts payable rather than debt to understate leverage.
- ▶ Window-dressing is not an intrinsic feature of SF.
- ▶ External liquidity utilization depends on the characteristics of the supplier pool ($\mu(0)$).
- ▶ More transparency in supplier finance agreements is needed for investors to evaluate the magnitude of window dressing.

Disclosure of Supplier Finance Program Obligations

Accounting Standards Update 2022-04—Liabilities—Supplier Finance Programs (Subtopic 405-50): Disclosure Of Supplier Finance Program Obligations

Overview

On September 29, 2022, the Financial Accounting Standards Board ([FASB](#)) issued [Accounting Standards Update No. 2022-04, Liabilities—Supplier Finance Programs \(Subtopic 405-50\): Disclosure of Supplier Finance Program Obligations](#), to enhance the transparency about the use of supplier finance programs for investors and other allocators of capital.

Summary

- ▶ Profit-Based Liquidity Cross-Subsidization
- ▶ Selective Inclusion
- ▶ Supplier finance mitigates the costs rise of external liquidity.
- ▶ Retail efficiency and liquidity provision can be substitutes or complements, depending on the shadow value of liquidity.
- ▶ Welfare is non-monotonic in nominal interest rates.