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 mang 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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  - Each produces a unique and indivisible good
  - Constant marginal costs, $c \in [\underline{c}, \bar{c}]$, differ among suppliers
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- Endowments
  - 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: $p - c = (u - c)/2$
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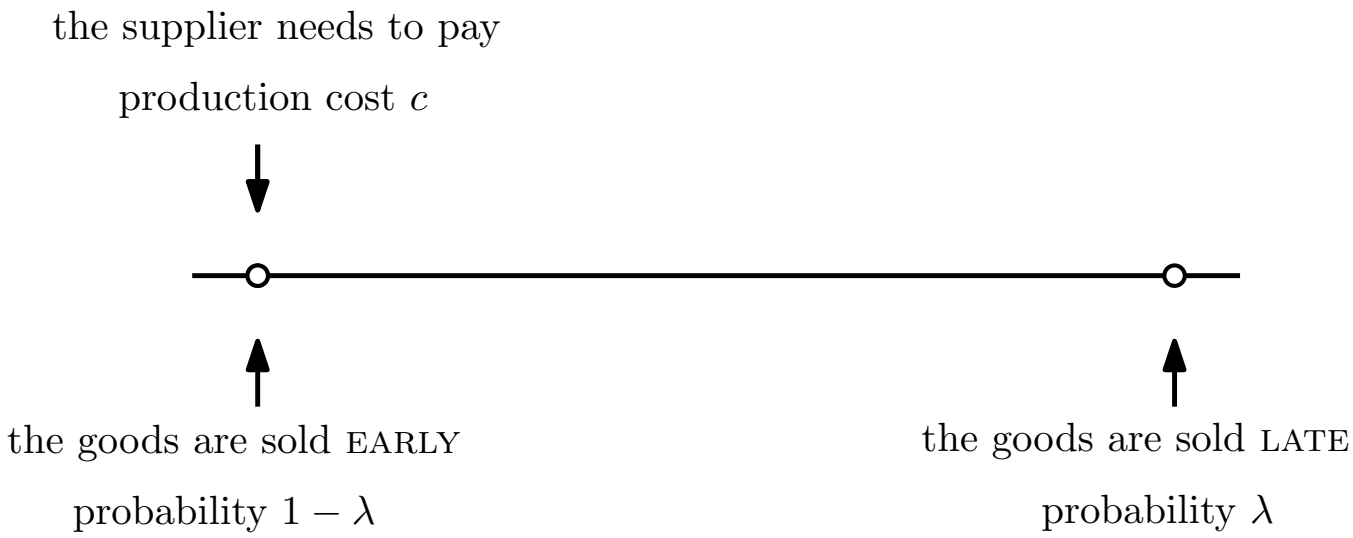
  - retail revenue can be used to cover production costs c
- Supplier's liquidity issue matters when:
  - disparity exists in the timing between production and trade.
  - a liquidity shock prevents suppliers from using retail revenue to cover production costs.



- 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:

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

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:

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

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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:

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

subject to the liquidity constraint:

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

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- The object is equivalent to

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

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

Profit-maximizing selection policy

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

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

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

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

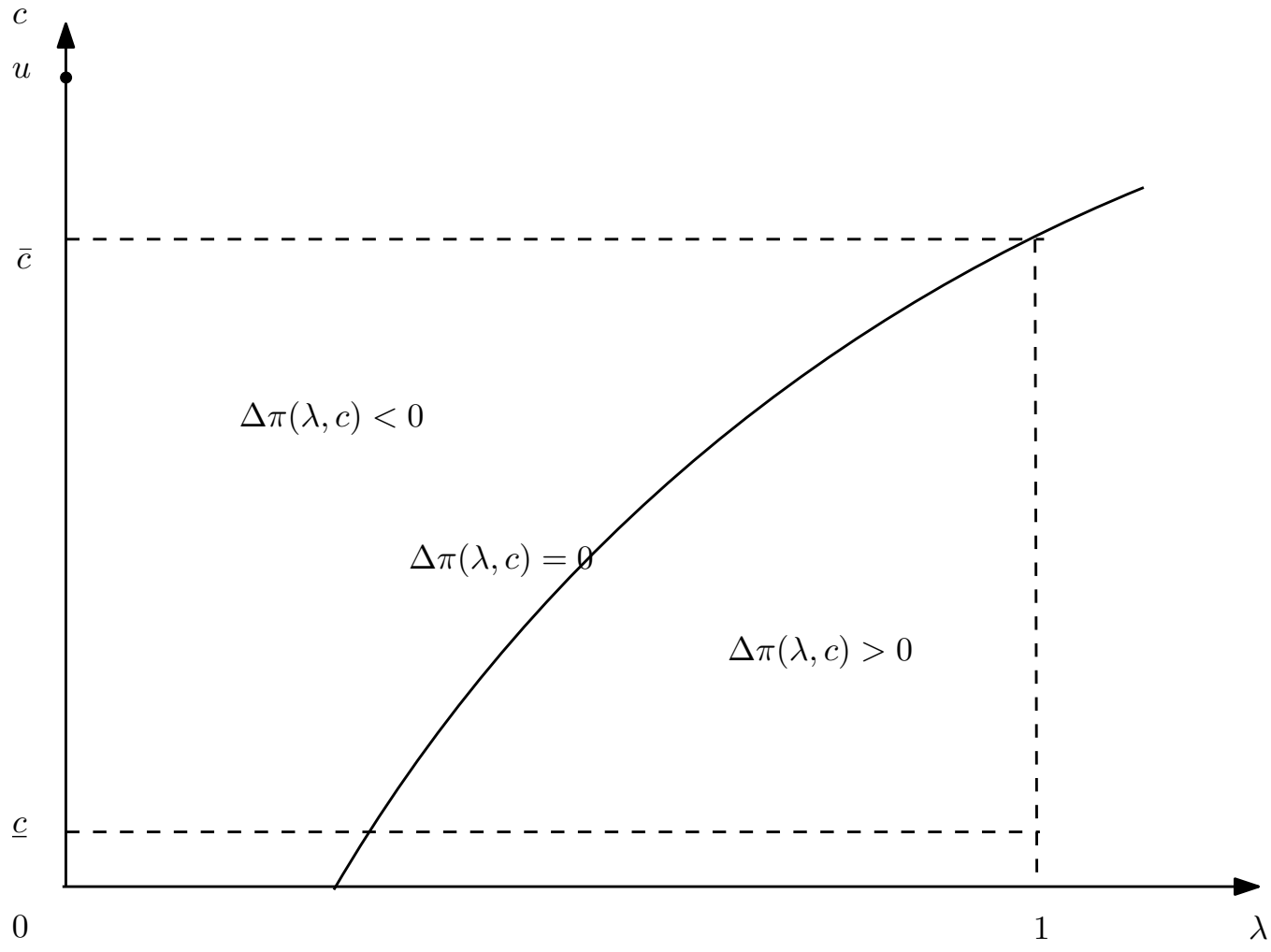


Figure: Incremental profit $\Delta\pi \equiv \pi_F - \pi_M$

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

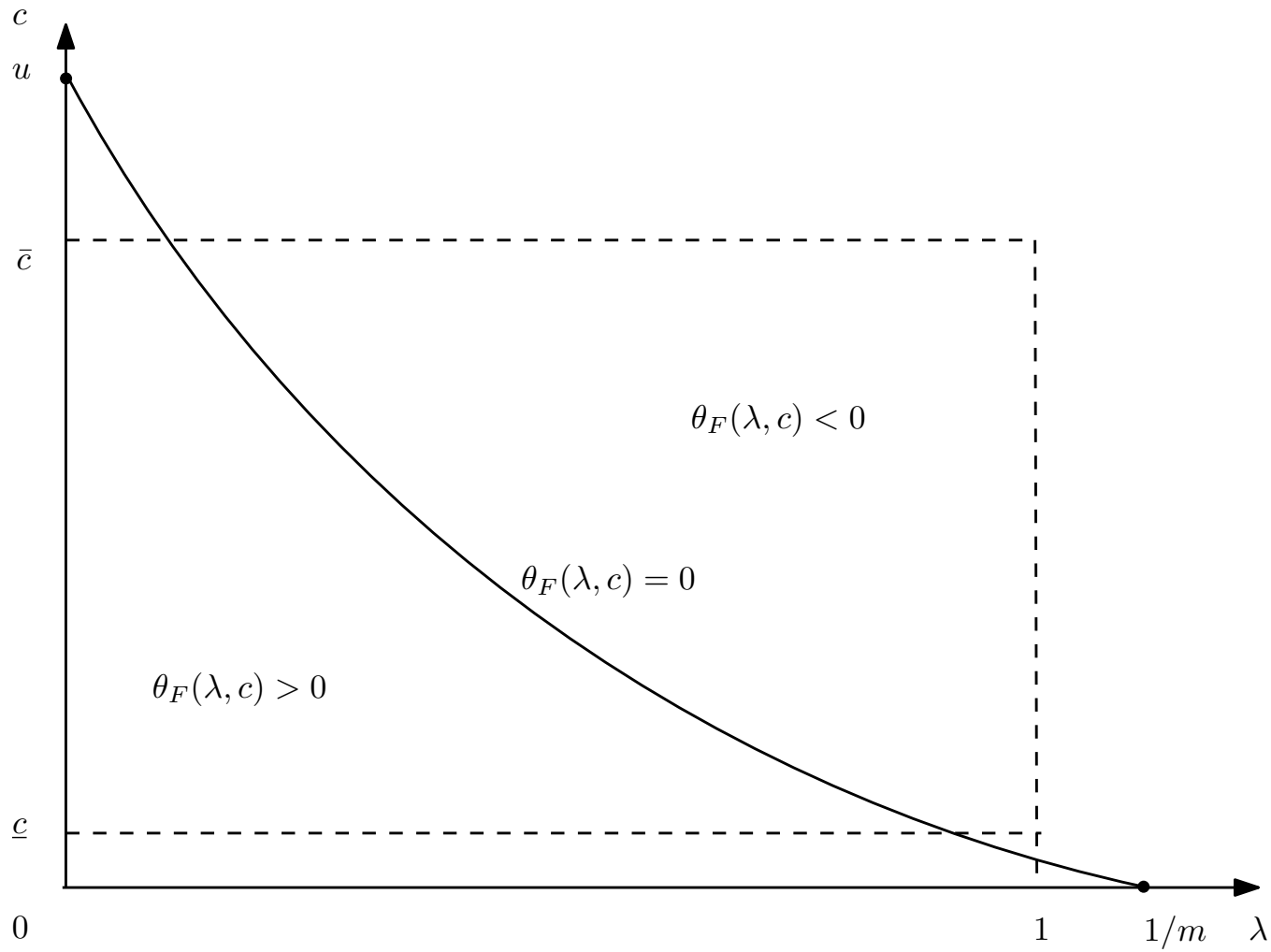


Figure: Liquidity $\theta_F(\lambda, c)$

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

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*

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

- *Region C: negative profit and positive liquidity*

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

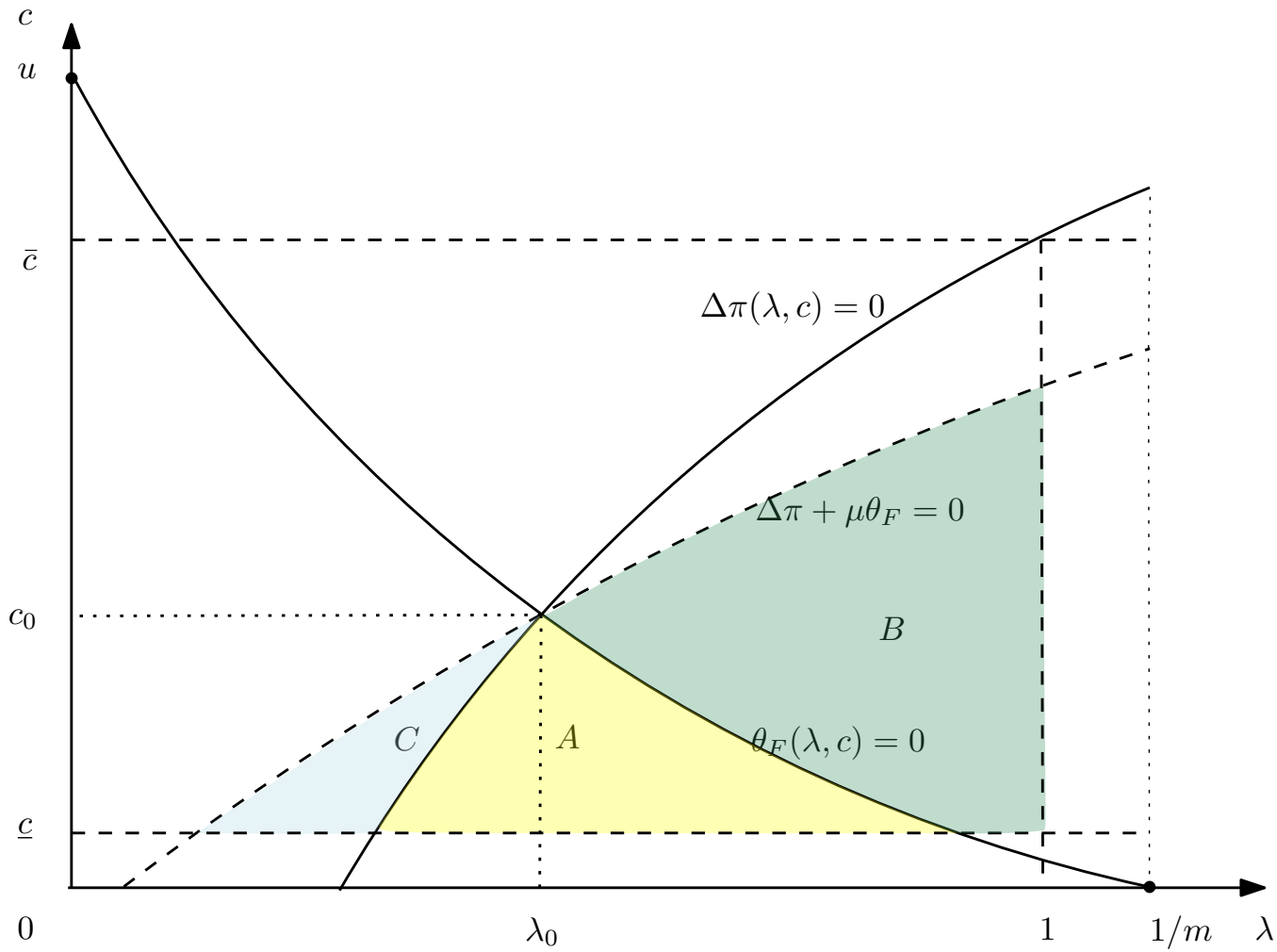


Figure: Profit-based liquidity cross-subsidization

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 $\mu = \mu(L)$:

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

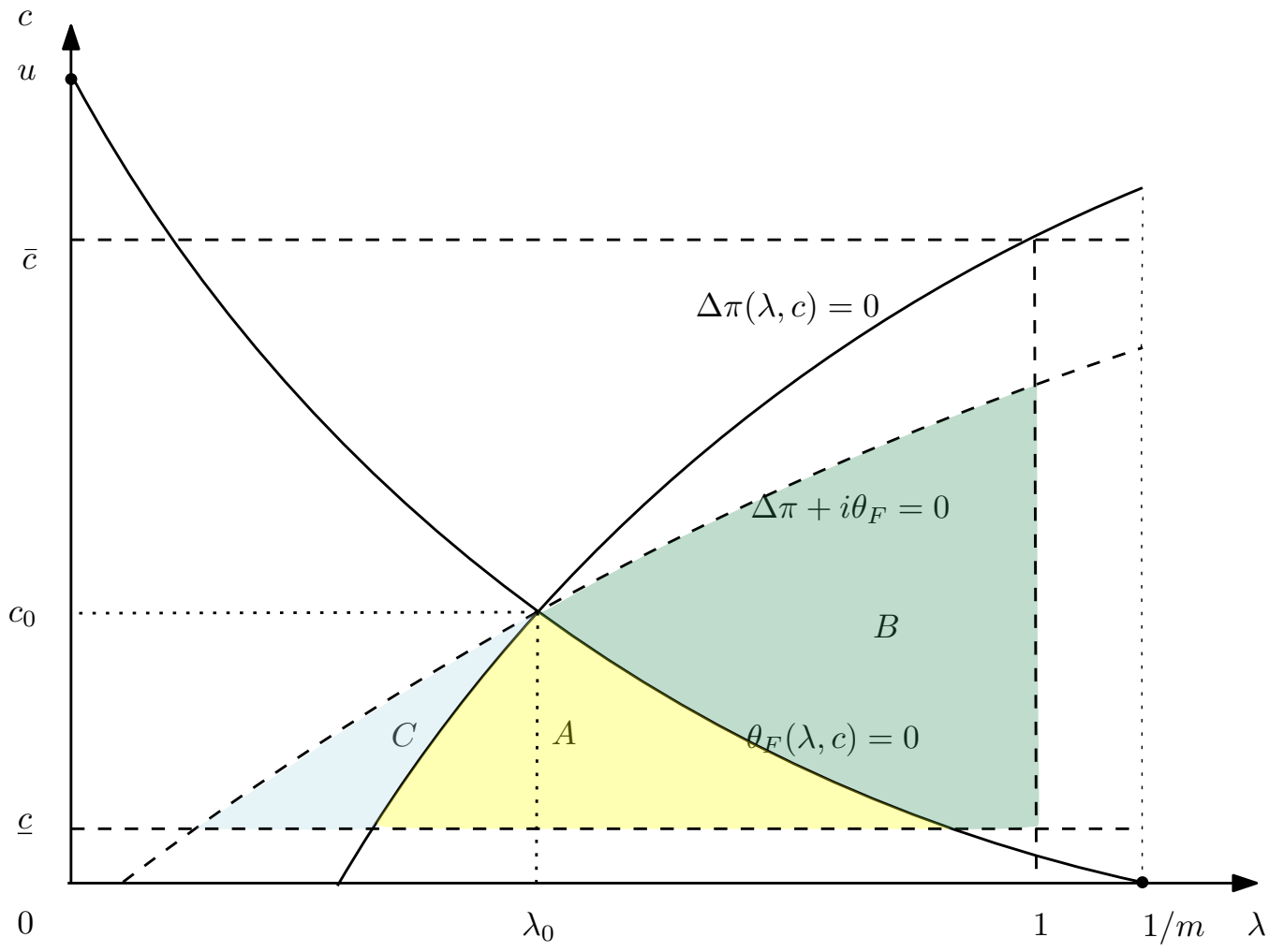
- $\mu(L) = 0$: liquidity does not matter for selecting suppliers; selection is solely based on $\Delta\pi(\lambda, c)$
- $\mu(L) > 0$: liquidity cross-subsidization, strictly decreases in L
- $\mu(0)$: the liquidity value at $L = 0$, or shadow price of the first marginal unit of liquidity

Endogenous L

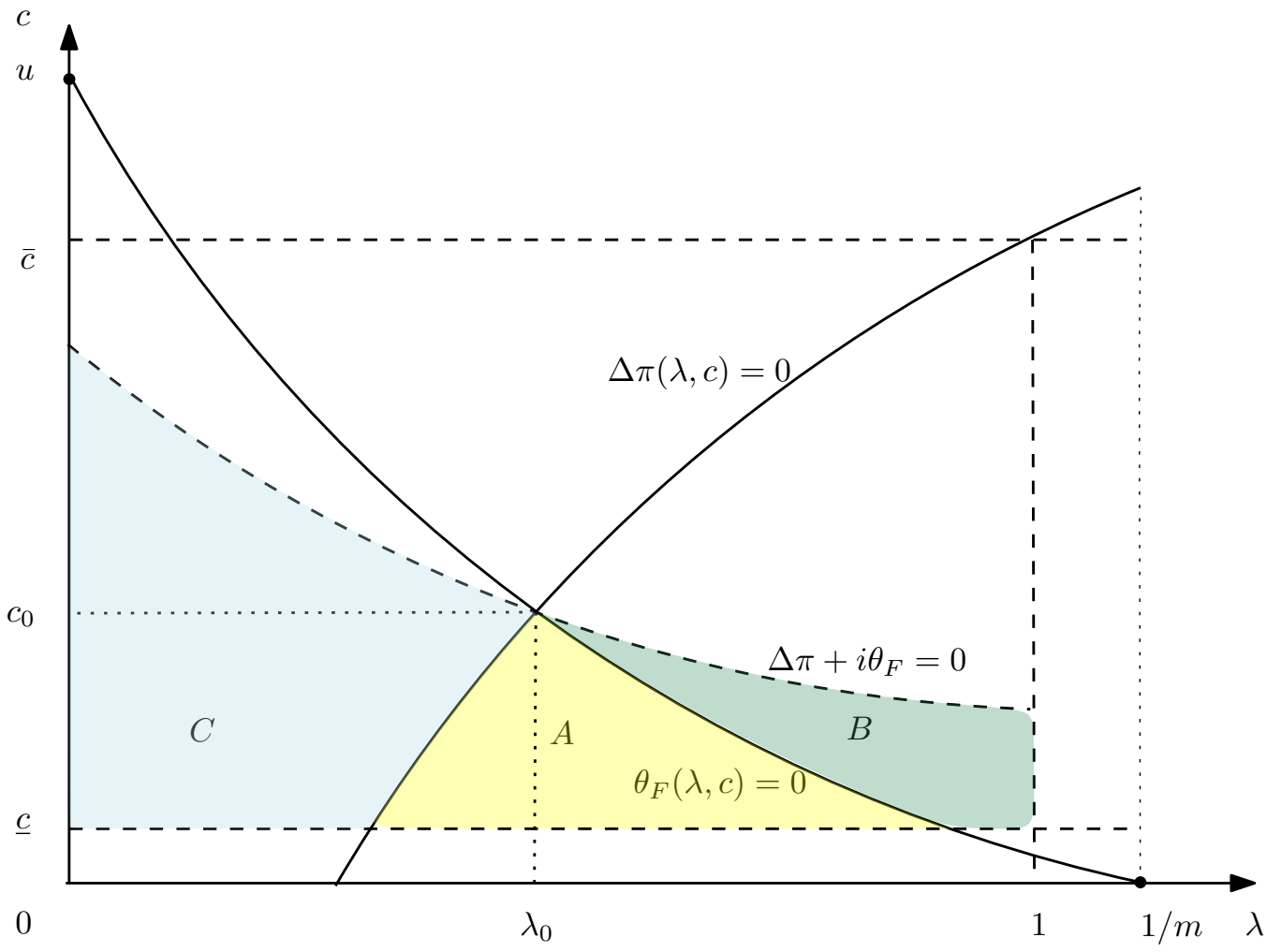
- Suppose the intermediary faces a liquidity cost in the money market i (nominal interest rate).
- The intermediary's liquidity holdings $L \geq 0$, which is strictly decreasing in $i \in (0, \mu(0))$, satisfying:

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

- 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 $i = 0$

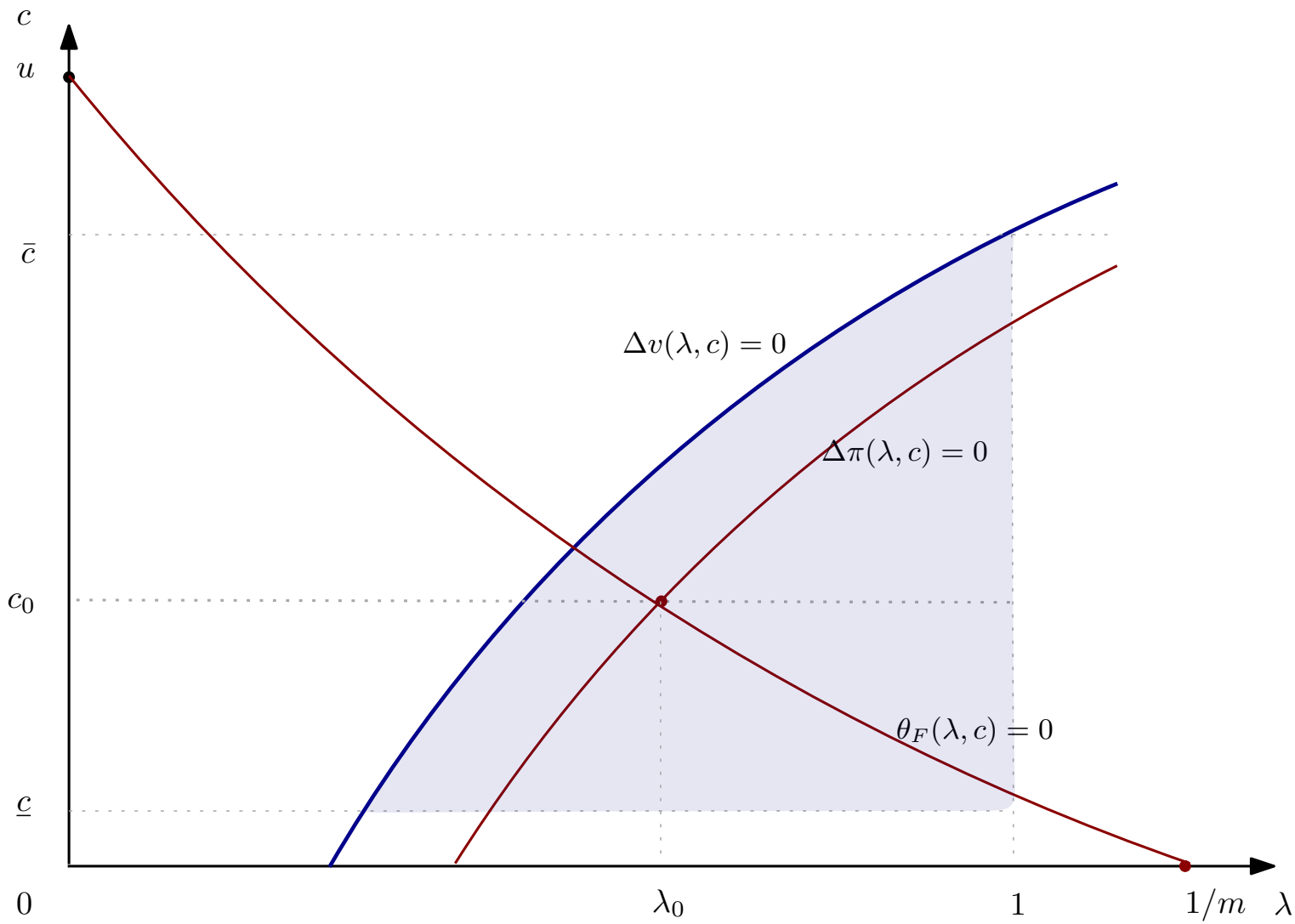


Figure: Supplier finance is welfare improving

When $i > 0$

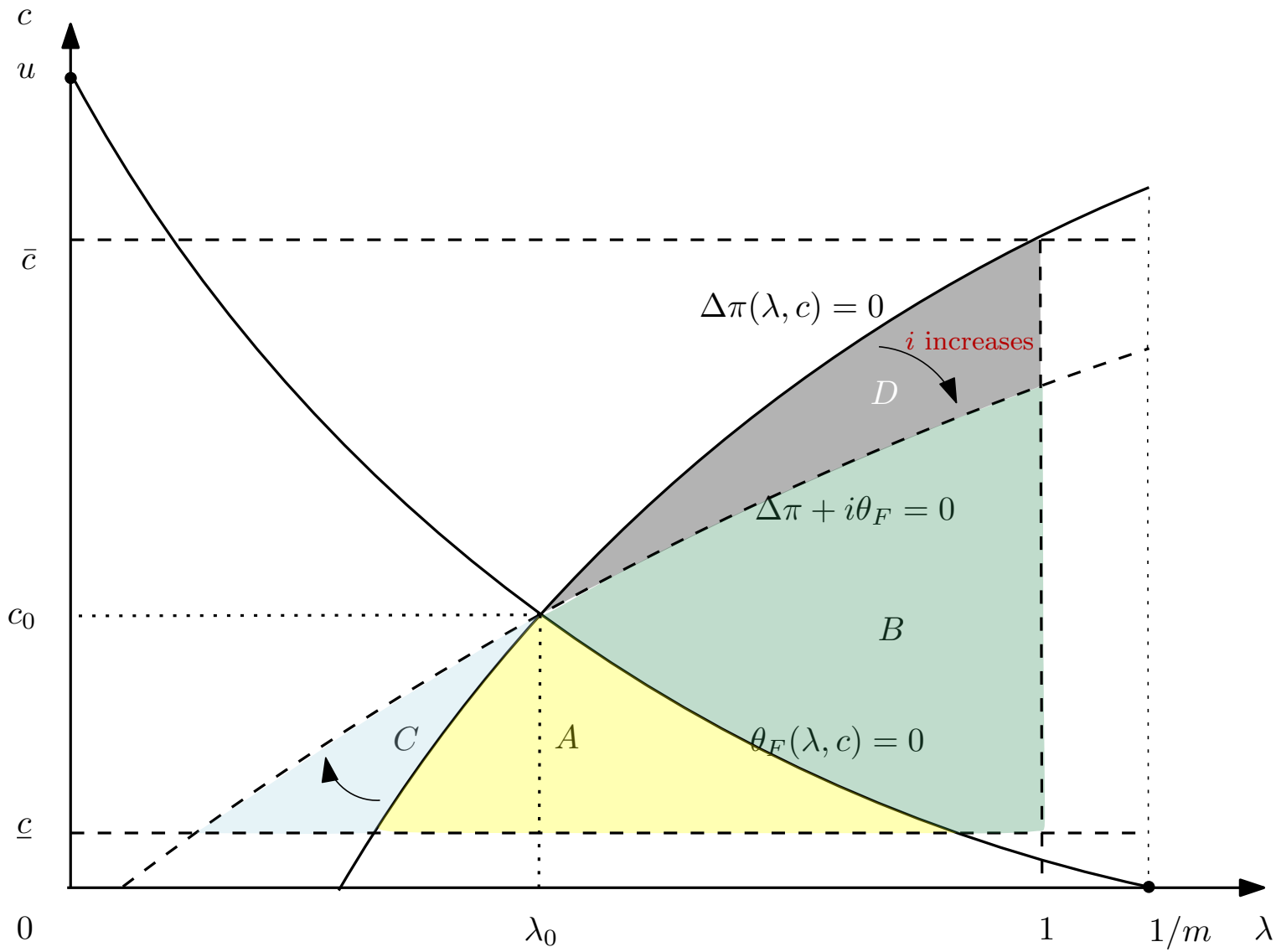


Figure: Marginal suppliers as i increases from $i = 0$

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

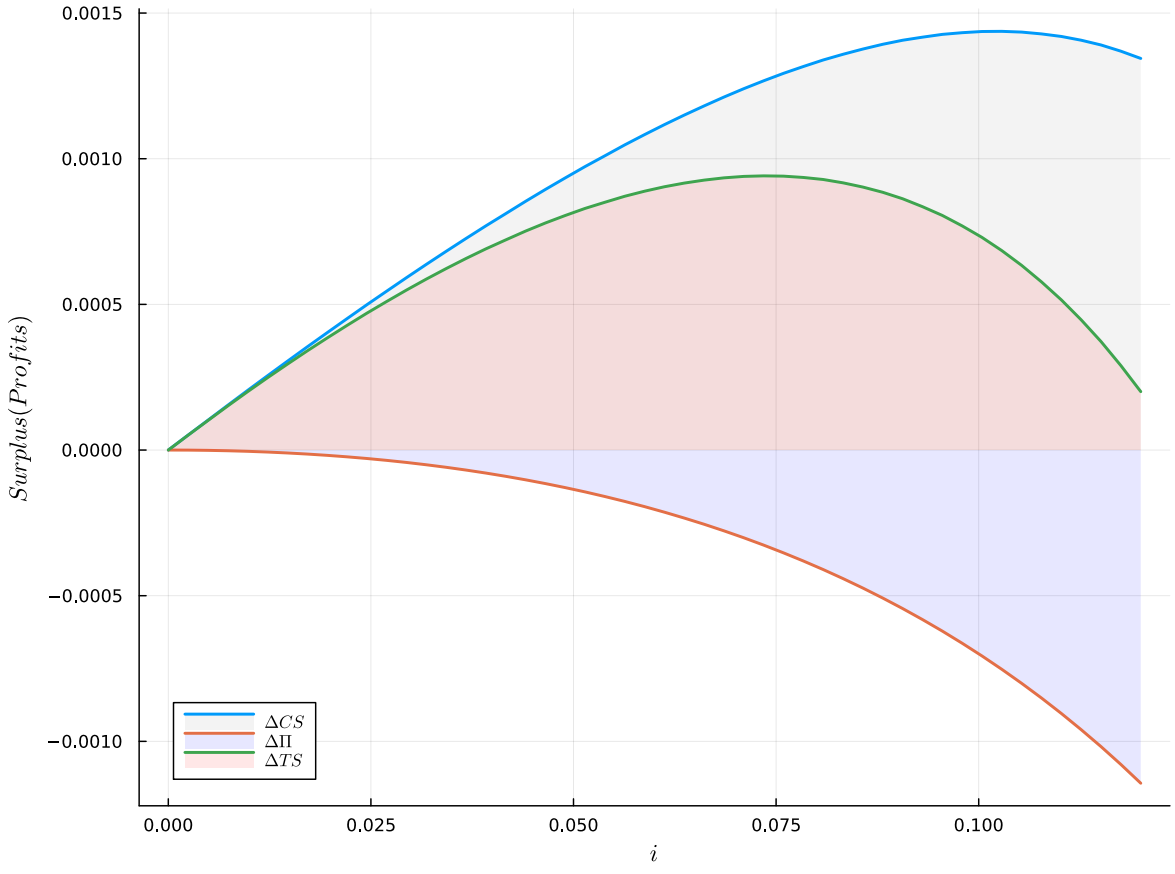


Figure: Welfare is non-monotonic in i under uniform distribution of (λ, c)

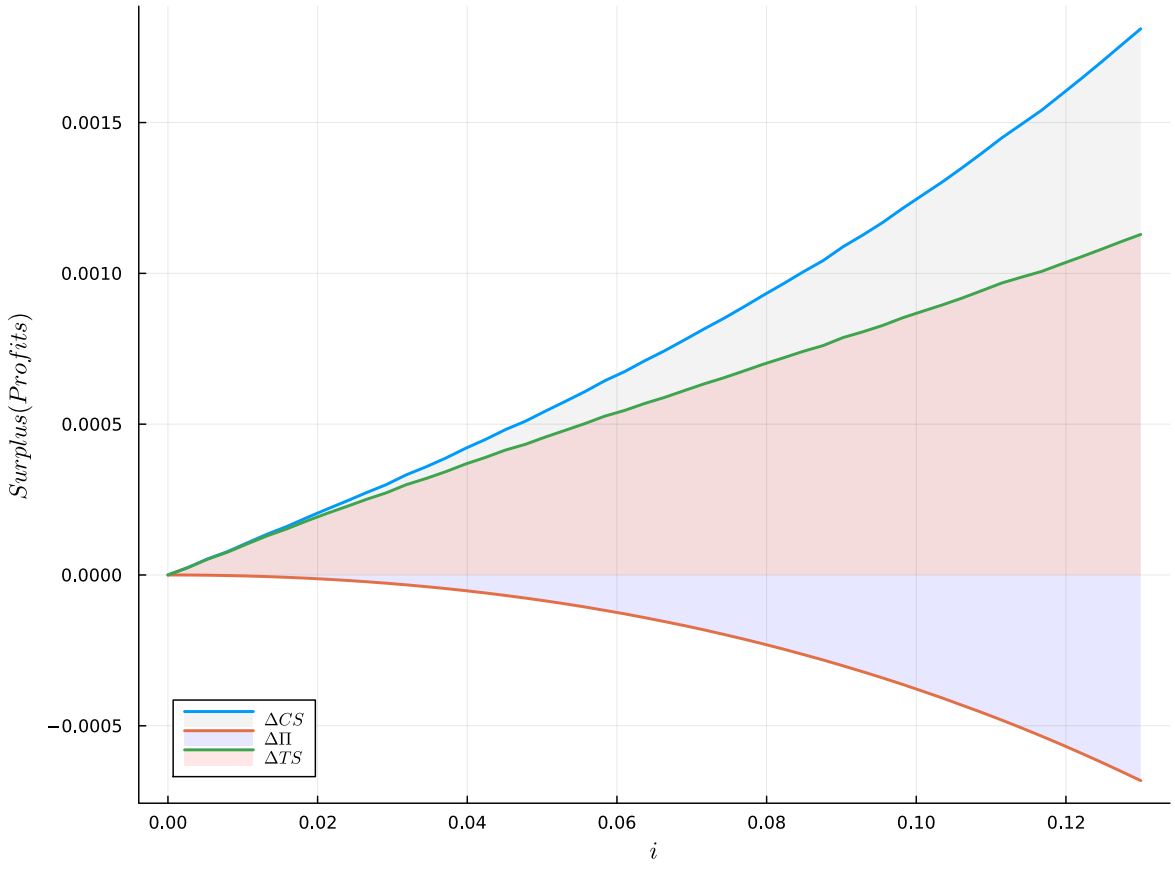
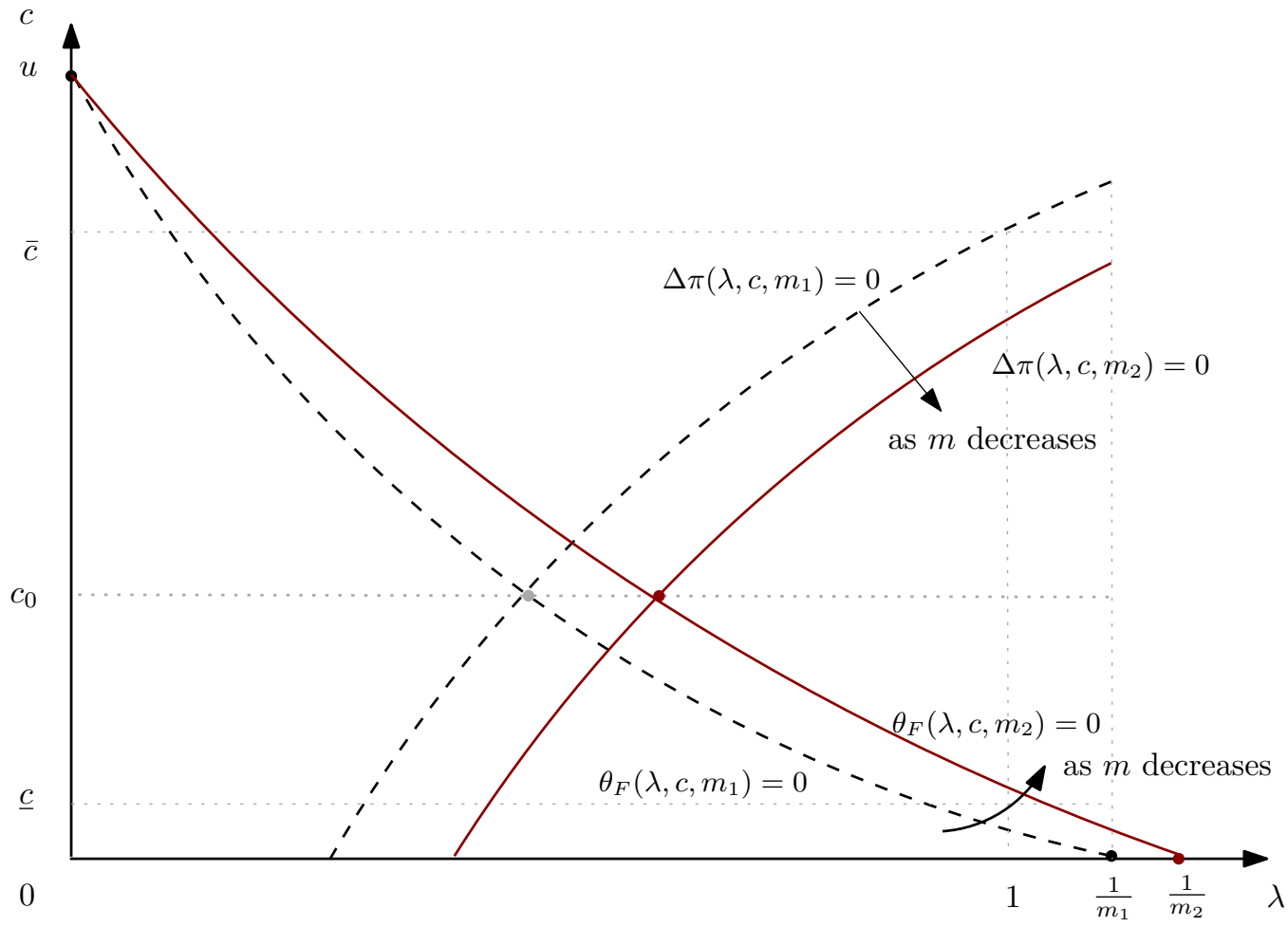


Figure: Welfare increases in i under Beta distributions of λ and c

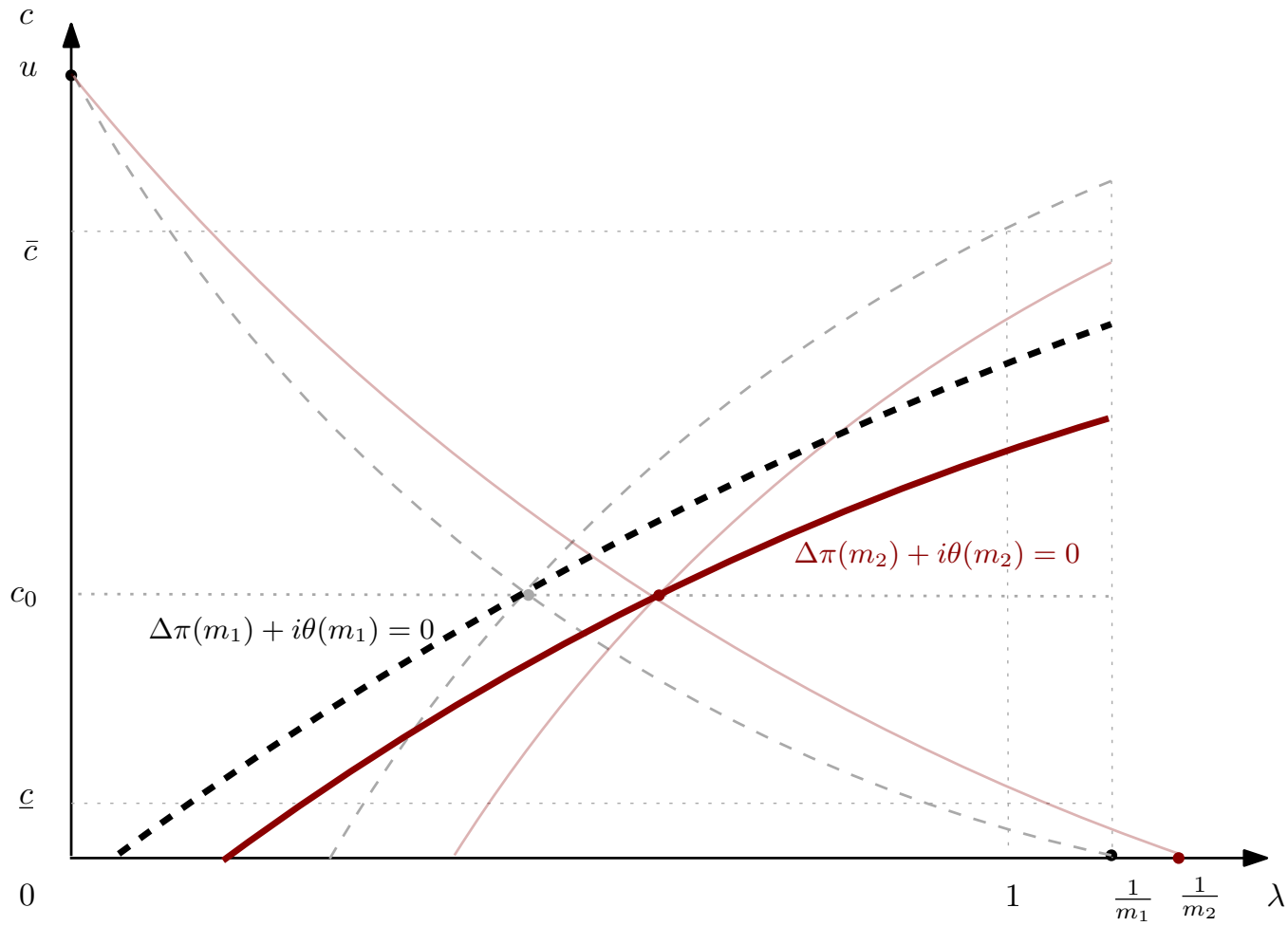
Matching efficiency and liquidity provision



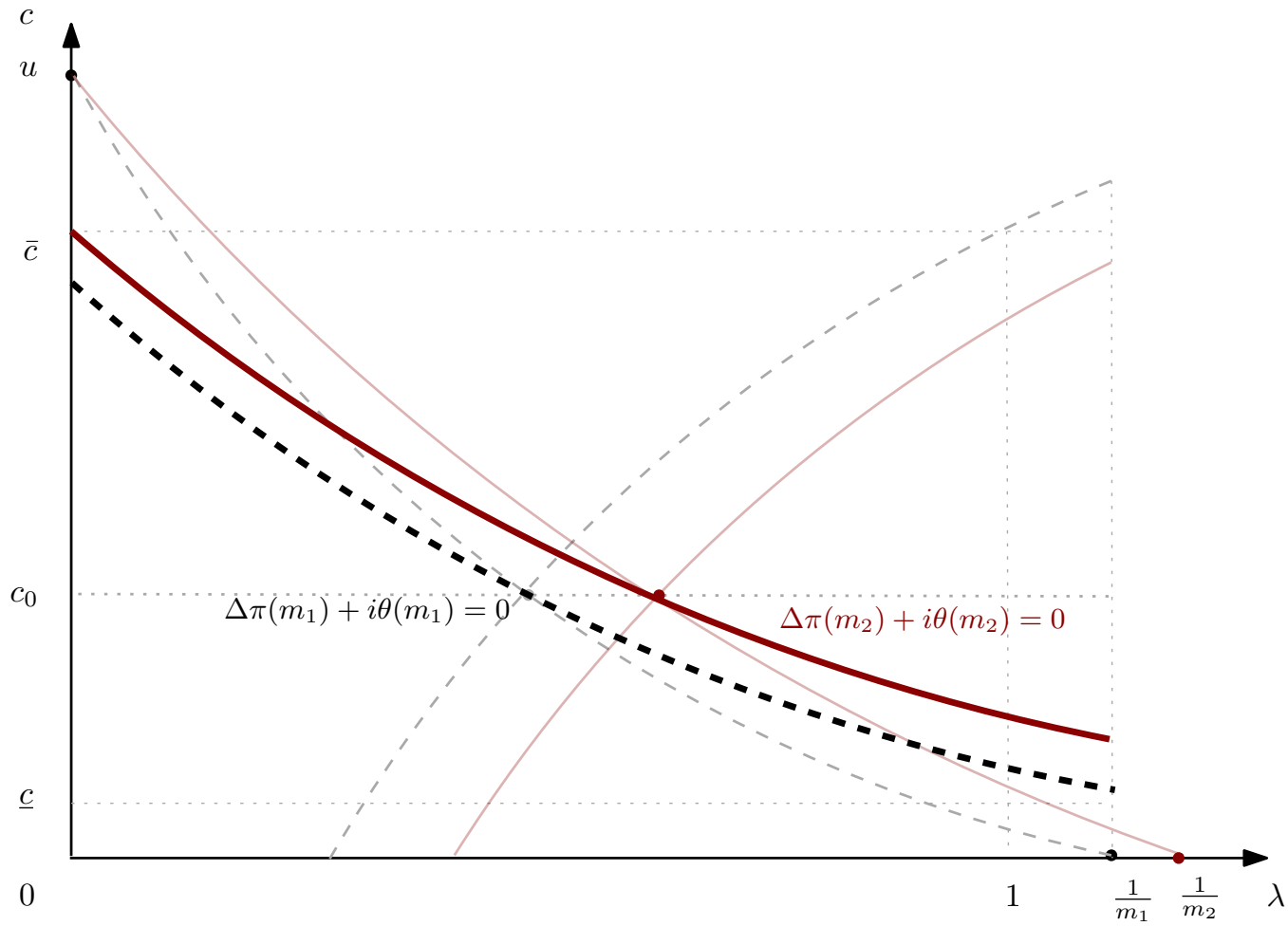
Effects of changes in matching efficiency m:

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

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



- 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

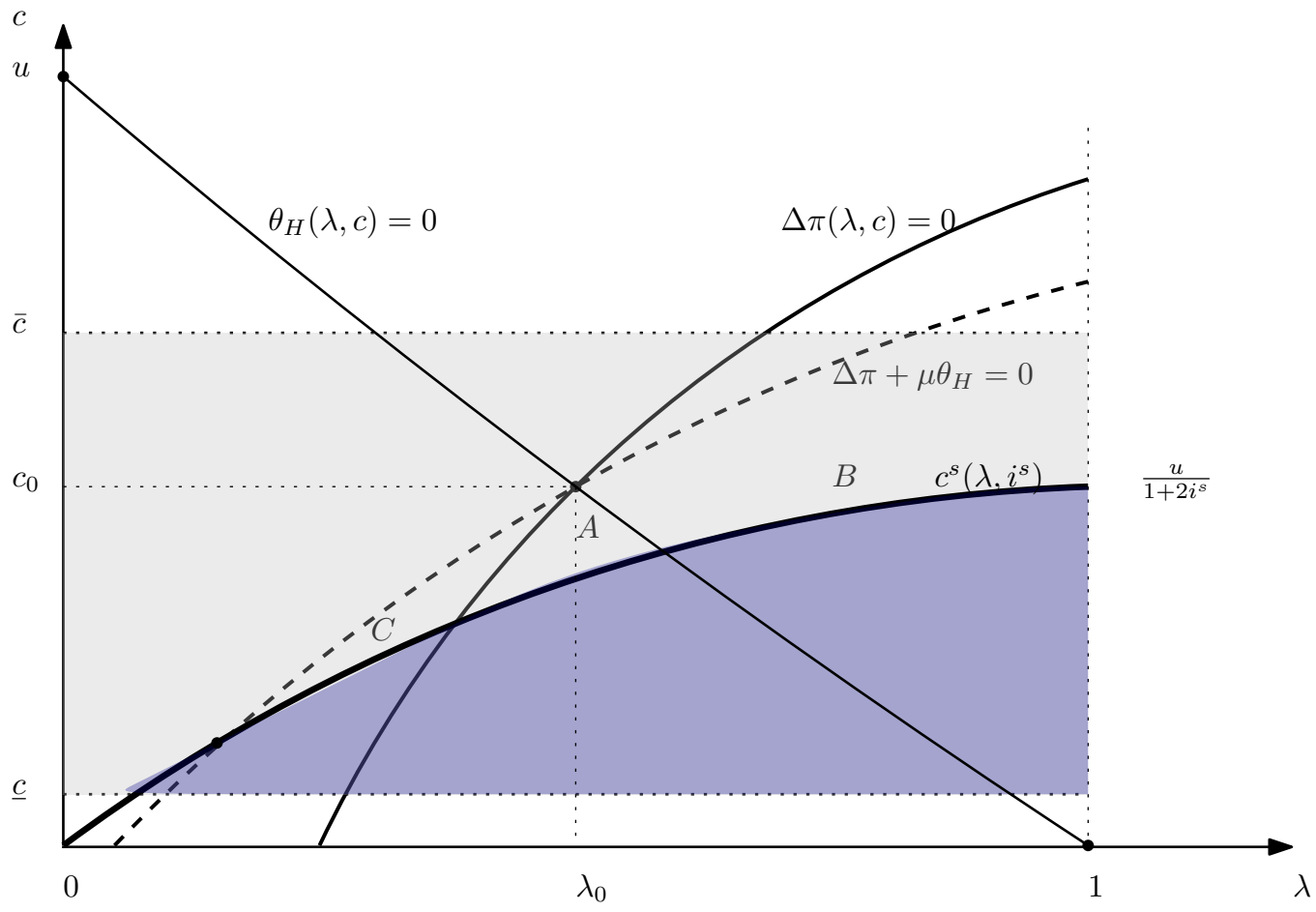


Figure: Suppliers' money holdings coexist with supplier finance

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.*

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:

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

subject to the liquidity constraint:

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

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

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

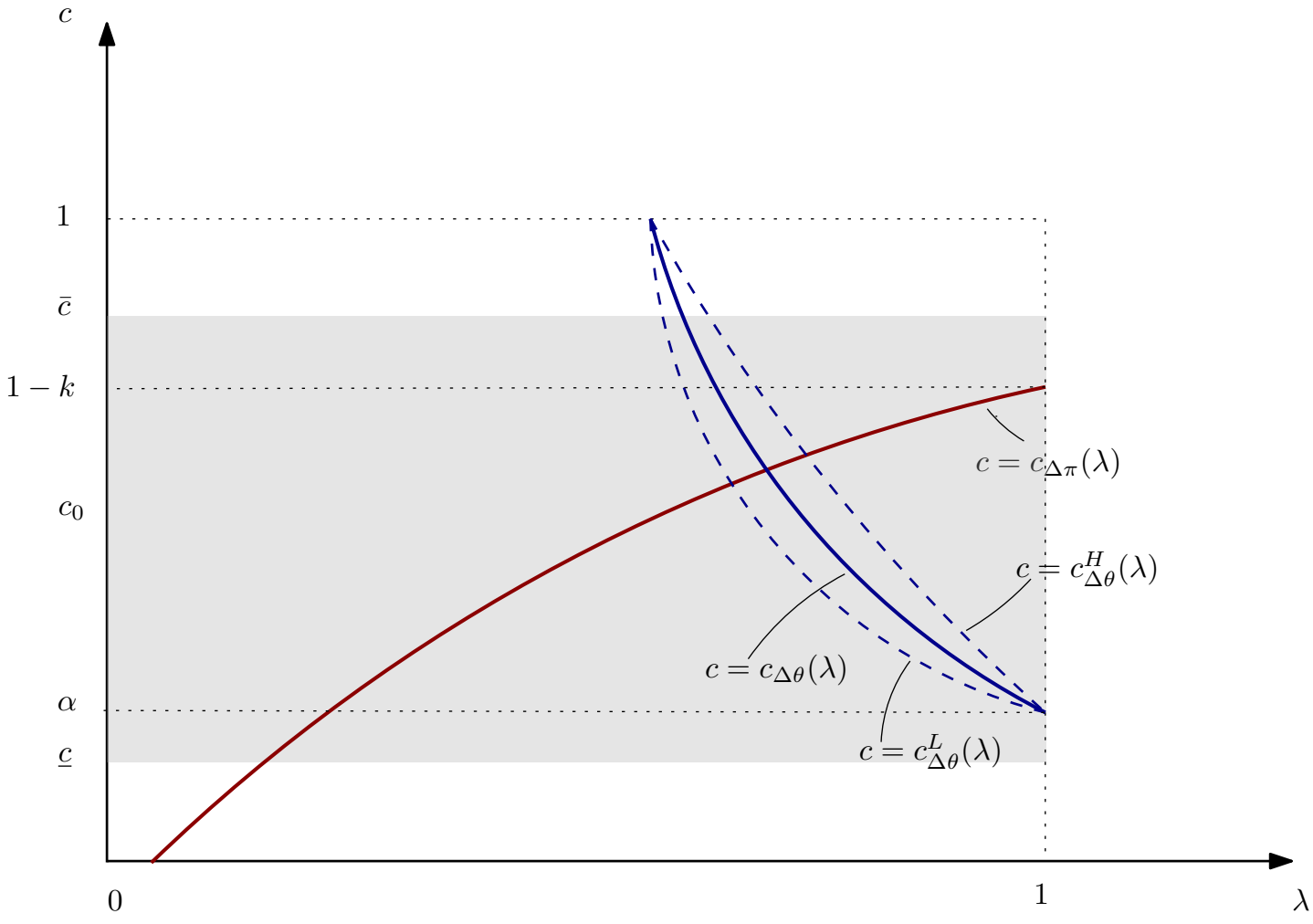


Figure: Manufacturer financing selection under linear production function

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.