Middlemen and Liquidity Provision

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Middlemen as a liquidity provider (middlemen finance)

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, middlemen liquidity provision has become more sophisticated:

- Middlemen can engage with a large number of suppliers.
- Middlemen can provide and/or obtain liquidity from suppliers.

An example of middlemen finance

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

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 it work?

1. Co-op establishes a funding program together with a FinTech company (*PrimeRevenue*):
   - Co-op invites *selected* suppliers to the program;
   - Co-op delays payment to the participating suppliers.
2. Once joining the program, suppliers can choose between
   - Holding invoices to maturity;
   - Selling unpaid invoices to *Barclays Bank* for early payment.
3. When the invoice is due, Co-op pays the full amount to whoever holds the invoice.

- Middlemen liquidity provision has been widely adopted:
  - Walmart, Amazon, Alibaba, JD.com, Carrefour, Coca Cola, PepsiCo, Unilever, Boeing, Airbus, Ford Motor Company, Nissan, General Electric, Dell, Hewlett-Packard (HP), IBM, Lenovo, Philips, Vodafone, Sony, Samsung, Schneider Electric, Bosch, Procter & Gamble (P&G), Johnson & Johnson, Michelin, L'Oreal, Keurig Dr Pepper, etc.
- According to the *Wall Street Journal*:
  - The global middleman/supplier finance market was valued at \$1.8 trillion in 2021.
  - It is growing at an annual rate of $15\% - 20\%$ (2019–2024).

What is so special about middlemen's liquidity provision?

- The middleman selects suppliers to fund:
  - Which suppliers to take care of?
  - Profitability versus liquidity needs?
  - Outside liquidity vs. inside liquidity
- How do middlemen's retail technologies matter for liquidity provision?
- Welfare implications:
  - Should a middleman provide liquidity to all its suppliers?
  - What is the welfare impact if outside liquidity becomes more expensive?

Related literature

- Middlemen and multi-product intermediaries:
  - Rubinstein & Wolinsky (1987), Suplber (1996), Watanabe (2010), Wong & Wright (2014), Rhodes, Watanabe & Zhou (2021)
  - Liquidity provision is not studied
- Banking and Money
  - Diamond & Dybvig (1983), Berentsen et al. (2007), Gu et al. (2013), Andolfatto et al. (2019)
  - Depositors are ex-ante heterogenous (ex-ante selection) and no incentive to run (not a demand deposit)
- Trade credit
  - Petersen & Rajan (1997), Burkart & Ellingsen (2004), Cunat (2007), Giannetti, Burkart & Ellingsen (2011), Garcia-Appendini & Montoriol-Garriga (2013), Nocke & Thanassoulis (2014)
  - Reallocation of trade credit among suppliers

Today's talk

1. A one-period benchmark model
2. Endogenous liquidity holdings of middleman
3. Welfare analysis
4. Suppliers have access to outside money market

1. The Benchmark Model

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
- A mass of consumers:
  - Unit demand for each good with *common* utility $u > \bar{c}$
- One middleman:
  - access to the retail and the finance technology (see below)

Endowments

- There is a *numeraire* good (used as a payment)
- Consumers have enough endowment of numeraire
- Middleman has an endowment $L \geq 0$
- Suppliers have no endowment

Retail market

- Suppliers can trade directly with consumers
- Suppliers can meet all consumers, trade bilaterally
- Trade surplus is split equally:

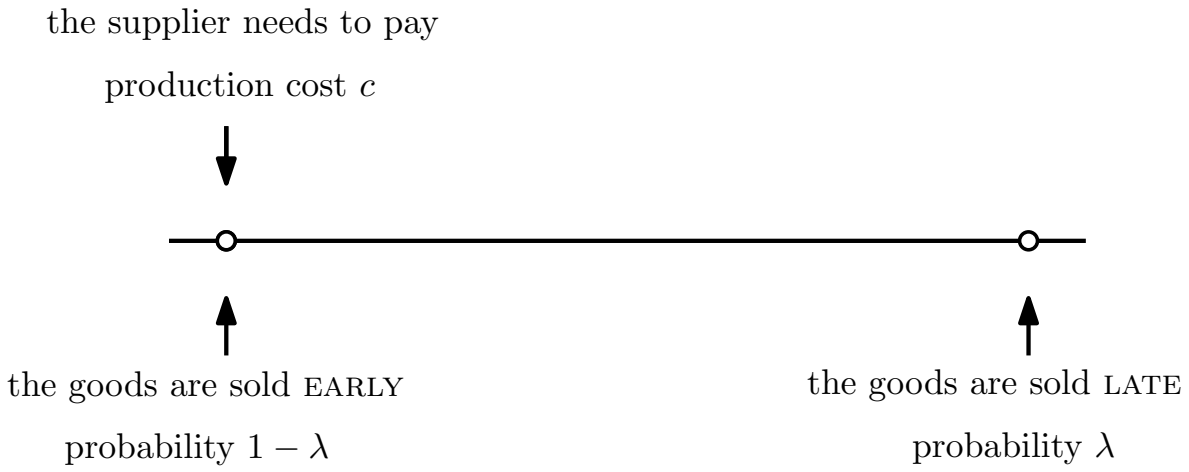
$$p - c = (u - c)/2$$

- Trade may not occur due to liquidity shocks

Liquidity shocks

- Supplier (with no initial endowment) finance does not matter in frictionless world:
  - Revenue can be used to finance production costs c
- Supplier finance matters when:
  - Disparity exists in the timing between production and trade
  - A liquidity shock prevents suppliers from receiving revenue before production

Liquidity shocks



- 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 retail revenue
  - With probability λ: a supplier matches with consumers *late*, c CANNOT be covered using retail revenue (i.e., liquidity shock)

Liquidity shocks

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

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

  where λ is the probability of liquidity shock, c is marginal cost

- (λ, c) is publicly observable, following a distribution C.D.F. G, P.D.F. $g > 0$ on Ω

Intermediation mode

Middleman observes (λ, c), and selects suppliers into one of the intermediation modes:

- Middleman mode (acting only as a middleman)
- Middleman–Finance mode (acting both as a middleman and liquidity provider)

Note: acting only as a liquidity provider is strictly dominated given middleman's advantage of matching technologies (see below)

Middleman mode (M)

- Middleman sells on behalf of suppliers
  - Middleman's probability of a liquidity shock: $m\lambda$
  - $m < 1$ represents middleman's relative matching advantage over the original suppliers (Rubinstein and Wolinsky 1987)
    - Better advertisement technologies to facilitate early display
    - Better inventory technologies to facilitate early delivery
    - Better communication technologies with consumers that facilitate production to order
- Middleman gives a TILI offer to a selected supplier (λ, c):
  - Transfer a reward $f_M(\lambda, c)$ immediately after consumers pay
  - Production costs have to be covered by suppliers themselves

Middleman–Finance mode (F)

- Middleman sells on behalf of suppliers
- Middleman delays payments to suppliers (till the end of the period) and meanwhile provides liquidity support
- Middleman gives a TILI offer to a selected supplier (λ, c):
  - Transfer a reward $f_F(\lambda, c)$ at the end of the period
  - Production costs c are covered by middleman

Middleman's offers:

$$\{q(\lambda, c), f_M(\lambda, c), f_F(\lambda, c)\}_{(\lambda,c)\in\Omega}$$

where $q(\lambda, c) = 1$ implies Middleman–Finance mode, while $1 - q(\lambda, c) = 1$ implies Middleman mode

Timing

1. Middleman announces contracts and invites suppliers
2. Suppliers decide whether to accept or not
3. Liquidity shocks are realized, middleman pays f_M or c to suppliers, suppliers produce, and trade occurs in the retail market
4. Middleman pays supplier f_F

Suppliers' participation decision

Rewards to suppliers, f_j, $j = M, F$, must satisfy their participation constraint:

$$\text{Supplier's Expected Payoff}_j(\lambda, c) \geq \underbrace{(1-\lambda)\frac{u-c}{2}}_{\text{direct selling}},$$

where

$$\text{Expected Payoff}_M(\lambda, c) = (1 - m\lambda)(f_M(\lambda, c) - c),$$
$$\text{Expected Payoff}_F(\lambda, c) = f_F(\lambda, c).$$

Profits in Middleman mode

- Profit contribution by a supplier (λ, c):

$$\begin{aligned}\pi_M(\lambda, c) &= (1 - m\lambda)\,(p - f_M(\lambda, c)) \\ &= (1-m)\lambda\frac{u-c}{2} > 0 \quad \text{since } m < 1\end{aligned}$$

- There is no liquidity constraint here.

Profits and liquidity in Middleman–Finance mode

- In F mode, suppliers contribute both profit and liquidity.
- Profit contribution by a supplier (λ, c):

$$\begin{aligned}\pi_F(\lambda, c) &= p - c - f_F(\lambda, c) - k \\ &= \lambda \frac{u - c}{2} - k\end{aligned}$$

- Liquidity contribution by a supplier (λ, c) (at the time of production):

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

Profit maximization

- The middleman's profit maximization problem:

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

subject to the liquidity constraint:

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

where initial liquidity holding $L \geq 0$ (exogenous for now)

Profit-maximizing selection policy

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

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

  where $\Delta\pi \equiv \pi_F - \pi_M$

- $\mu \geq 0$: Lagrange multiplier of the liquidity constraint
  - The shadow value of liquidity

- The optimal selection rule is:

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

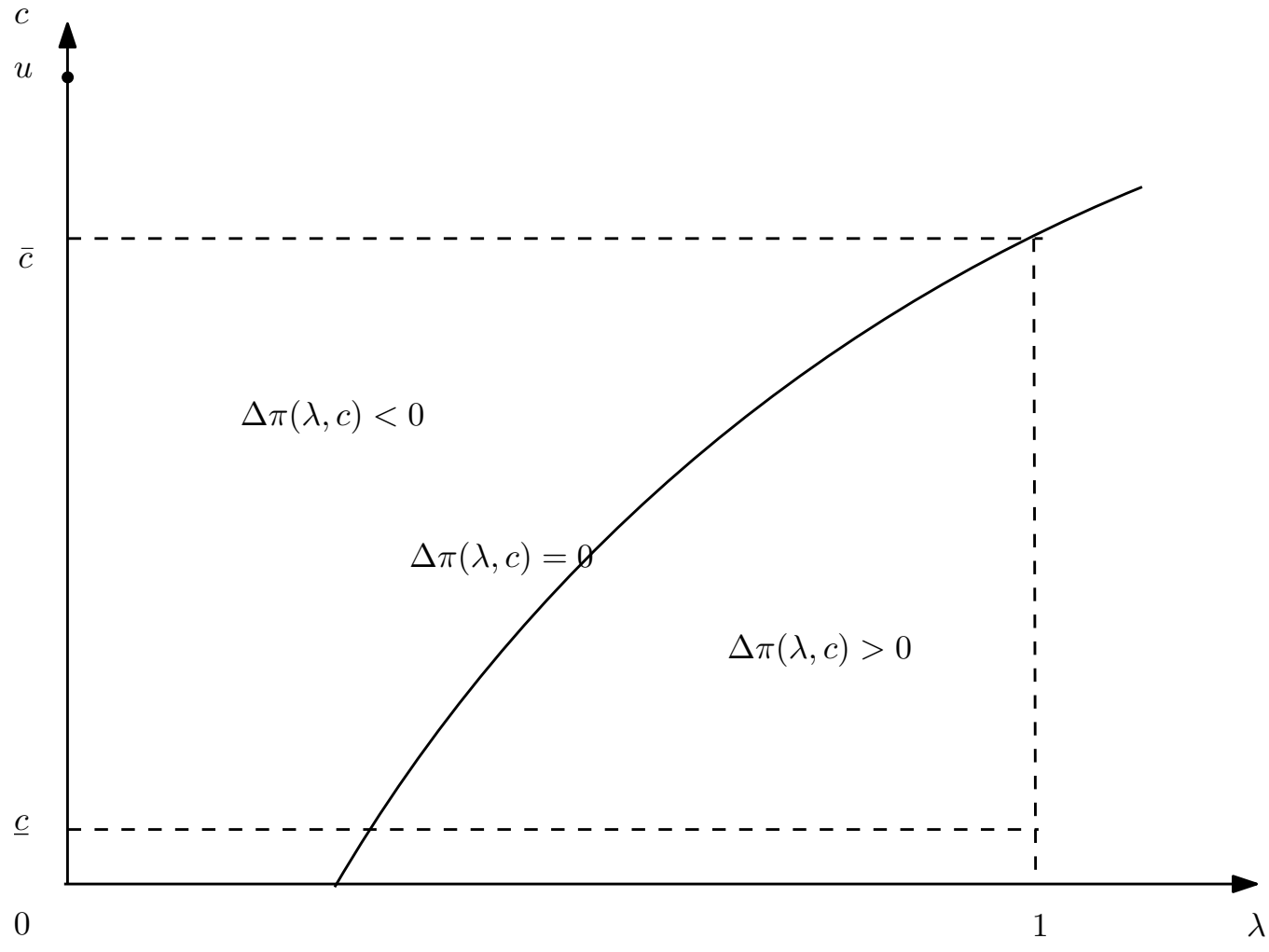


Figure: Incremental profit $\Delta\pi \equiv \pi_F - \pi_M$

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

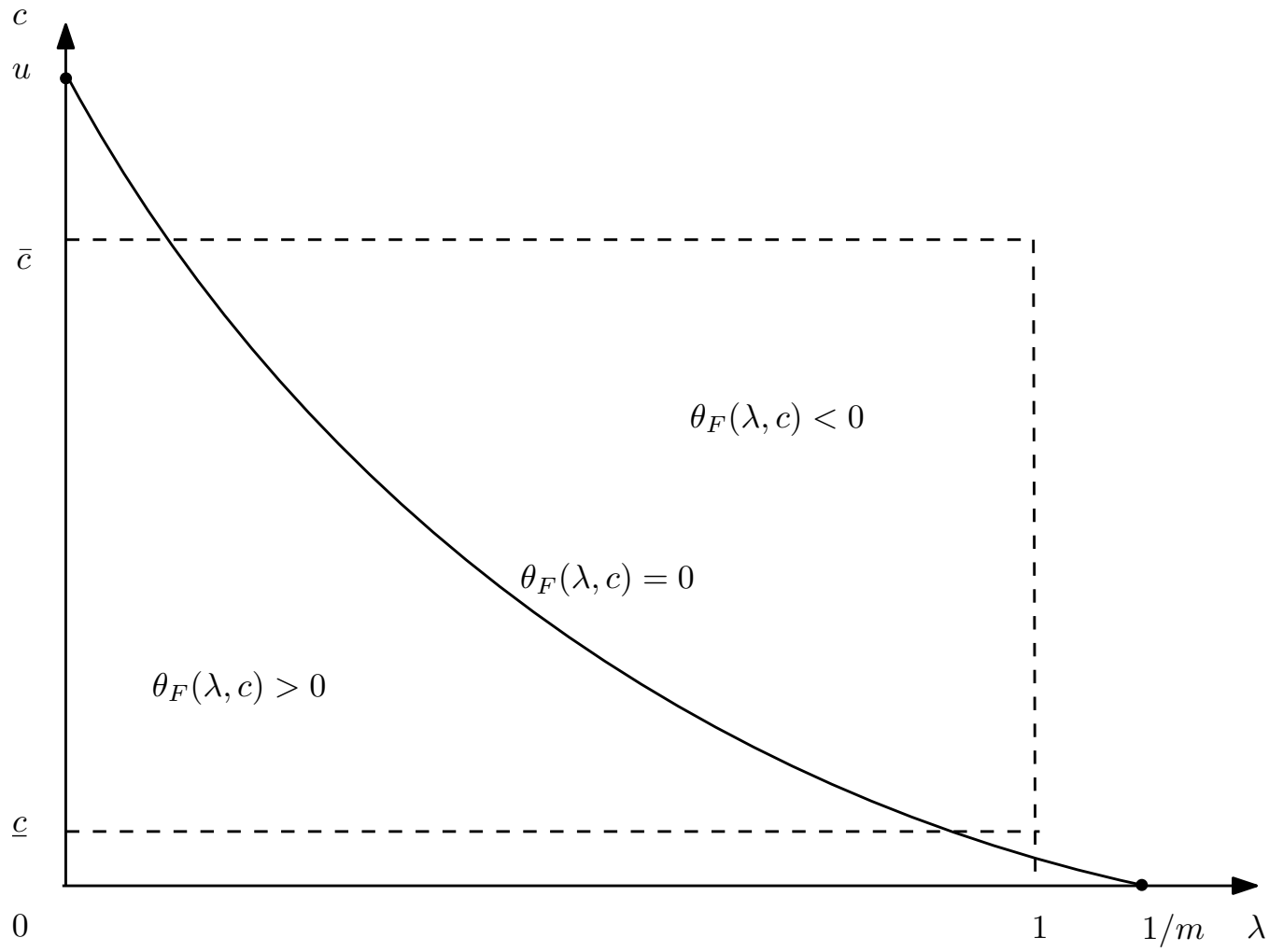


Figure: Liquidity $\theta_F(\lambda, c)$

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

Proposition (Profit-based liquidity cross-subsidization)

Middleman finance optimally selects suppliers from

- *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*

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

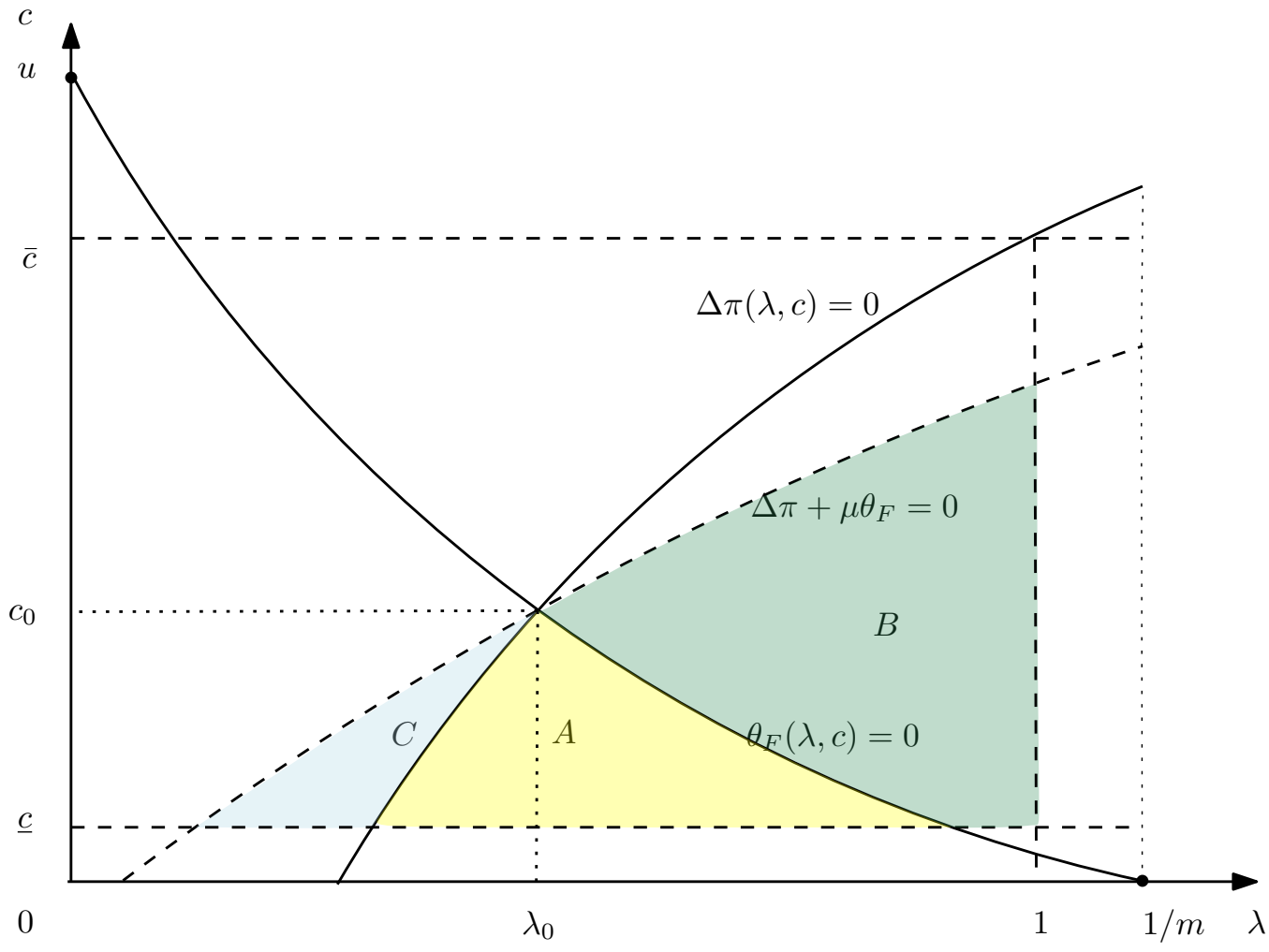


Figure: Profit-based liquidity cross-subsidization

Determination of μ

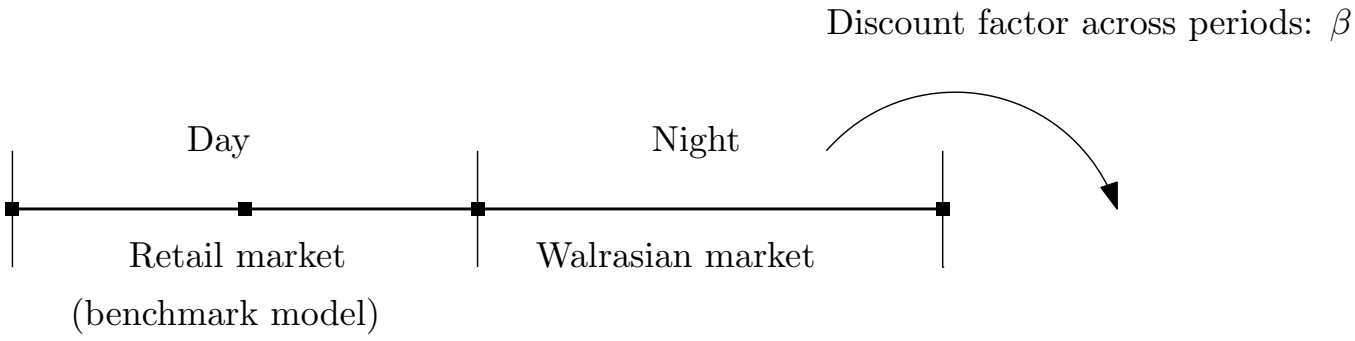
The liquidity constraint determines $\mu = \mu(L)$:

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

- $\mu(L) = 0$: 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

2. Endogenous liquidity holdings

A monetary approach (Lagos and Wright, 2005)



- Day market (the benchmark model)
  - Fiat money is used as a medium of exchange
  - Suppliers must pay for production costs using fiat money
- Night market (Walrasian)
  - Middleman and consumers can "earn" fiat money by producing a "general good"
  - 1 unit of fiat money worth ϕ_t units of general good: $L_t = \phi_t l_t$.
  - Assume that suppliers live for one period (for now)

Liquidity holdings

- Middleman chooses $l(\equiv L/\phi)$ money to hold:

$$\max_{l\geq 0} \quad \Big\{ -\phi_{t-1} l + \beta V_t(l) \Big\} \quad \Rightarrow \quad \phi_{t-1} \geq \beta V_t'(l)$$

- The middleman's value:

$$V_t(l) = \Big\{ \phi_t l + \max_{q(\lambda,c)} \int_\Omega q(\lambda,c)\Delta\pi(\lambda,c)dG, \quad \text{s.t.} \quad \Theta + \phi_t l \geq 0 \Big\}$$

$$\Rightarrow \quad V_t'(l) = \phi_t \Big(1 + \mu(L) \Big)$$

- Euler equation: $\phi_{t+1} \geq \beta\phi_t(1+\mu(L))$, or equivalently

$$i \geq \mu(L)$$

Proposition (Monetary equilibrium with middleman and finance)

For $i \in (0, \bar{i}]$, there exists a unique monetary equilibrium with middleman' intermediation and finance described by $q(\lambda, c, \mu)$, $f_j(\lambda, c)$, $j = M, F$, shadow value of liquidity:

$$\mu = \min\{\mu(0), i\},$$

and middleman's liquidity holdings $L \geq 0$, which is strictly decreasing in $i \in (0, \mu(0))$, satisfying:

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

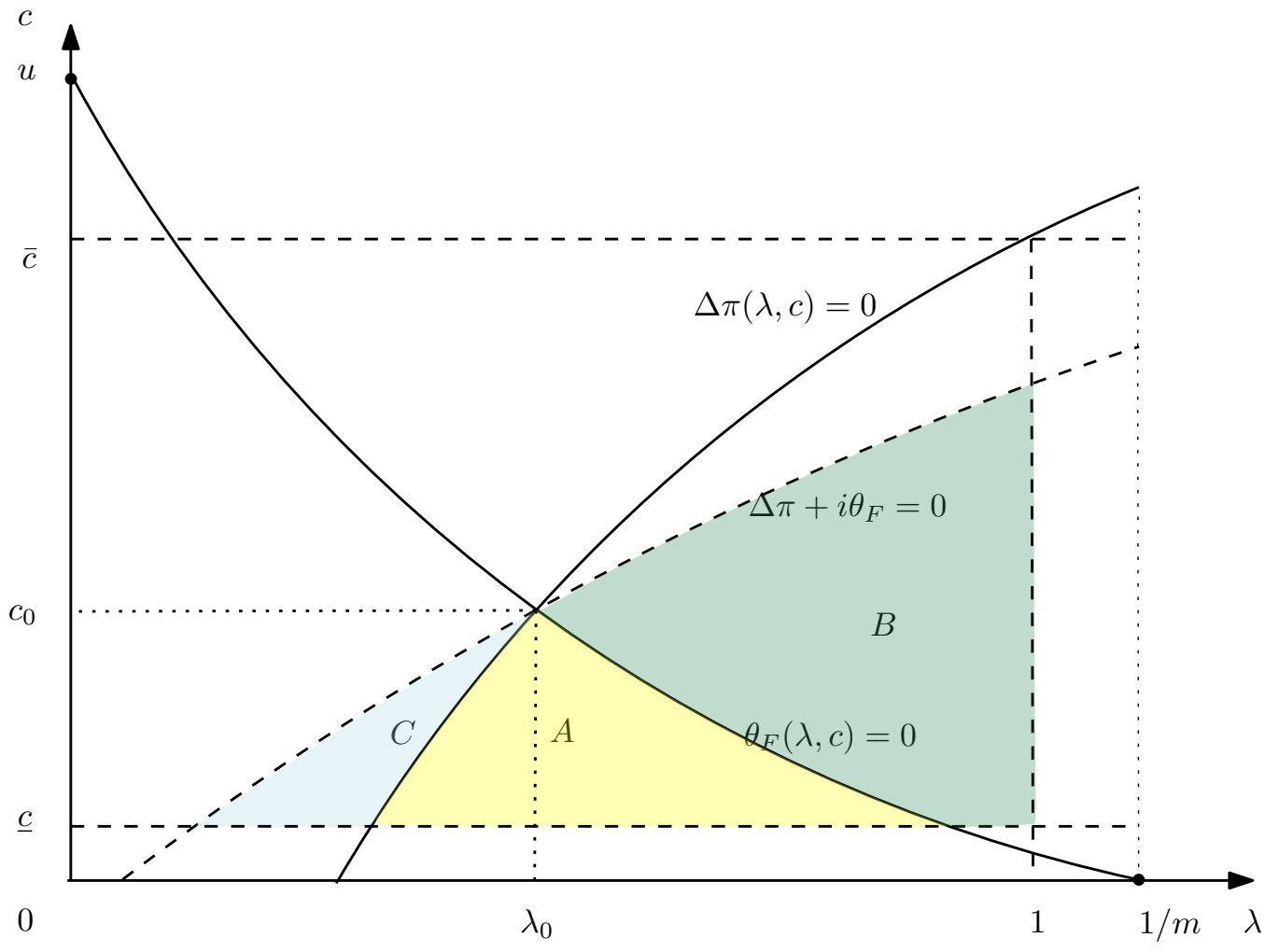
Characterization of monetary equilibrium

- The liquidity value $\mu = \min\{\mu(0), i\}$ is jointly shaped by
  - Richness of suppliers' liquidity: $\mu(0)$
  - Cost of outside market liquidity: i
- As $i \to 0$, middleman finance features $\mu \to 0$
  - All suppliers with $\pi > 0$ are selected
- As i increases from 0 to $\mu(0)$, L decreases
- For $i \geq \mu(0)$, middleman holds $L = 0$
  - Middleman finance solely relies on liquidity from suppliers
  - Insensitive to funding costs

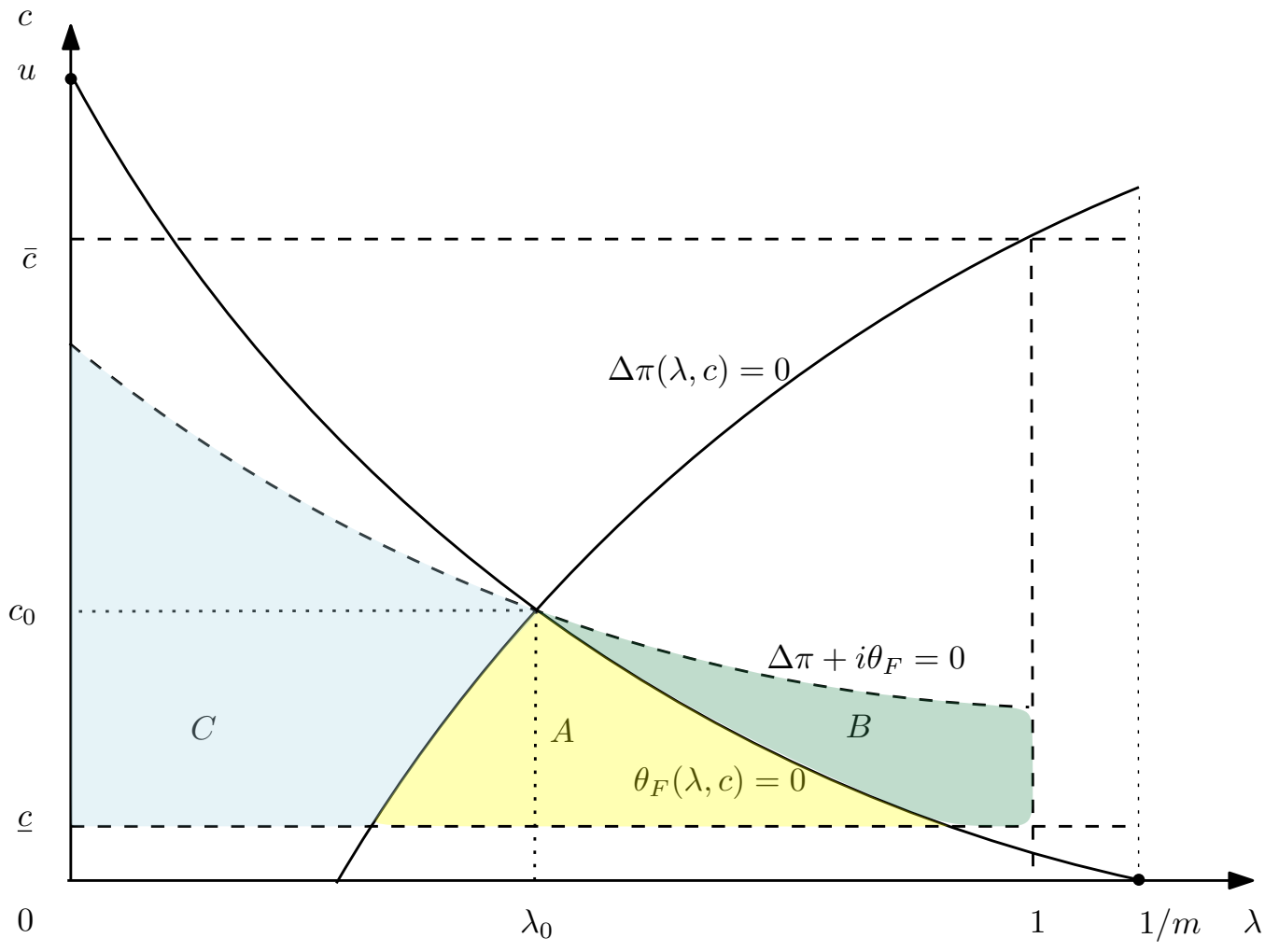
Characterization of monetary equilibrium

The slope of selection curve ($\Delta\pi + i\theta = 0$) can be positive or negative

- Positively–sloped selection curve:
  - $i < i_0$ (some $i_0 \in (0, \bar{i})$: Profits are relatively more important than liquidity for middleman finance
  - Hence, upward sloping, just like $\Delta\pi = 0$ curve
- Negatively–sloped selection curve:
  - $i \geq i_0$: Liquidity is relatively more important than profits for middleman finance
  - Hence, downward sloping, just like $\theta_F = 0$ curve

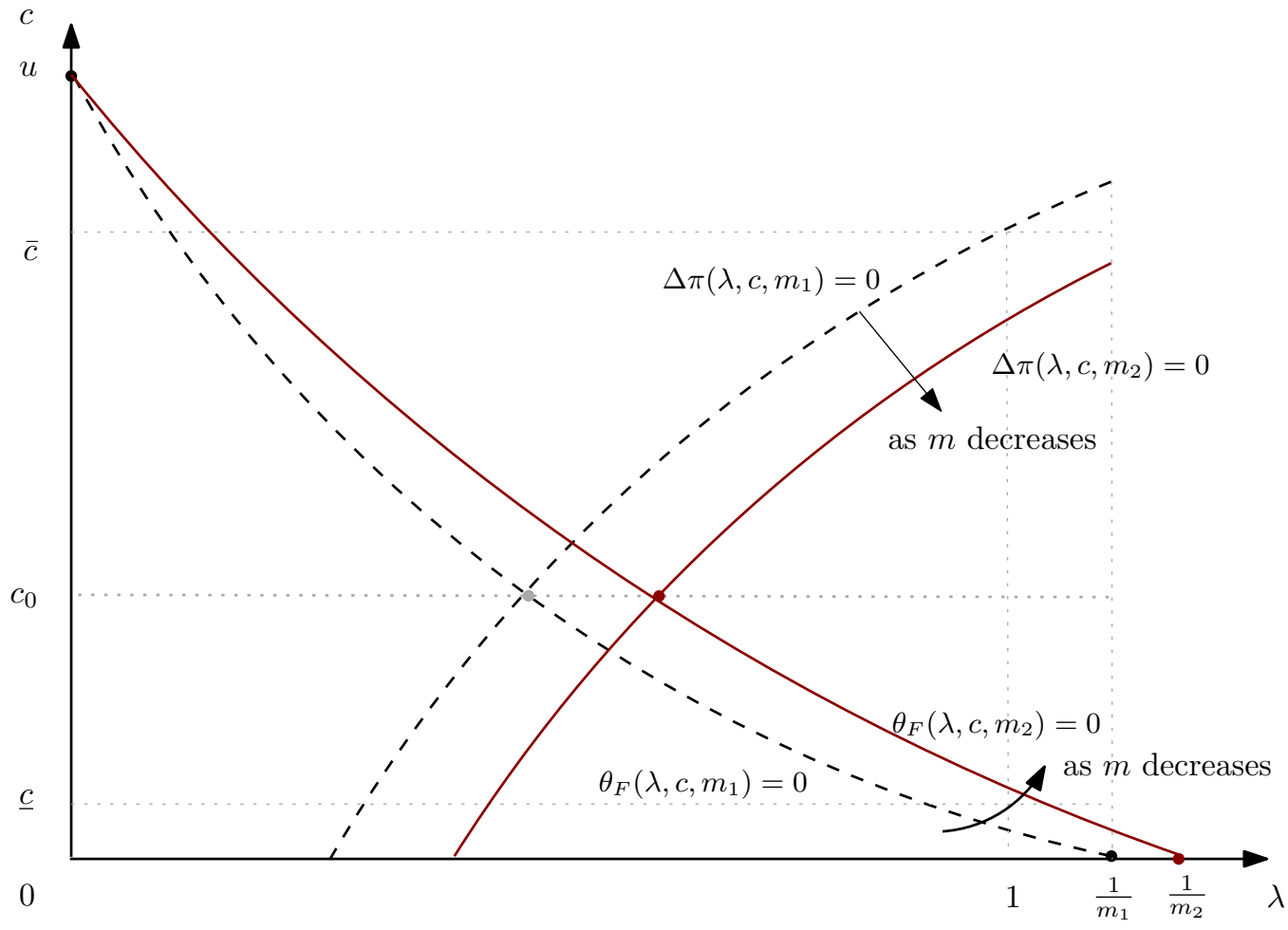


Positively-sloped selection curve



Negatively-sloped selection curve

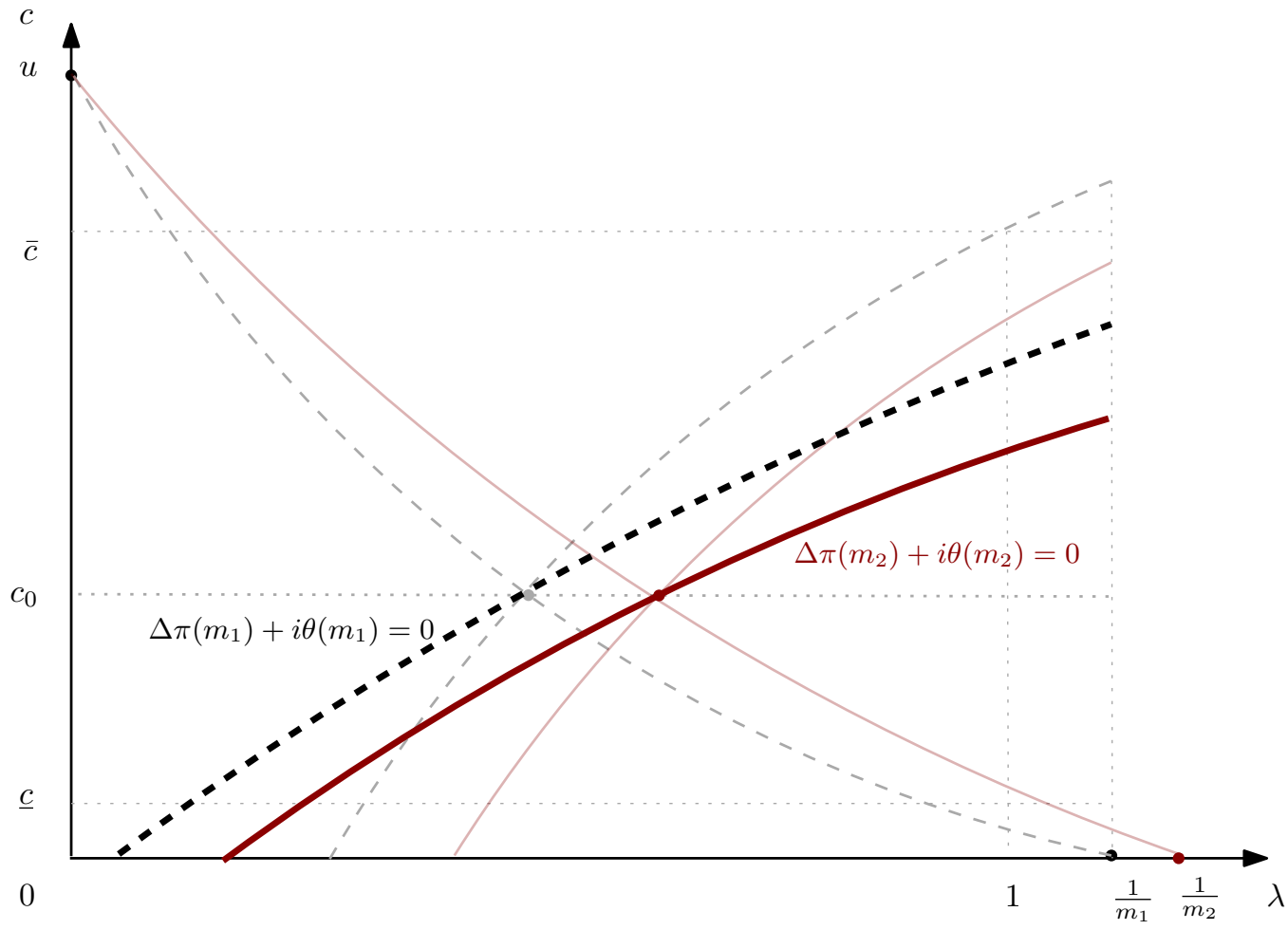
2.1 Matching efficiency and Middleman finance



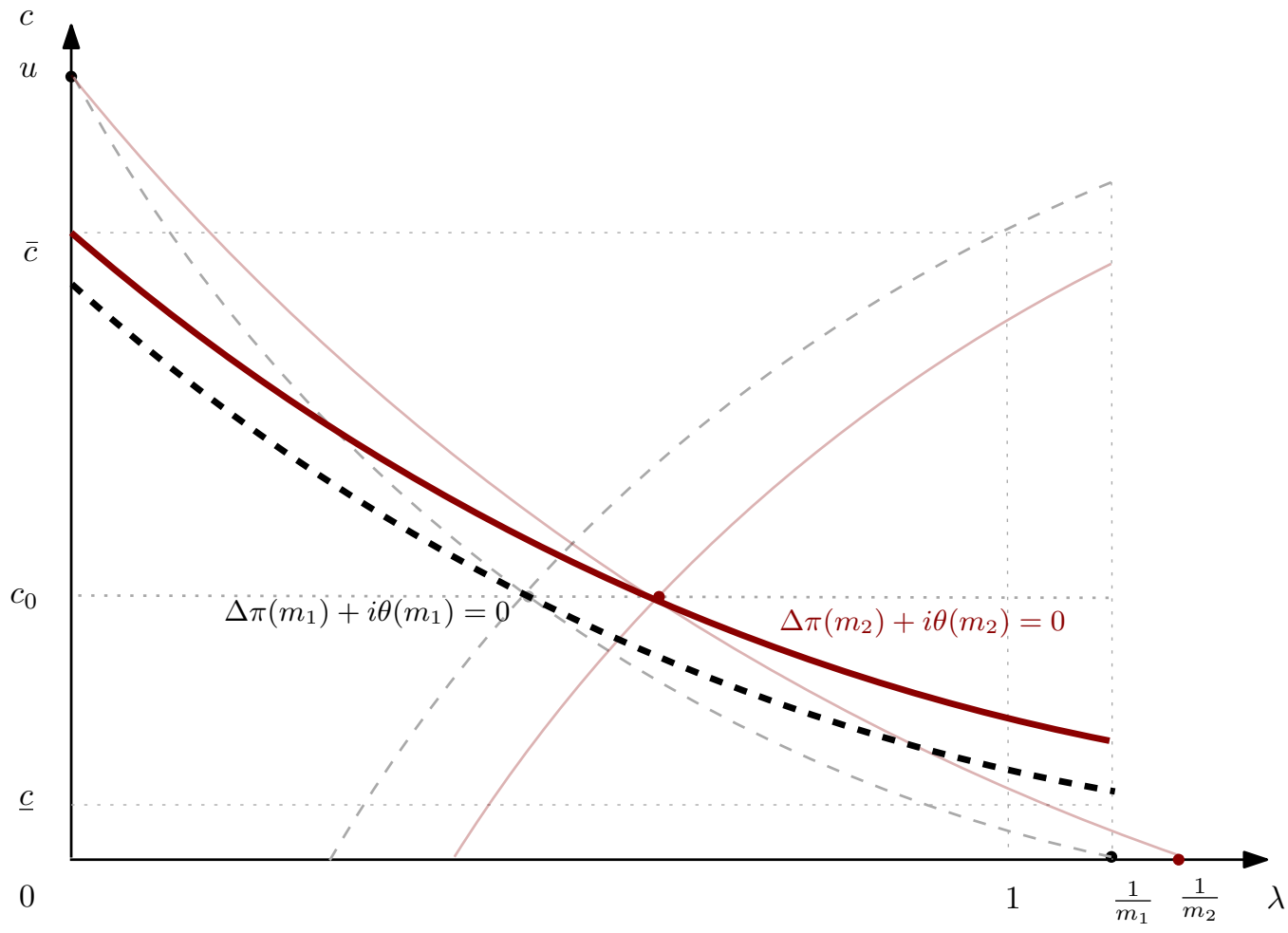
Effects of changes in matching efficiency m

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

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



- If the selection curve is upward-sloping, middleman finance shrinks as m decreases



- If the selection curve is downward-sloping, middleman finance expands as m decreases

Proposition (Matching advantage and middleman finance)

- *If the selection curve is upward-sloping ($i < i_0$), then the middleman finance shrinks as m decreases*
- *If the selection curve is downward-sloping ($i \geq i_0$), then the middleman finance expands as m decreases*

3. Nominal Interest Rate and Welfare

Welfare

- Incremental total surplus for middleman fiance:

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

Note

- Whenever middleman profits are positive $\Delta\pi(\lambda, c) = m\lambda(u - c)/2 - k > 0$, adding finance leads to $\Delta v(\lambda, c) > 0$ for any given set of suppliers
- Middleman finance is welfare improving

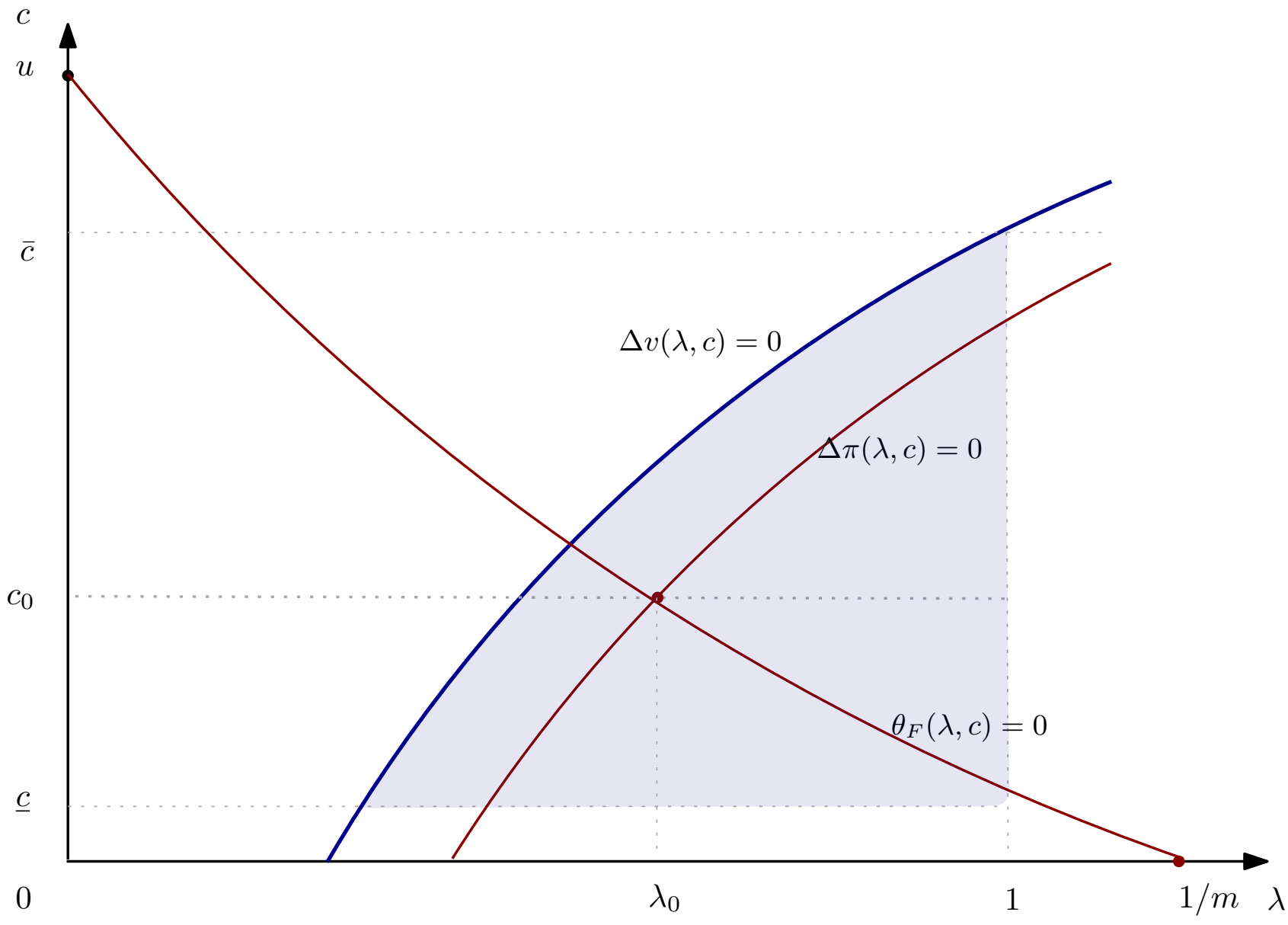


Figure: Middleman finance is welfare improving

Marginal deviation from $i = 0$, Uniform distribution

Proposition (Non-zero nominal interest 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.*

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

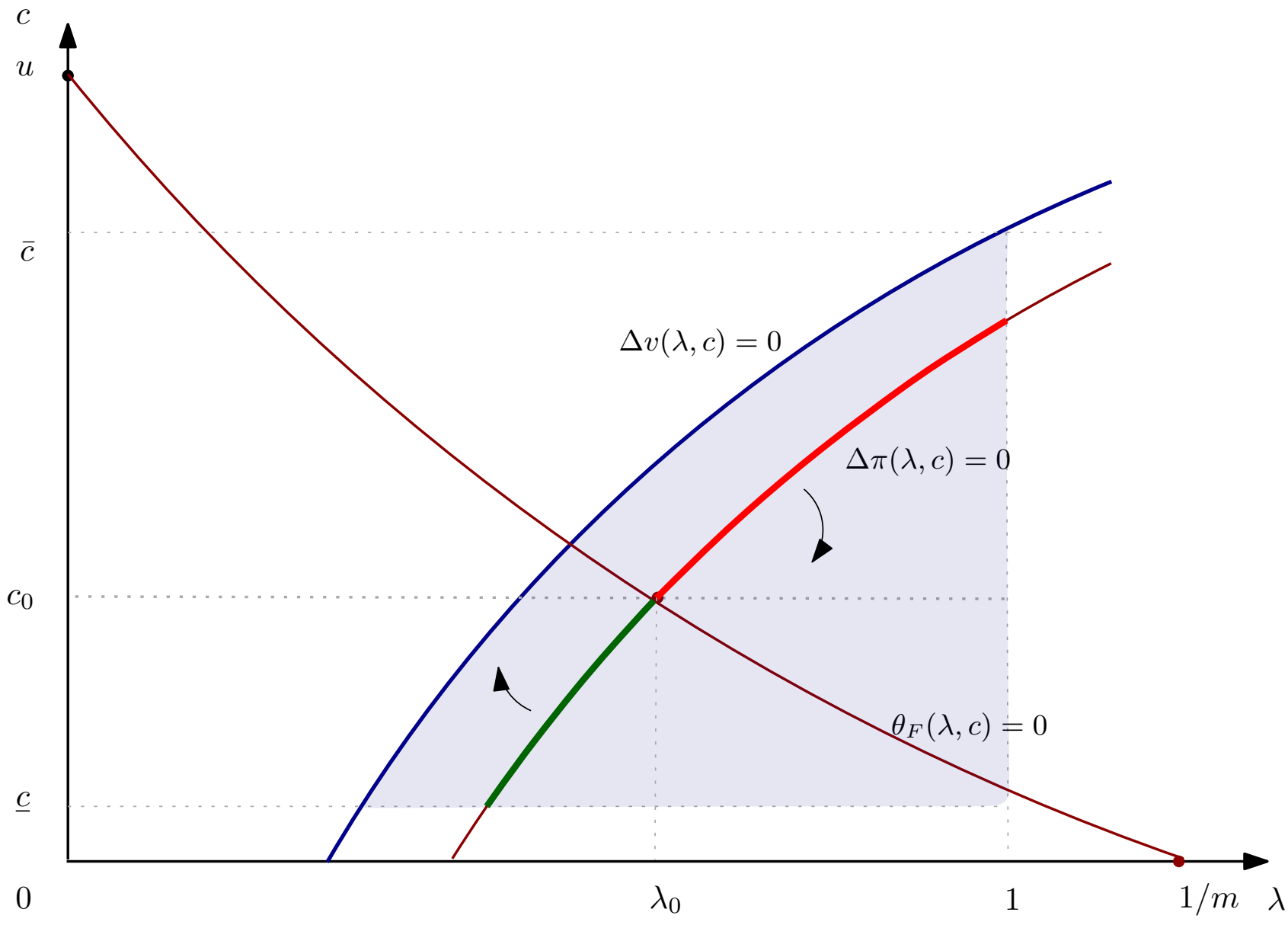
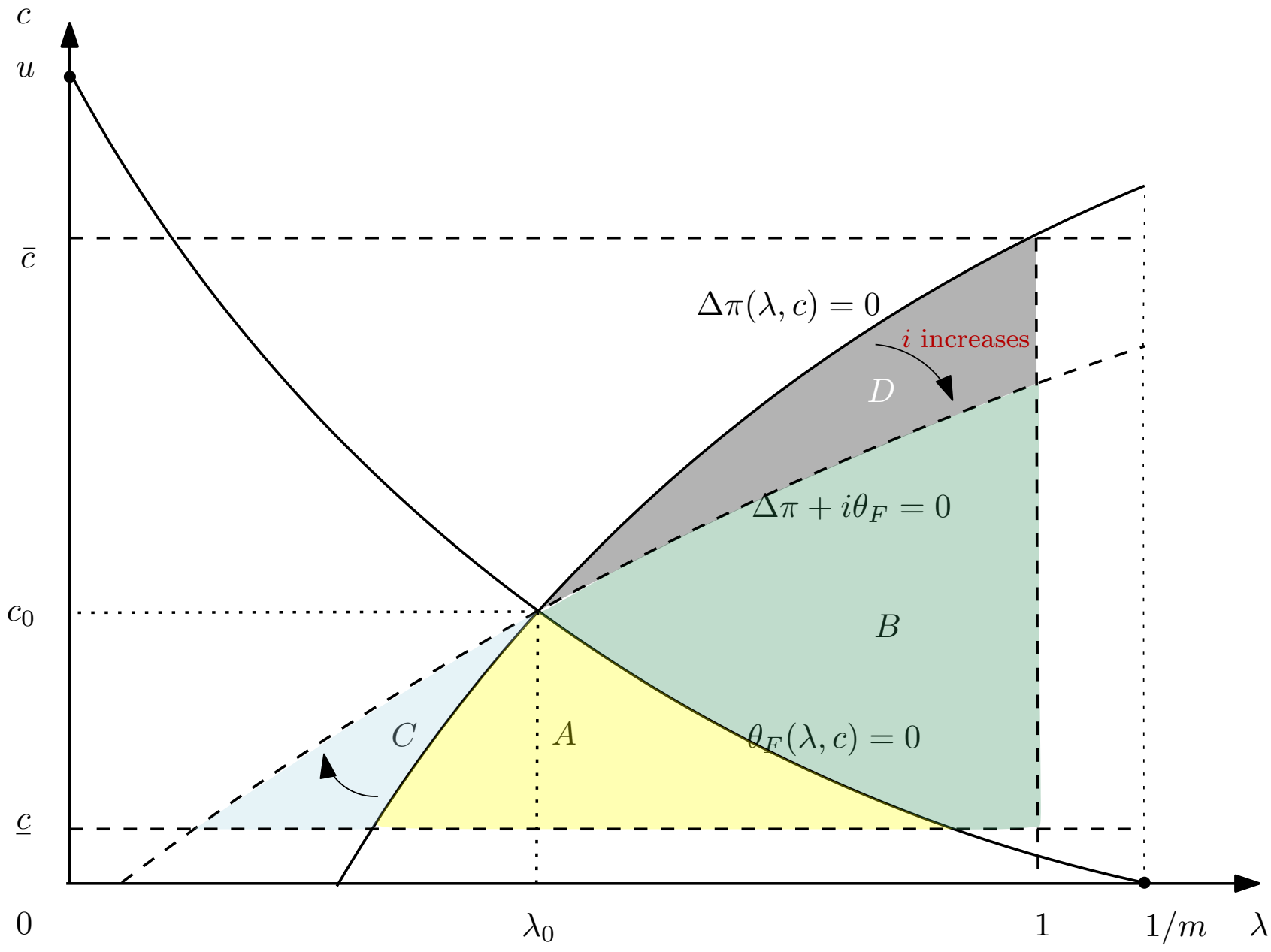


Figure: Marginal suppliers as i increases from $i = 0$



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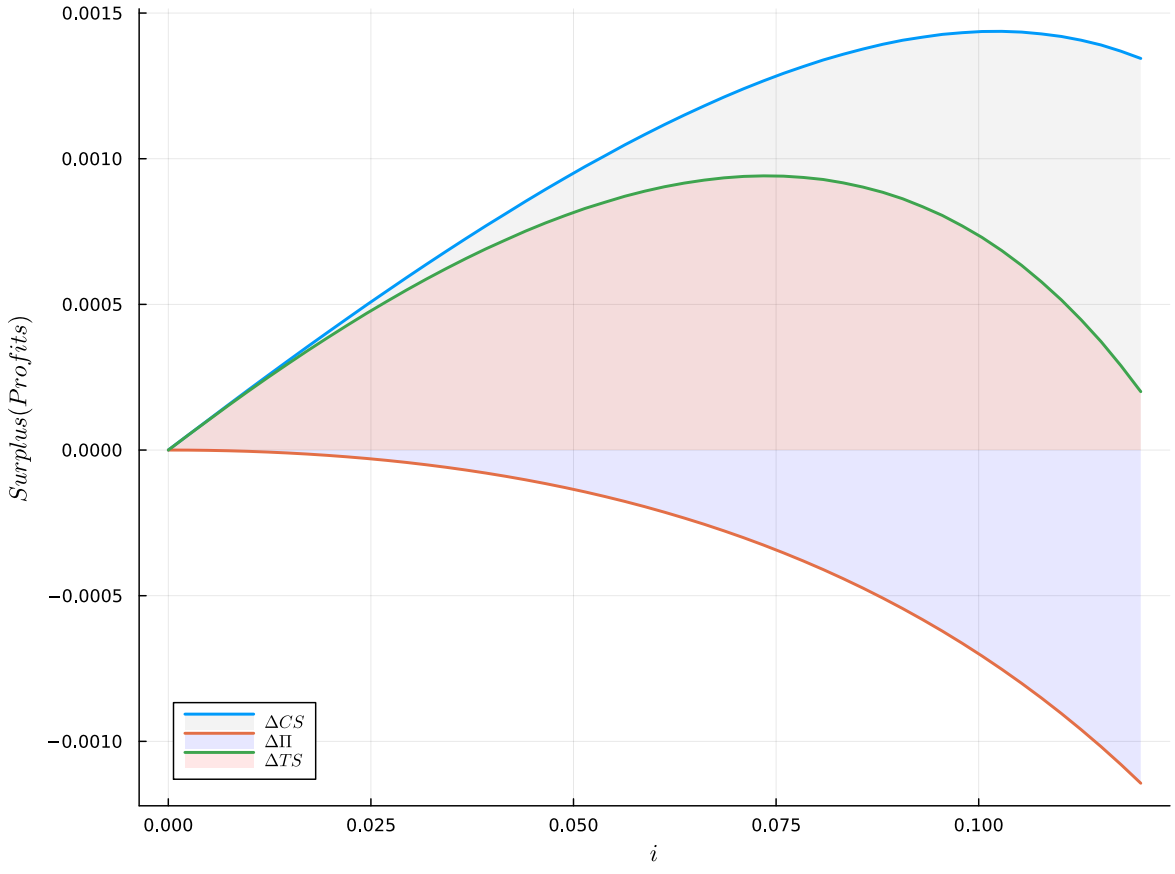

Figure: Welfare is non-monotonic in i under uniform distribution of (λ, c)

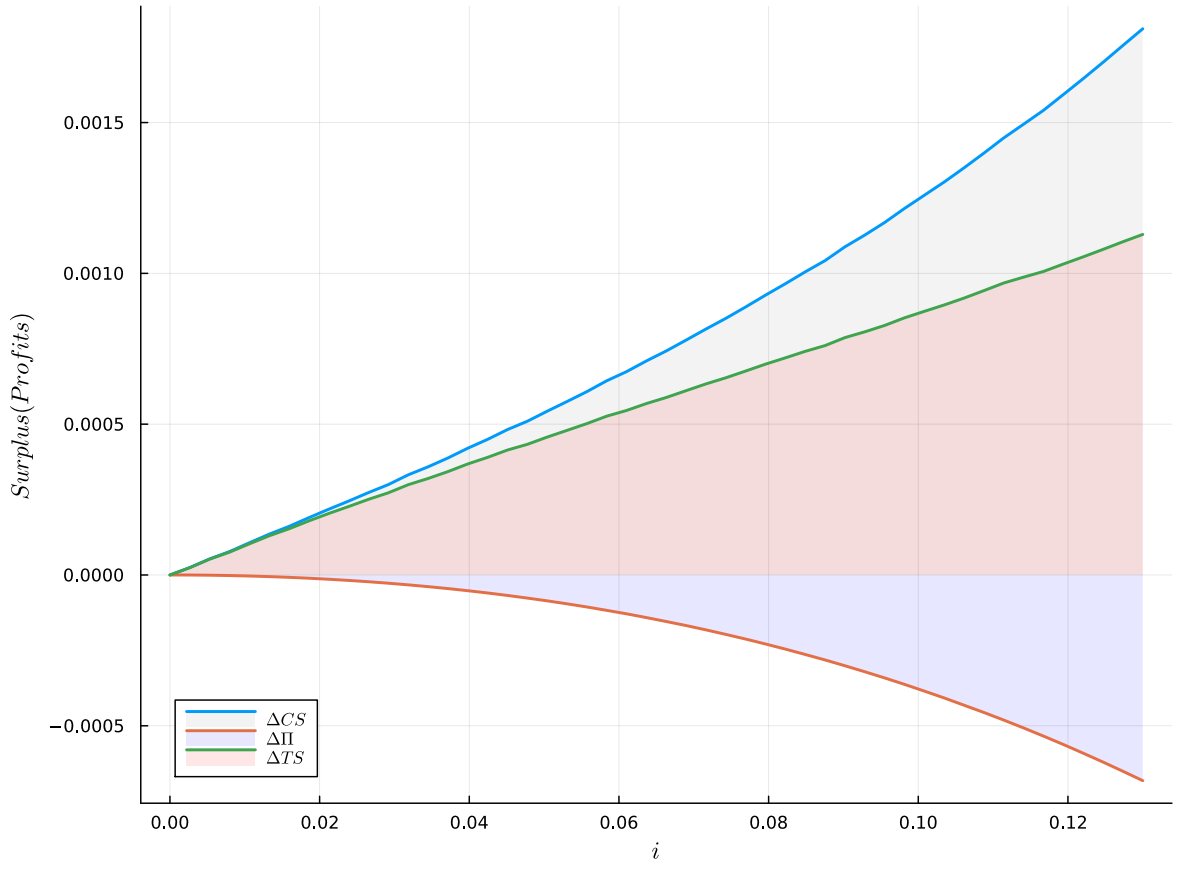

Figure: Welfare increases in i under Beta distributions of λ and c

4. Suppliers' access to outside market liquidity

Suppliers' money holding

- Discount factor of suppliers: $\beta^s \in (0, \beta]$
- A supplier needs to hold a real balance of $z^s = c$ in the previous night market. It is profitable if

$$\beta^s \left[\frac{\lambda(u-c)}{2} + c \right] \geq \frac{\phi}{\phi_+} c,$$

or equivalently

$$c < c^s(\lambda, i^s) \equiv \frac{\lambda}{\lambda + 2i^s} u.$$

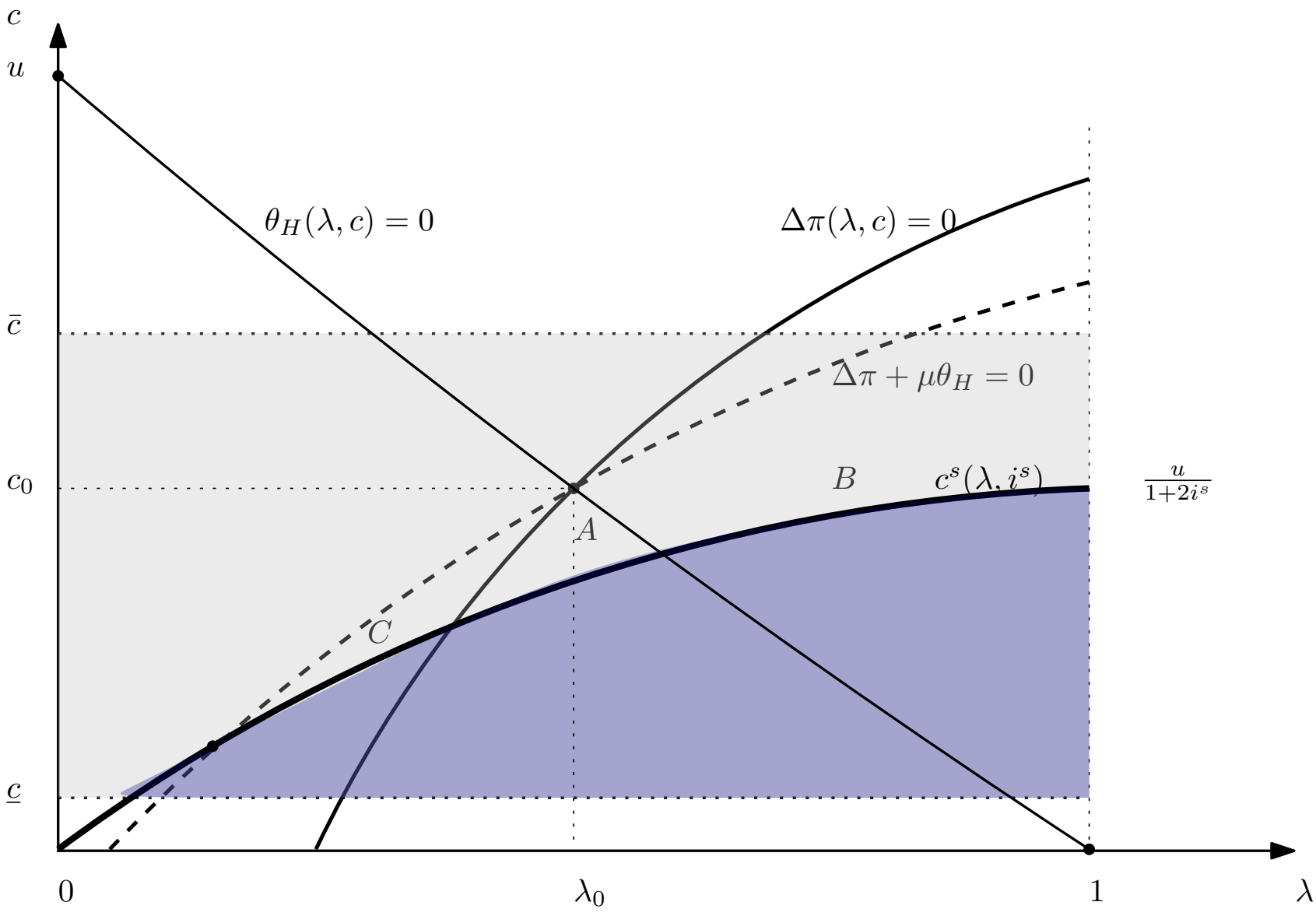

Figure: Suppliers' money holdings coexist with middleman liquidity program

Proposition

Suppose suppliers can access the money market at an effective interest of $i^s \geq i$. Then there exists $i < \underline{i}^s < \bar{i}^s$ such that:

- *For $i^s \leq \underline{i}^s$, suppliers with $c \leq c^s(\lambda, i^s)$ hold money for liquidity needs, and middleman finance is inactive*
- *For $i^s \geq \bar{i}^s$, no supplier holds money, and middleman finance is active*
- *For $i^s \in (\underline{i}^s, \bar{i}^s)$, suppliers with $c \leq c^s(\lambda, i^s)$ holds money while middleman finance is active*

Takeaways

- Middleman finance: pools liquidity from suppliers and funds suppliers for liquidity needs.
- Middleman finance features profit-based liquidity cross-subsidization.
- Middleman finance mitigates costs of market liquidity.
- Middleman finance is affected by middleman's matching efficiency.
- Welfare is non-monotonic in nominal interest rates.