# Middlemen and Liquidity Provision

Bo Hu[1]    Makoto Watanabe[2]    Jun Zhang[3]

[1, 3] Fudan University

[2]KIER, Kyoto University

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# Middleman as a liquidity provider

A middleman, who purchases goods from suppliers and sells to consumers, provides 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 technology, *supplier finance programs* have been widely adopted by most large middlemen (even manufacturing companies), e.g., Walmart, Amazon, JD.com, etc.

# 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.

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## Key features of middleman liquidity provision

- a large number of small suppliers who are very different
- suppliers are invited, and contract terms are personalized
- payments to suppliers are delayed
- suppliers can request advanced payment at low rates

## Research questions:

- Why delay payment while providing liquidity support?
- What trade-offs do middlemen face when providing liquidity?
- How does middlemen's matching advantage interact with liquidity provision?
- What are the welfare implications?

# Preview of the model

- A simple model of a middleman funding suppliers.
- Heterogeneous suppliers in profitability and liquidity needs.
- Profit-based liquidity cross-subsidization
  - use liquidity from suppliers with negative profits
  - to fund suppliers with positive profits
  - related to the *cost of market liquidity* and *middleman's matching advantage*
- Integrate benchmark into Lagos and Wright's (2005) framework.

# Related literature

- Middlemen and multi-product intermediaries:
  - Rubinstein & Wolinsky (1987), Suplber (1996), Watanabe (2010), Wong & Wright (2014), Rhodes, Watanabe & Zhou (2021)
  - liquidity issues are not addressed
- 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 have 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

# This talk

1. A one-period benchmark model
2. Endogenous liquidity holdings of middleman
3. Discussions:
   - matching and financing
   - nominal interest rate and welfare
   - suppliers have access to the 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:
  - also has access to a finance technology
  - fixed cost $k > 0$ to include each supplier

# Endowments/Liquidity

- There is a *numeraire* good (money)
- Consumers have enough endowment of numeraire
- Middleman has endowment (measure) $L \geq 0$
- Suppliers have no endowment; however, production cost $c$ must be paid using the numeraire good.

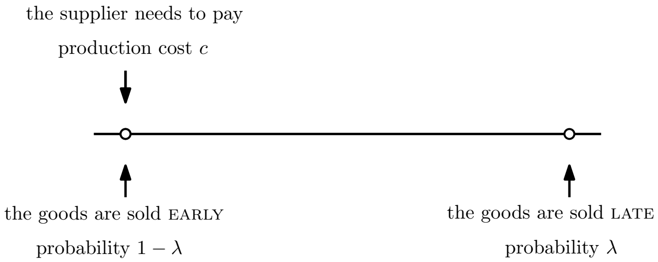
# Retail market

- Even without the middleman, suppliers can trade directly with consumers.
- Suppliers can meet all consumers, trade bilaterally:
- The trade surplus is split equally:

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

- Trade may not occur due to liquidity shocks.

# Liquidity shocks




- A liquidity shock is realized at the beginning of the period
- $1-\lambda$: a supplier meets consumers *early*, $c$ can be covered using retail revenue
- $\lambda$: a supplier meets consumers *late*, $c$ can NOT be covered using future revenue

# Ex ante heterogeneity of suppliers

- Each supplier is indexed by

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

  where $\lambda$ is prob liquidity shock, $c$ is marginal cost
- $(\lambda, c)$ is publicly observable, following a distribution C.D.F. $G$, P.D.F. $g > 0$ on $\Omega$
- Middleman observes $(\lambda, c)$, and selects suppliers into *the pure middleman mode* or *the middleman finance (hybrid) mode*.

# Pure middleman mode

- Middleman sells on behalf of suppliers (who then exit the market)
  - late arrival prob becomes $m\lambda$
  - $m < 1$ middleman has a matching advantage

    e.g., better retail technologies (facilitating the payment, delivery, display, and visibility of goods) that make consumers convinced to pay early rather than late
  - The case of matching disadvantage ($m > 1$) in the paper
- Given a supplier is invited $q_M(\lambda, c) = 1$, middleman gives a TILI offer:
  - transfers $f_M(\lambda, c)$ to the supplier immediately after consumers pay.

# Middleman finance (hybrid) mode

- Middleman sells on behalf of suppliers (who then exit the market) with late arrival prob is $m\lambda$
- Middleman delays payments and provides liquidity support.
- Given a supplier is invited $q_H(\lambda, c) = 1$, middleman gives a TILI offer:
  - transfers $f_H(\lambda, c)$ to the supplier at the end of the period
  - pays cost $c$ to the supplier at the time of production

Middleman's offers:

$$\{q_j(\lambda, c), f_j(\lambda, c)\}_{(\lambda,c)\in\Omega},\ j \in \{M, H\}.$$

Timing

1. Middleman announces contracts and invites suppliers.
2. Suppliers decide to accept or not.
3. Liquidity shocks are realized, middleman pays $f_M$ or $c$, suppliers produce, and agents trade in the retail market.
4. The middleman pays supplier $f_H$ by the end of the period.

# Profits contributions in pure middleman mode

- $f_M$ and $f_H$ must satisfy suppliers' IR:

$$\text{supplier's value} \geq \underbrace{(1-\lambda)\frac{u-c}{2}}_{\text{direct selling}}.$$

- In middleman mode, profit contribution:

$$\begin{aligned}\pi_M(\lambda, c) &= (1-m\lambda)\frac{u-c}{2} - (1-\lambda)\frac{u-c}{2} \\ &= (1-m)\lambda\frac{u-c}{2} \quad \text{positive if } m < 1\end{aligned}$$

and no liquidity contribution (at the time of production).

# Profits and liquidity contributions in hybrid mode

- In hybrid mode, supplier contributes profit and liquidity.
- The profit contribution:

$$\begin{aligned}\pi_H(\lambda, c) &= \frac{u-c}{2} - (1-\lambda)\frac{u-c}{2} - k \\ &= \lambda\frac{u-c}{2} - k;\end{aligned}$$

  the liquidity provision allows the production and trade to occur with probability one;
- liquidity contribution (at the time of production):

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

# Profit maximization

- The middleman's profit maximization problem:

$$\max_{q_H(\cdot),q_M(\cdot)} \int_\Omega \Big( q_M(\lambda,c)\pi_M(\lambda,c) + q_H(\lambda,c)\pi_H(\lambda,c) \Big) dG$$

subject to the liquidity constraint:

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

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

# Profit-maximizing selection policy

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

$$\mathcal{L} = \int_{\Omega} \Big[ q_M(\cdot)\pi_M(\cdot) + q_H(\cdot)\Big(\pi_H(\cdot) + \mu\theta_H(\cdot)\Big)\Big] dG(\lambda, c).$$

- $\mu \geq 0$: Lagrangian multiplier of the liquidity constraint; the shadow value of liquidity.

- Let $\Delta\pi \equiv \pi_H - \pi_M$. The optimal selection rule is:

$$q_H(\lambda, c, \mu) = 1 \text{ if } \Delta\pi(\lambda, c) + \mu\theta_H(\lambda, c) \geq 0,$$
$$q_M(\lambda, c, \mu) = 1 \text{ otherwise}$$

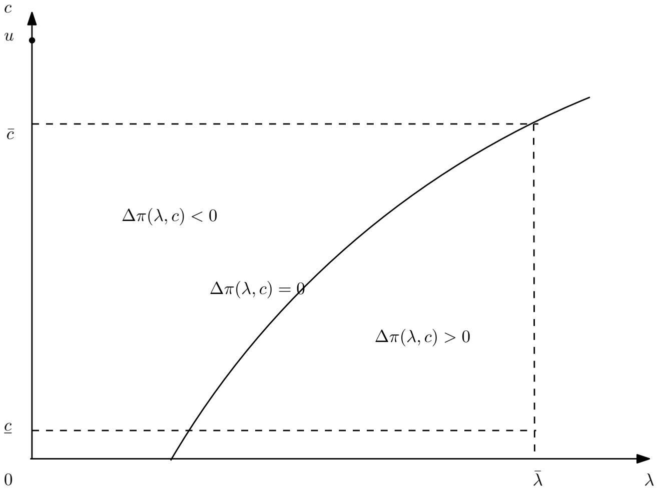



Figure: incremental profit $\Delta\pi$ in $(\lambda, c)$ space

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

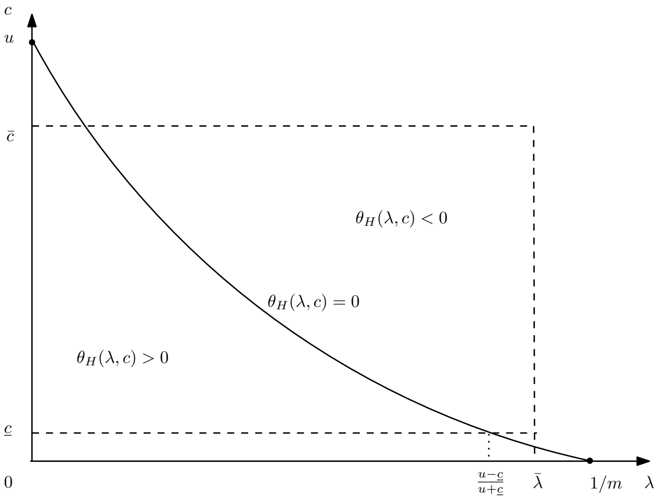



Figure: liquidity $\theta_H(\lambda, c)$ in $(\lambda, c)$ space

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

## Proposition (Liquidity cross-subsidization)

*Suppliers are selected into the hybrid mode if* $\Delta\pi(\lambda, c) + \mu\theta_H(\lambda, c) \geq 0$. *There are three regions:*

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

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

- *Region B: positive profit and negative liquidity*

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

- *Region C: negative profit and positive liquidity*

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

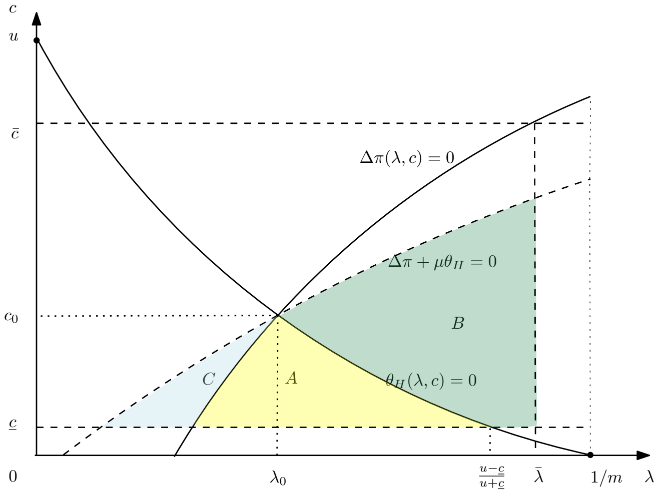



Figure: Profit-based liquidity cross-subsidization

# Determine $\mu$

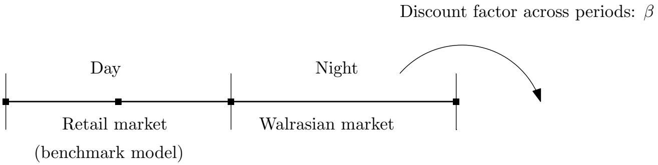
The liquidity constraint determines $\mu = \mu(L)$:

$$\int_{\Omega} q_H(\lambda, c, \mu)\theta_H(\lambda, c)dG + L = 0.$$

- $\mu(L) = 0$: 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

# Standard monetary approach (Lagos and Wright, 2005)




- Day market (the benchmark model)
  - the numeraire good is a medium of exchange, e.g., fiat money
  - suppliers must pay for production costs using fiat money
- Night market (Walrasian)
  - all other markets, where the middleman and consumers can "earn" fiat money by producing a "general good"
  - 1 unit of fiat money worth $\phi_t$ units of general good: $L_t = \phi_t l_t$.
  - suppliers live for one period

# Liquidity holdings of the middleman

- The middleman chooses $l (\equiv L/\phi)$ units fiat money

$$\max_{l \geq 0} \left\{ -\phi_{t-1} l + \beta V_t(l) \right\} \Rightarrow \phi_{t-1} \geq \beta V_t'(l).$$

- The middleman's value of carrying $l$ units of fiat money:

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

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

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

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

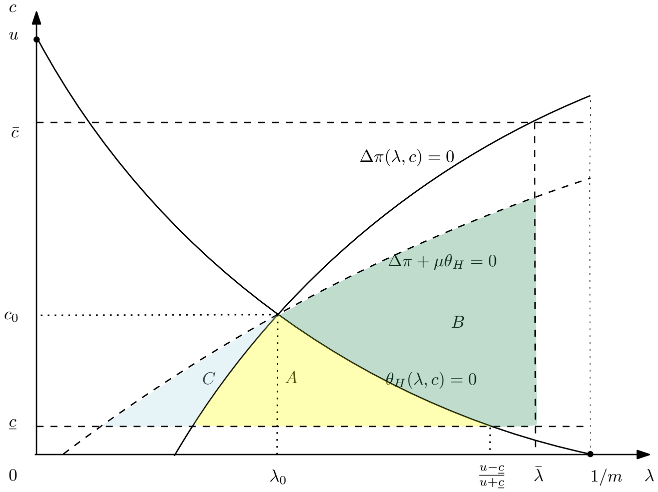
## Proposition (Liquidity holdings of the middleman)

*For $i \leq \bar{i}$, there exists a unique monetary equilibrium with middleman finance described by $q_H(\lambda, c, \mu)$ and $f_H(\lambda, c)$, shadow value of liquidity:*

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

*and middleman's liquidity holdings:*

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

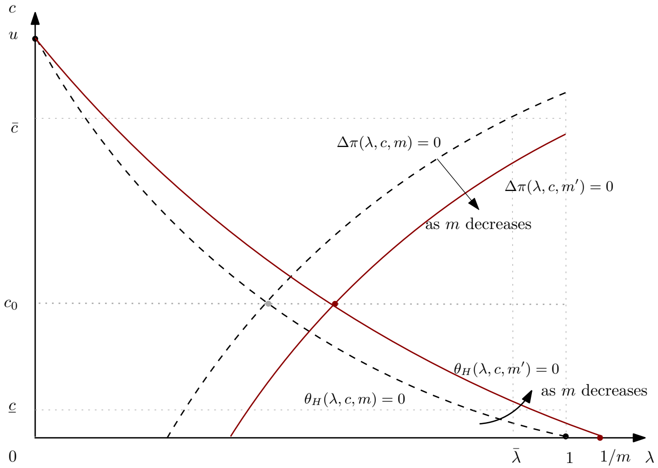



In equilibrium, $\mu = \min\{\mu(0), i\}$.

# 3. Discussions

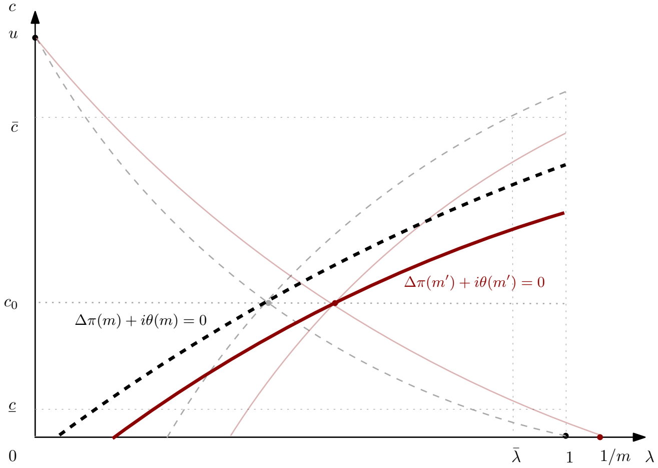
# 3.1 Matching and Financing

# Interplay between matching and financing

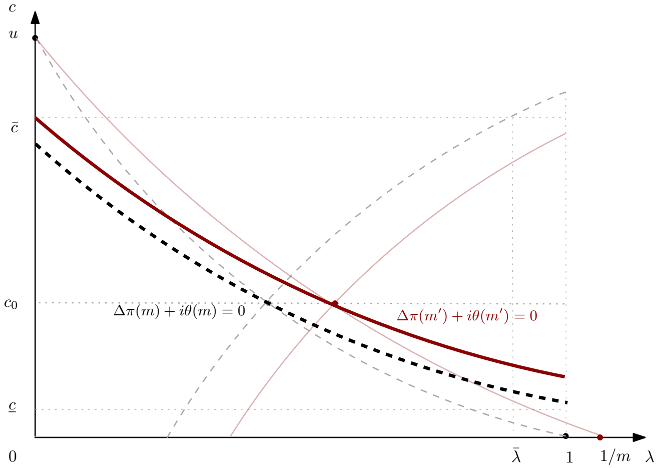



$$\Delta\pi(\lambda, c) = m\lambda(u - c)/2 - k,$$

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




- 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.

# As $m$ decreases further

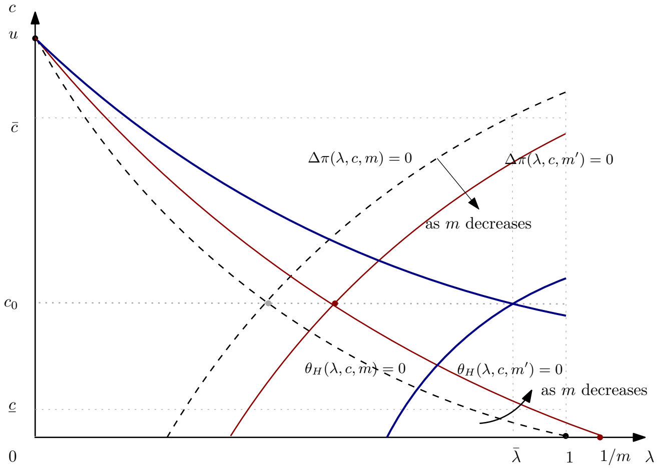



Figure: As $m$ decreases further

## 3.2 Nominal Interest Rate and Welfare

# Planner's problem

- When choosing suppliers to finance, the planner cares about trade surplus

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

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

- Planner's problem:

$$\max_{I(\lambda,c)} \int_{\Omega} I(\lambda, c)\Delta v(\lambda, c)dG.$$

- The efficient allocation:

$$I(\lambda, c) = 1 \text{ if } \Delta v(\lambda, c) \geq 0$$

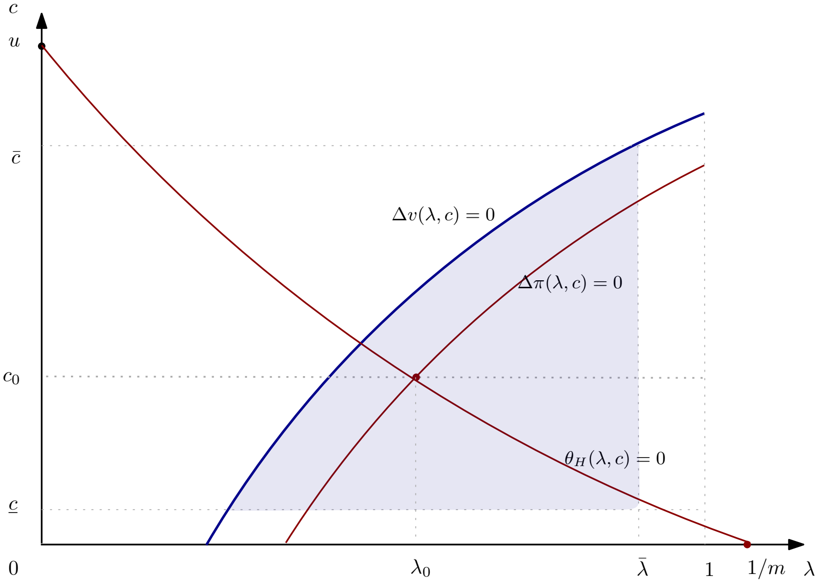



Figure: Trade surplus versus middleman profits

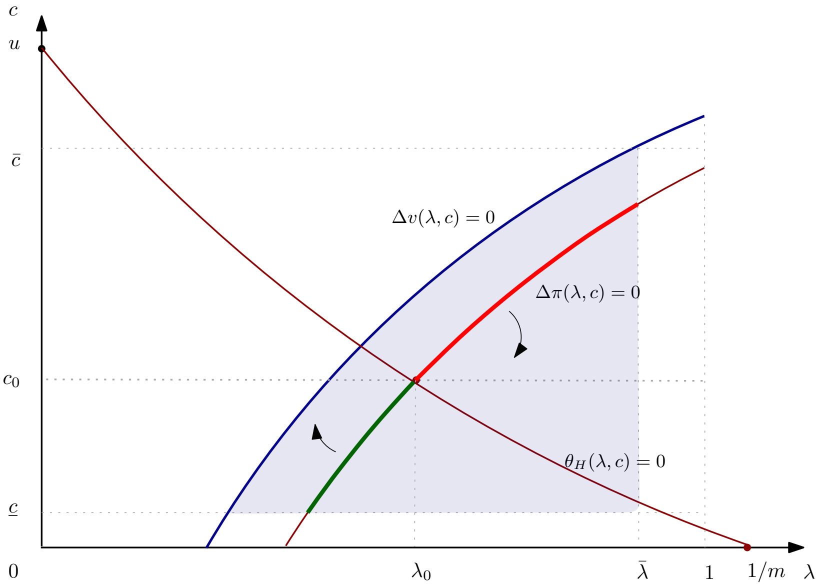



Figure: Marginal suppliers as $i$ increases from $i = 0$

# Marginal deviation at $i = 0$, uniform distribution

**Proposition (Friedman rule suboptimal)**

*Suppose $\mu(0) > 0$, and $(\lambda, c)$ follows a uniform distribution. There exists $m^*(k) \in (\tilde{m}, 1)$ and $k^* \in (0, u/2]$ such that if $m < m^*(k)$ or $k < k^*$, marginally increasing $i$ from $i = 0$ improves welfare.*

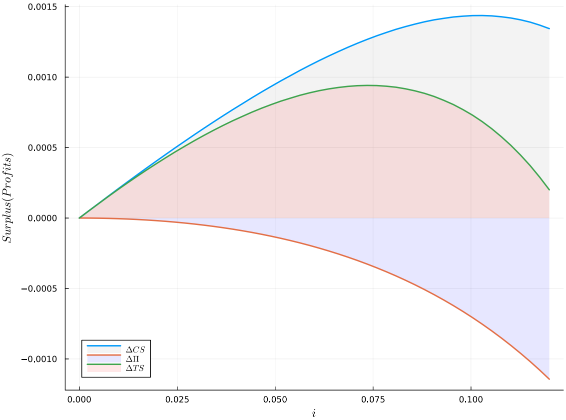



Figure: Welfare is non-monotonic in $i$ under uniform distribution of $(\lambda, c)$

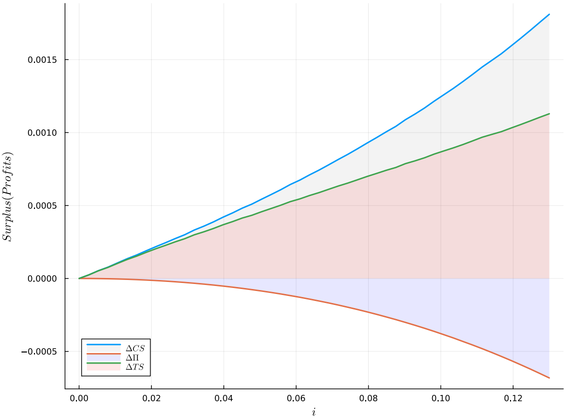



Figure: Welfare increases in $i$ under Beta distributions of $\lambda$ and $c$

## 3.3 Suppliers have access to 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

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

or equivalently

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

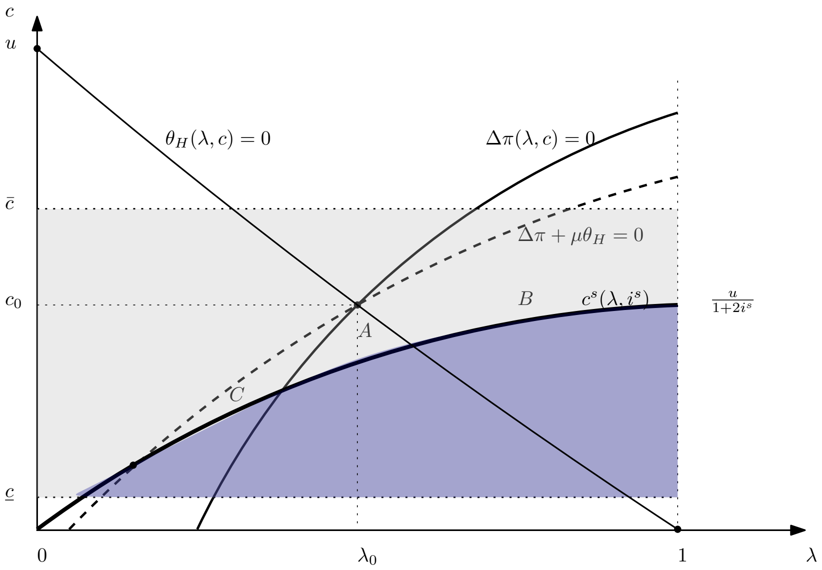



Figure: Suppliers' money holdings coexist with middleman liquidity program

### Proposition

*Suppose* $\underline{c} > 0$, $i < \min\{i_1, \frac{k\bar{\lambda}}{mu\bar{\lambda}-2k}\}$, *and suppliers can access the money market at an effective interest of* $i^s \geq i$. *Then there exists* $i < \underline{i}^s < \bar{i}^s \equiv \frac{(u-\underline{c})\bar{\lambda}}{2\underline{c}}$ *such that:*

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

### Proposition

*Let* $m = 1, \bar{\lambda} = 1$. *For intermediate values of* $i = i^s < i_2$, *an active middleman with* $k < u/6$ *can coexist with suppliers who hold money by themselves.*

# Takeaways

- The middleman pools liquidity from suppliers and funds suppliers for liquidity needs.
- It features profit-based liquidity cross-subsidization.
- It mitigates the high cost of market liquidity.
- It is affected by the middleman's matching technology.
- Welfare is non-monotonic in nominal interest rates.