Middleman Finance and Product Market Distortions

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Jan 12, 2026

Middlemen as Liquidity Providers

Middlemen, who purchase goods from suppliers and sell to consumers, provide liquidity support to suppliers.

Historically, middlemen and liquidity provision were closely related:

- *Colonial Trade*: The Dutch East India Company extended credit to local growers in the form of advanced payments
- *Input Financing:* Middlemen provide seeds, fertilizers, and farming equipment to small farmers

Nowadays, with advances in financial technologies, financing suppliers has become increasing critical for middlemen, e.g., Walmart, Amazon, JD.com, etc.

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

By **PrimeRevenue** • 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.

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Research questions:

- What are the economic rational behind trade credit extension and supplier selection?
- How does middleman finance affect retail prices and product market efficiency?

Related literature

- Intersection of IO and Corporate Finance
  - Nocke & Thanassoulis JEEA 2014: Downstream financial constraint leads to risk-sharing between buyer and seller firms, resulting in double-marginalization.
- Multi-product Intermediaries
  - Rhodes, Watanabe & Zhou JPE 2021
  - Liquidity provision and intermediaries' retail advantages
- Diamond-Dybvig model and Trade Credit
  - Petersen & Rajan RFS 1997; Burkart & Ellingsen AER 2004; Cunat RFS 2007;
  - Reallocation of trade credit among suppliers

1. The Benchmark Model

Agents

- A mass of suppliers:

- A mass of consumers:

- One intermediary:

Agents

- 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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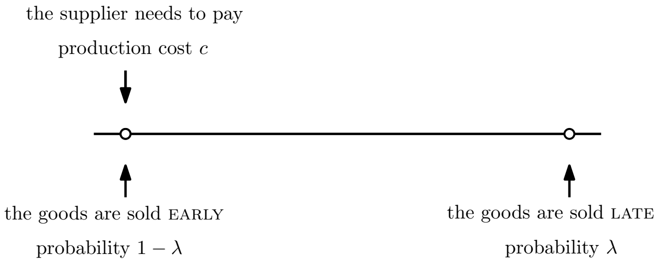
  - retail revenue can be used to cover costs c
- Supplier's liquidity issue matters when:
  - disparity exists in the timing between production and trade.

Trade and Liquidity Shocks



- Two sub-periods: early and late
  - production occurs only in the early sub-period
  - suppliers may match with consumers early or late
- Prob. $1 - \lambda$: consumers arrive early, c can be paid by revenue
- Prob. λ: consumers arrive later, c can not be covered using revenue
- It is one micro-foundation for generating liquidity shocks.

Ex ante heterogeneity of suppliers

- Suppliers are indexed by

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

$$\text{where} \quad \lambda: \text{ prob. of liquidity shock;}$$
$$c: \text{ marginal cost.}$$

- The pair (λ, c) of each supplier is publicly observable.
- (λ, c) follows some C.D.F. $G(\lambda, c)$.

Intermediary

The intermediary selects suppliers into either mode:

- Middleman mode (M): pure middleman
- Finance mode (F): middleman *plus* liquidity provider

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Middleman matching advantage:

- The intermediary sells on behalf of suppliers
- prob. of liquidity shocks decreases to $m \cdot \lambda$
- $m < 1$: middlemen's matching advantage (Rubinstein and Wolinsky 1987)

Middleman Mode (M)

- The intermediary gives Take-It-Or-Leave-It (TIOLI) offers:
  - Supplier pays c by himself;
  - Intermediary makes a transfer $f_M(\lambda, c)$ **upon receipt of consumer payment.**
- Supplier (λ, c) contributes profit:

$$\begin{aligned}\pi_M(\lambda, c) &= (1 - m\lambda)p - \underbrace{(1-\lambda)(u-c)/2}_{\text{direct-selling value}} \\ &= (1-m)\lambda(u-c)/2 > 0 \text{ (since } m < 1).\end{aligned}$$

Finance Mode (F)

- The intermediary resells **and** provides liquidity.
- Financing supplier is costly: per-user cost $k > 0$.
- Intermediary gives TIOLI offers:
  - c is covered by the intermediary in the early sub-period;
  - Intermediary pays $f_F(\lambda, c)$ to supplier **by the end of the period**
- Supplier (λ, c) contributes **profit**:

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

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and contributes **liquidity** (at the time of production):

$$\theta_F(\lambda, c) = (1 - m\lambda)p - c$$

The intermediary's problem

- The intermediary selects suppliers into one of the two modes:

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

subject to the liquidity constraint:

$$\underbrace{\int_\Omega q(\lambda, c)\theta_F(\lambda, c) dG}_{\text{total liquidity}} + L \geq 0.$$

- Define $\Delta\pi(\cdot) = \pi_F(\cdot) - \pi_M(\cdot)$. The objective is equivalent to

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

Profit-maximizing selection rule

- Solve the problem using Lagrangian:

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

$\mu \geq 0$: The shadow value of liquidity

- The optimal selection rule is:

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

Proposition (Selecting Suppliers)

The intermediary optimally selects suppliers from three regions

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

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

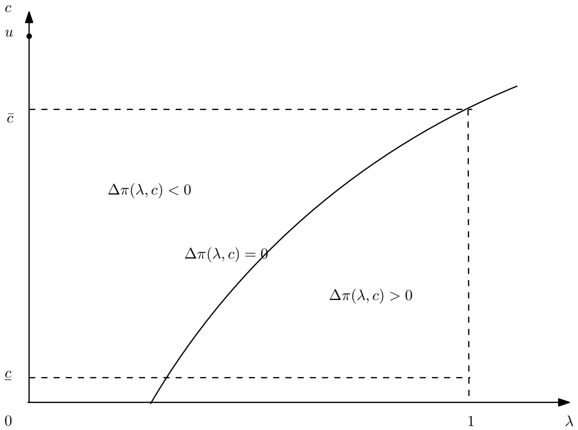
- *Region B:* **positive** *profit and* **negative** *liquidity*

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

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

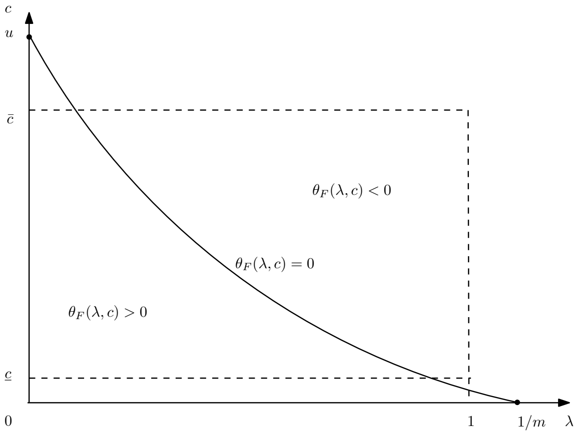
$$\Delta\pi(\lambda, c) < 0, \quad \theta_F(\lambda, c) > 0, \quad \underbrace{-\Delta\pi/\theta_F}_{\textit{costs}} \leq \mu$$

$\Delta\pi$ in the space of λ and c



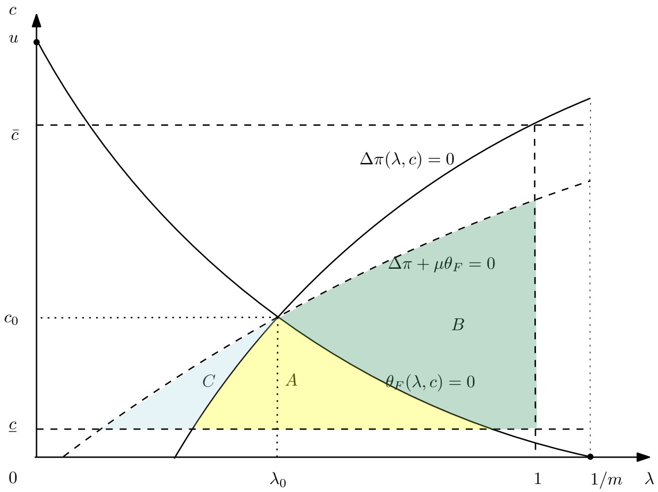
$$\Delta\pi(\lambda, c) = m\lambda(u - c)/2 - k$$

θ_F in the space of λ and c



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

Profit-based liquidity cross-subsidization



Profit-maximizing selection rule

- μ is determined by

$$L = -\Theta(\mu) \equiv -\int_{\Omega} q(\lambda, c, \mu)\theta_F(\lambda, c)dG. \tag{1}$$

If liquidity constraint is slack, i.e., $-\Theta(0) \leq L$, then $\mu = 0$.

Proposition

Given liquidity endowment $L \geq 0$ and $k/m < (u - \underline{c})/2$, the intermediary's profit-maximizing strategy involves active F mode, which is characterized by

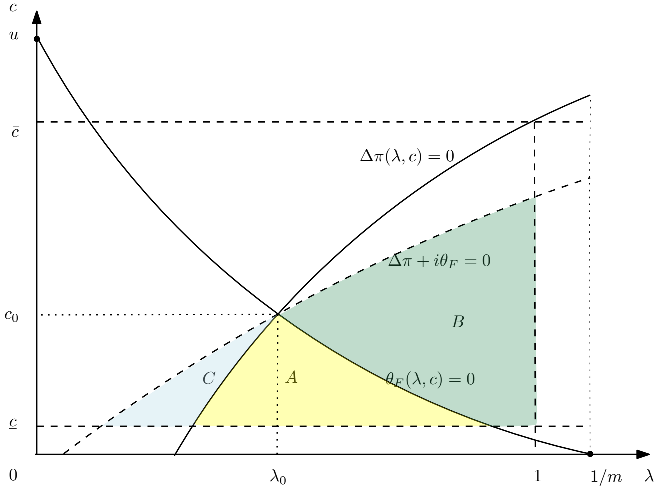
$$\{q(\lambda, c, \mu), f_F(\lambda, c), f_M(\lambda, c), \mu(L)\}.$$

Endogenize L

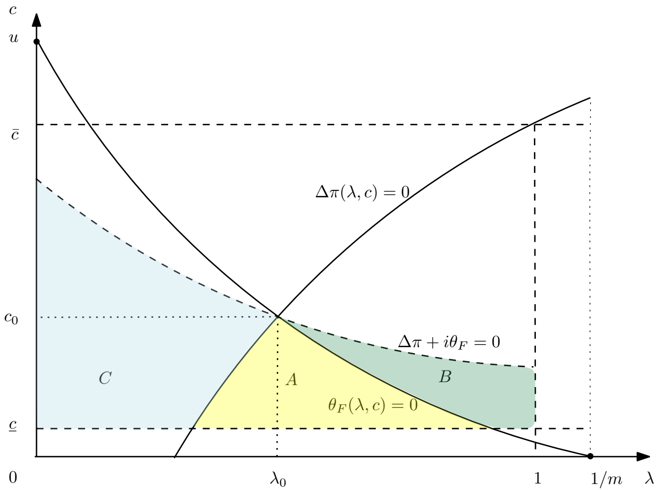
- So far, a downward sloping demand curve for liquidity $\mu(L)$
- Suppose the intermediary faces a liquidity cost i
- The intermediary's liquidity holdings $L \geq 0$ satisfy

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

- The equilibrium liquidity value $\mu = \min\{\mu(0), i\}$ is shaped by
  - richness of suppliers' liquidity: $\mu(0)$
  - cost of external liquidity: i



Positively-sloped selection curve



Negatively-sloped selection curve

Generalize suppliers' direct selling value

- Let suppliers' direct selling value be $\Phi(\lambda, c) \geq 0$.
- We have profit contributions of F and M contracts:

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

- What matters for our analysis is

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

2. Middleman Finance and Product Market

We endogenize the retail price...

Downward-sloping demand $D(p)$

- A continuum of consumers; demand for each product $D(p)$
- c is a per-unit cost

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Direct-selling:

- A supplier produces only if consumers arrive early
- In that state, he sets the monopoly price

$$p^*(c) \equiv \arg\max_{p \geq c} (p - c)D(p)$$

Assume the objective is strictly quasi-concave in p and let the monopoly profit be

$$\pi^*(c) \equiv (p^*(c) - c)D(p^*(c)).$$

The intermediary

The intermediary can offer M or F contracts to suppliers.

M contract:

- With prob. $1 - m\lambda$, match with consumers early.
- The intermediary sets the monopoly price $p^*(c)$ for that state and pays to suppliers direct selling value.
- Supplier of (λ, c) contributes profit of

$$\pi_M(\lambda, c) = (1 - m)\lambda\pi^*(c).$$

Recall that in the benchmark:

$$\pi_M(\lambda, c) = (1 - m)\lambda\frac{u - c}{2}.$$

F contract:

- Intermediary advances production cost $c \cdot D(p)$ to the supplier.
- The expected profit at retail price p is

$$\pi_F(\lambda, c, p) = (p - c)D(p) - (1 - \lambda)\pi^*(c) - k.$$

- The incremental profit is

$$\Delta\pi(\lambda, c, p) \equiv (p - c)D(p) - (1 - m\lambda)\pi^*(c) - k.$$

- The liquidity contribution from supplier (λ, c):

$$\theta_F(\lambda, c, p) = (1 - m\lambda)pD(p) - cD(p).$$

Intermediary's problem

- The intermediary chooses $q(\lambda, c) \in 0, 1$ and $p(\lambda, c) \in \mathbb{R}_+$:

$$\max_{\{q(\cdot), p(\cdot)\}_{(\lambda,c)\in\Omega}} \int_\Omega \left[q(\cdot)\Delta\pi(\lambda, c, p(\cdot))\right] dG,$$

$$\text{s.t.} \int_\Omega \left[q(\cdot)\theta_F(\lambda, c, p(\cdot))\right] dG + L \geq 0.$$

- The corresponding Lagrangian:

$$\mathcal{L} = \int_\Omega \left[q(\lambda, c) \underbrace{\Big(\Delta\pi(\lambda, c, p(\lambda, c)) + \mu\theta_F(\lambda, c, p(\lambda, c))\Big)}_{\equiv S(\cdot)}\right] dG.$$

Optimal pricing for financed products

- The net value of financing supplier (λ, c):

  $$S(\cdot) = (1 + \mu(1 - m\lambda))\,(p - \tilde{c})\,D(p) - k - (1 - m\lambda)\pi^*(c),$$

  with effective cost $\tilde{c} = \gamma c$. γ captures liquidity-related costs:

  $$\gamma \equiv \frac{1 + \mu}{1 + \mu(1 - m\lambda)} \geq 1.$$

  $\gamma = 1$ iff $\mu = 0$ or $\lambda = 0$; γ increases in μ and λ.

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- The profit-maximizng retail price:

  $$p(\lambda, c) = p^*(\tilde{c})$$

  $p^*(\tilde{c}) - p^*(c)$: liquidity-driven double marginalization.

The new selection rule

- We decompose the net valuation $S(\lambda, c)$ into a baseline component and a premium derived from pricing flexibility:

$$S(\lambda, c, \mu) = \underbrace{S_{base}(\lambda, c, \mu)}_{\text{Baseline value}} + \underbrace{\mathcal{G}(\lambda, c, \mu)}_{\text{Pricing gain}}.$$

- S_{base} represents the valuation if price is fixed to $p^*(c)$

$$S_{base}(\lambda, c, \mu) = \underbrace{m\lambda\pi^*(c) - k}_{\text{Baseline Profit}} + \mu \underbrace{\left[(1 - m\lambda)p^*(c) - c\right] D(p^*(c))}_{\text{Baseline Liquidity}}.$$

Price gain and risk resilience

- $\mathcal{G}(\lambda, c, \mu)$, captures the gain by setting $p = p^*(\tilde{c})$:

$$\mathcal{G}(\lambda, c, \mu) \equiv (1 + \mu(1 - m\lambda))\Big[\pi^*\Big(p^*(\tilde{c}), \tilde{c}\Big) - \pi\Big(p^*(c), \tilde{c}\Big)\Big].$$

- $\mathcal{G}(\cdot)$ is strictly positive, strictly increasing in λ and μ.

Proposition

The intermediary's selection rule is characterized by a strictly expanded and less risk-sensitive financing boundary:x

$$c^*(\lambda) > c^*_{base}(\lambda), \rightharpoonup \ \textit{expanded financed set}$$
$$\partial c^* / \partial \lambda > \partial c^*_{base} / \ \partial \lambda, \rightharpoonup \ \textit{reduced risk sensitivity.}$$

Implications on product market surplus

- The change in trade surplus by financing:

$$\Delta W(\lambda, c) \equiv \underbrace{W\Big(p^*(\tilde{c})\Big)}_{\text{F contract surplus}} - \underbrace{\Big(1 - m\lambda\Big) W\Big(p^*(c)\Big)}_{\text{M contract surplus}}.$$

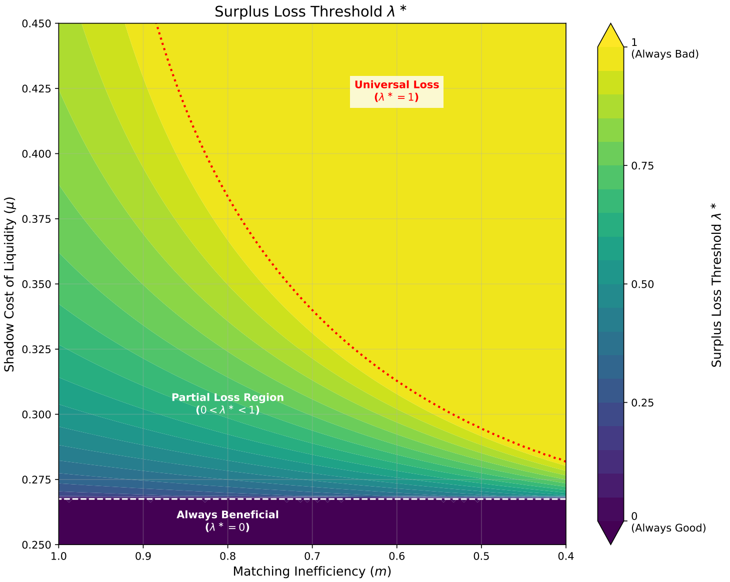
where $W(p, c) = \int_p^\infty D(t)dt + (p - c)D(p)$.

Proposition (Retail trade surplus loss)

Suppose $\Delta W'_\lambda(0, c) < 0$. There exists a threshold $\lambda^* \in (0, 1/m)$ such that **financing suppliers strictly reduces retail trade surplus** *for $\lambda \in (0, \lambda^*)$.*

Funding cost μ and matching efficiency m

- **Higher funding costs** $\mu \uparrow \Longrightarrow$ **Loss-range expands** $\lambda^* \uparrow$
- Higher μ exacerbates the double marginalization problem, requiring a higher risk λ to offset the price distortion.
- **Better matching** $m \downarrow \Longrightarrow$ **Loss-range expands** $\lambda^* \uparrow$
- As $m \downarrow$, the M contract becomes a tougher benchmark to beat. The insurance value of financing reduces, but the price distortion remains.



Trade surplus loss threshold λ^* with $D(p) = p^{-\varepsilon}$

Implications on consumer surplus

- The change in consumer surplus by financing:

$$\Delta CS(\lambda, c) \equiv CS(p^*(\tilde{c})) - (1 - m\lambda) CS(p^*(c)),$$

where $CS(p) \equiv \int_p^{\bar{p}} D(z)dz$.

Proposition (Consumer surplus loss)

Fix c and suppose $\Delta W(\lambda, c) < 0$ for $\lambda < \lambda^*$. Then there exists $\lambda^*_{CS} > \lambda^*$ such that

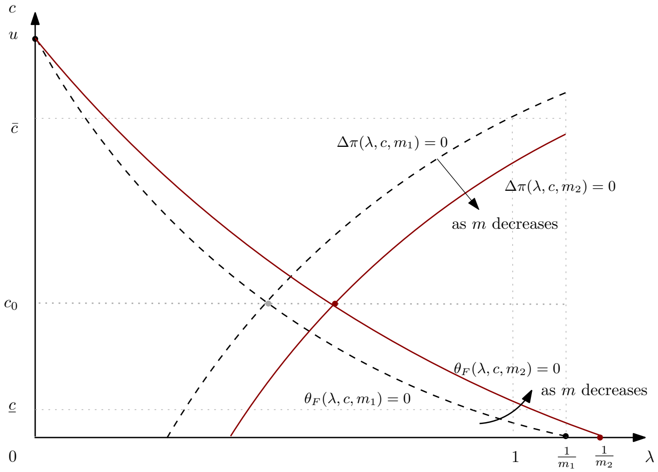
$$\Delta CS(\lambda, c) < 0 < \Delta W(\lambda, c) \text{ for } \lambda \in (\lambda^*, \lambda^*_{CS}).$$

Summary

- Middlemen finance features **profit-based liquidity cross-subsidization.**
- Middlemen finance leads to **liquidity-driven double marginalization** and potentially harms product market trade surplus.

Supplementary materials

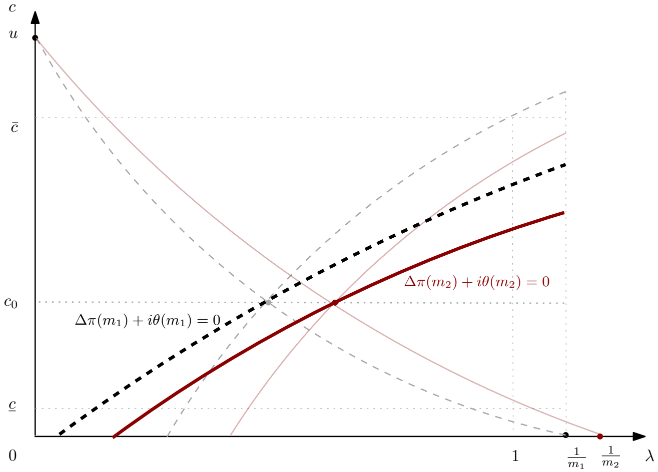
Matching efficiency and liquidity provision



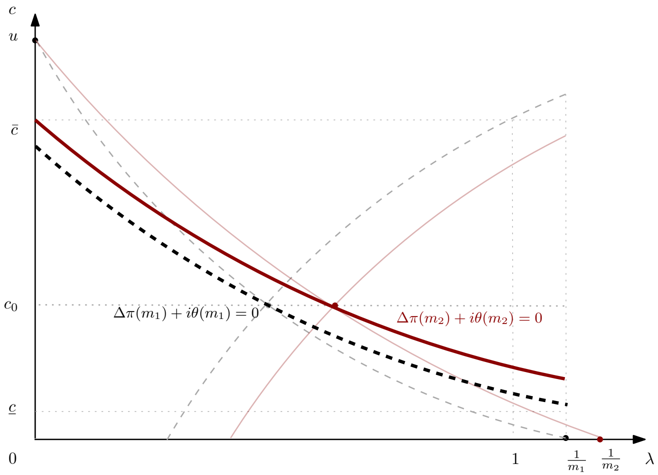
Effects of changes in matching efficiency m:

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

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



- 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 liquidity

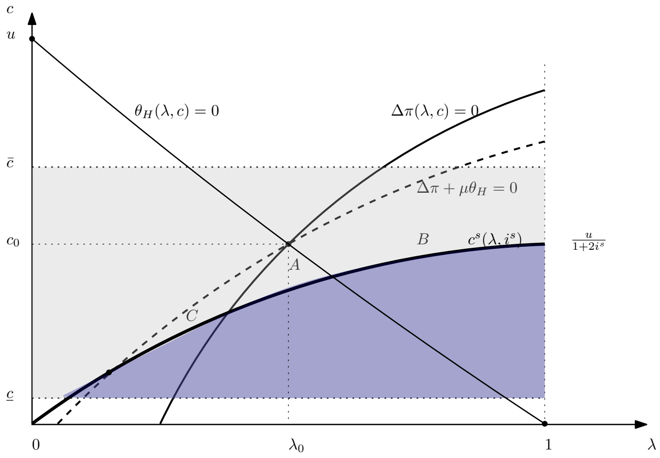


Figure: Suppliers' money holdings coexist with supplier finance

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.*