Supply Chain Finance: The Operational Benefits

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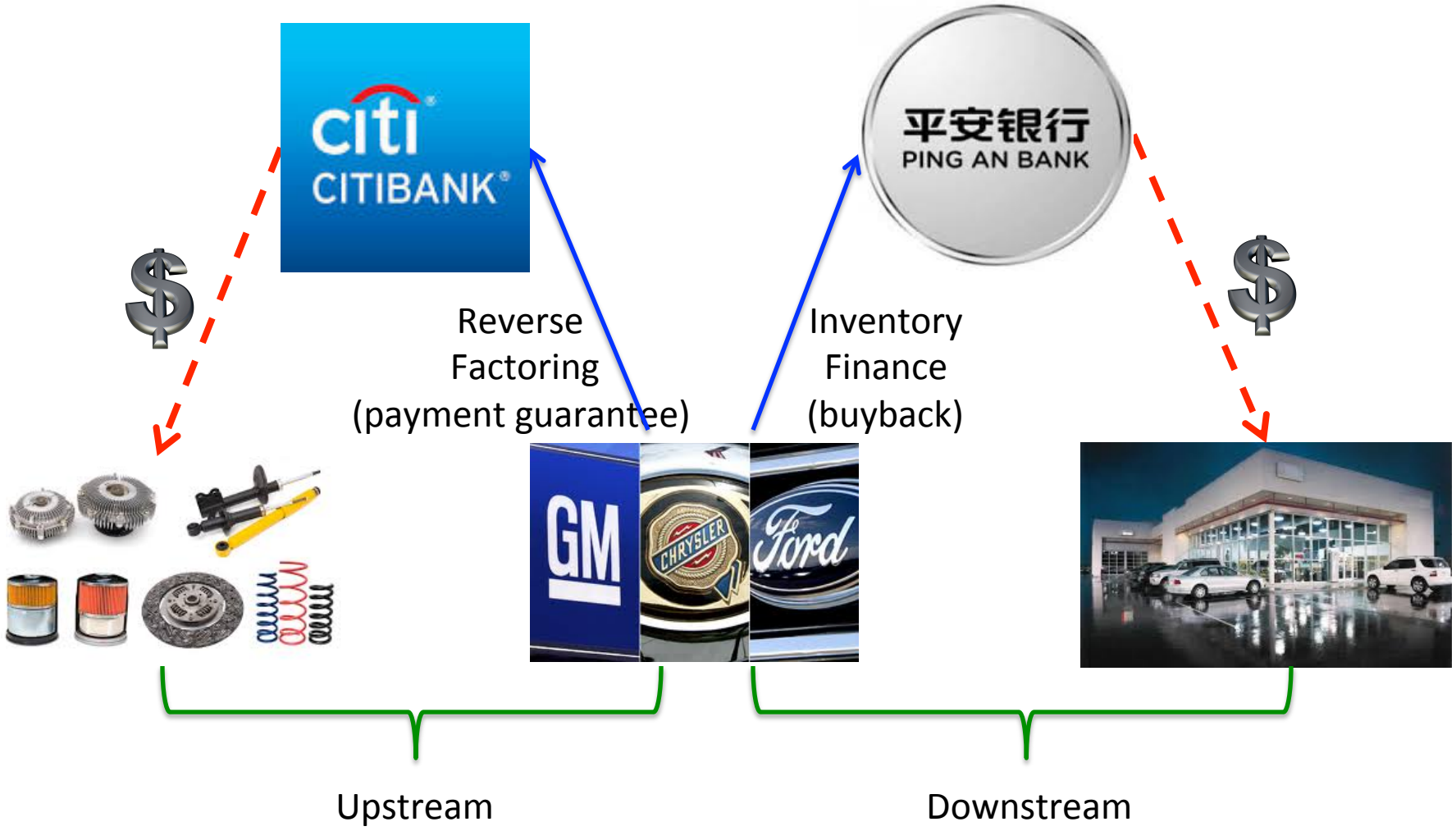
Motivation

- As business expands (e.g., globalization), working capital is tight within its supply chains
- Financial institutes use Supply Chain Finance (SCF) to provide short-term credit to optimize working capital for both seller and buyer
- In the US, SCF is defined as Reverse Factoring
  - Buyer (with better credit rating) helps seller to obtain cheaper finance than under factoring—seller sells its receivables
- In China, SCF also includes Inventory Finance
  - Seller (with better credit rating) helps buyer to obtain (cheaper) finance by committing to buyback excess inventory


citi
CITIBANK
平安银行
PING AN BANK
$
$
Reverse
Factoring
(payment guarantee)
Inventory
Finance
(buyback)
GM
CHRYSLER
Ford
Upstream
Downstream

Practice Example

- A Chinese commercial bank provides Difference Repurchase (DR) contract to car dealers with car maker buys back unsold cars (difference) at time T, where [0,T] is the sales period
  1. Dealer sets order quantity and pays deposit to the bank, usually 30-40% of total cost (at time 0)
  2. Bank issues commercial draft to car maker with maturity time T (at time 0)
  3. Car maker sends cars to the dealer and certificates to the bank (at time 0)
  4. Dealer redeems certificates after sales during (0,T)
  5. Car maker buys back unsold cars and collects money from bank (at time T)

An Example (wholesale price=$10k, retail price=$15k, dealer's initial wealth=$200k)

- Trade credit
  - Car maker sends 100 cars (of cost $1M) to a dealer
  - Dealer sells for a month
  - If 100 sold
    - Dealer earns $500k profit, pays car maker in full
    - Car maker receives $1M
  - If 30 sold
    - Dealer earns 0, pays $450k+200k (< $1M)
    - Car maker receives $650k
- DR (SCF)
  - Dealer pays 30% deposit of $300k, bank issues car maker commercial draft of $1M
  - Car maker sends 100 cars to dealer and the car certificates to bank
  - If 100 sold
    - Dealer earns $500k profit, pays bank $700k (in addition to deposit)
    - Car maker receives $1M
  - If 30 sold
    - Dealer earns $150k profit, pays bank 0
    - Car maker buys back 70 unsold and pays $700k to bank, receiving $300k net

Research Question

- It's known SCF provides unique financial benefits to core enterprises in supply chains
  - Improved on-book financial performances and affordable finance to their small supply chain partners (upstream and downstream)
- Any operational benefits? Earn more profit?
- How should supplier choose financing schemes, internal finance (trade credit) or SCF?

Single-Period Model I: Trade Credit

- 1-supplier (big, principle) and 1-retailer (small and capital constrained, agent)
- Supplier: sets wholesale price w_t (paid at the end)
- Retailer: set order quantity q, responding to w_t
  - Initial wealth η
  - Face uncertain demand D
  - Sell at unit price p (sales volume=min{D,q})
  - Holding cost and salvage value are assumed 0
  - Payment of $w_t q$ with probability β (assumed binary, pay or no pay, independent of its revenue earned)

Model I: Trade Credit

Step 1: Retailer sets optimal order quantity $q^*(w_t)$

$$\max_{q\geq 0} \pi_r(q|w_t) = \frac{1}{1+r_r}\left\{pE[D\wedge q] - \beta E\left[w_t q \wedge (\eta(1+r_r)+pD)\right]\right\}.$$

Step 2: Supplier sets optimal w^*_t, knowing retailer's $q^*(w_t)$

$$\max_{w_t\in(\frac{c(1+r_s)}{\beta},p)} \pi_s(w_t) = \frac{\beta}{1+r_s}\left[\eta(1+r_r) + p\int_0^{d_t^*(w_t)} \bar{F}(x)dx\right] - cq^*(w_t).$$

Supply chain's profit evaluated at time T (rather than time 0) is:

$$\pi_c = \pi_r + \pi_s = pE[D\wedge q] - c(1+r_s)q.$$

Model II: SCF (DR)

- 1-supplier (big, principle), 1-retailer (small and capital constrained, agent), and 1 bank
- Bank: requires deposit of $\alpha w_d q$ from retailer
- Supplier: sets wholesale price w_d (paid by bank)
  - Payment of $w_d(q-S)$ to bank
- Retailer: set order quantity q, responding to w_d
  - Initial wealth η (must be enough to pay deposit $\alpha w_d q$)
  - Face uncertain demand D
  - Sell at unit price p (sales volume $S=\min\{D,q\}$)
  - Payment of $w_d S$

Model II: DR

Step 1: Retailer sets optimal order quantity $q^*(w_d)$

$$\max_{q \le \frac{\eta}{\alpha w_d}} \pi_r(q|w_d) = \frac{1}{1+r_r}\{(p-w_d)E[D \wedge q] + \alpha w_d q(1+r_f)\} - \alpha w_d q.$$

Step 2: Supplier sets optimal w^*_d, knowing retailer's $q^*(w_d)$

$$\max_{w_d \in (c(1+r_s), \frac{p}{1+\alpha(r_r-r_f)})} \pi_s(w_d) = \frac{1}{1+r_s} E\left[w_d(D \wedge q^*(w_d))\right] - cq^*(w_d).$$

Bought back inventory has no value!
(consistent with the Trade credit model)

Model III: Reverse DR

Step 1: Retailer sets optimal order quantity $q^*(w_d)$

$$\max_{q \le \frac{\eta}{\alpha w_r}} \pi_r(q|w_r) = \frac{1}{1+r_r}\left\{(p-w_r)E[D \wedge q] + \alpha w_r q(1+r_f) - \gamma w_r E[(q-D)^+]\right\} - \alpha w_r q.$$

Step 2: Supplier sets optimal w^*_d, knowing retailer's $q^*(w_d)$

$$\max_{w_r \in (c(1+r_s), \frac{p}{1+\alpha(r_r-r_f)})} \pi_s(w_r) = \frac{1}{1+r_s} E\left[w_r(D \wedge q^*(w_r)) + \gamma w_r (q^*(w_r)-D)^+\right] - cq^*(w_r).$$

Equivalent to buyback at a discounted price, $(1-\gamma)w_r$!

Model II and III (SCF)

Step 1: Retailer sets optimal order quantity $q^*(w_d)$

$$\max_{q \le \frac{\eta}{\alpha w_r}} \pi_r(q|w_r) = \frac{1}{1+r_r}\left\{(p-w_r)E[D \wedge q] + \alpha w_r q(1+r_f) - \gamma w_r E[(q-D)^+]\right\} - \alpha w_r q.$$

Step 2: Supplier sets optimal w^*_d, knowing retailer's $q^*(w_d)$

$$\max_{w_r \in (c(1+r_s), \frac{p}{1+\alpha(r_r - r_f)})} \pi_s(w_r) = \frac{1}{1+r_s} E\left[w_r(D \wedge q^*(w_r)) + \gamma w_r (q^*(w_r) - D)^+\right] - c q^*(w_r).$$

Supply chain's profit evaluated at time T (rather than time 0) is:

$$\pi_c = \pi_r + \pi_s = pE[D \wedge q] - c(1+r_s)q - \alpha w q(r_r - r_f).$$

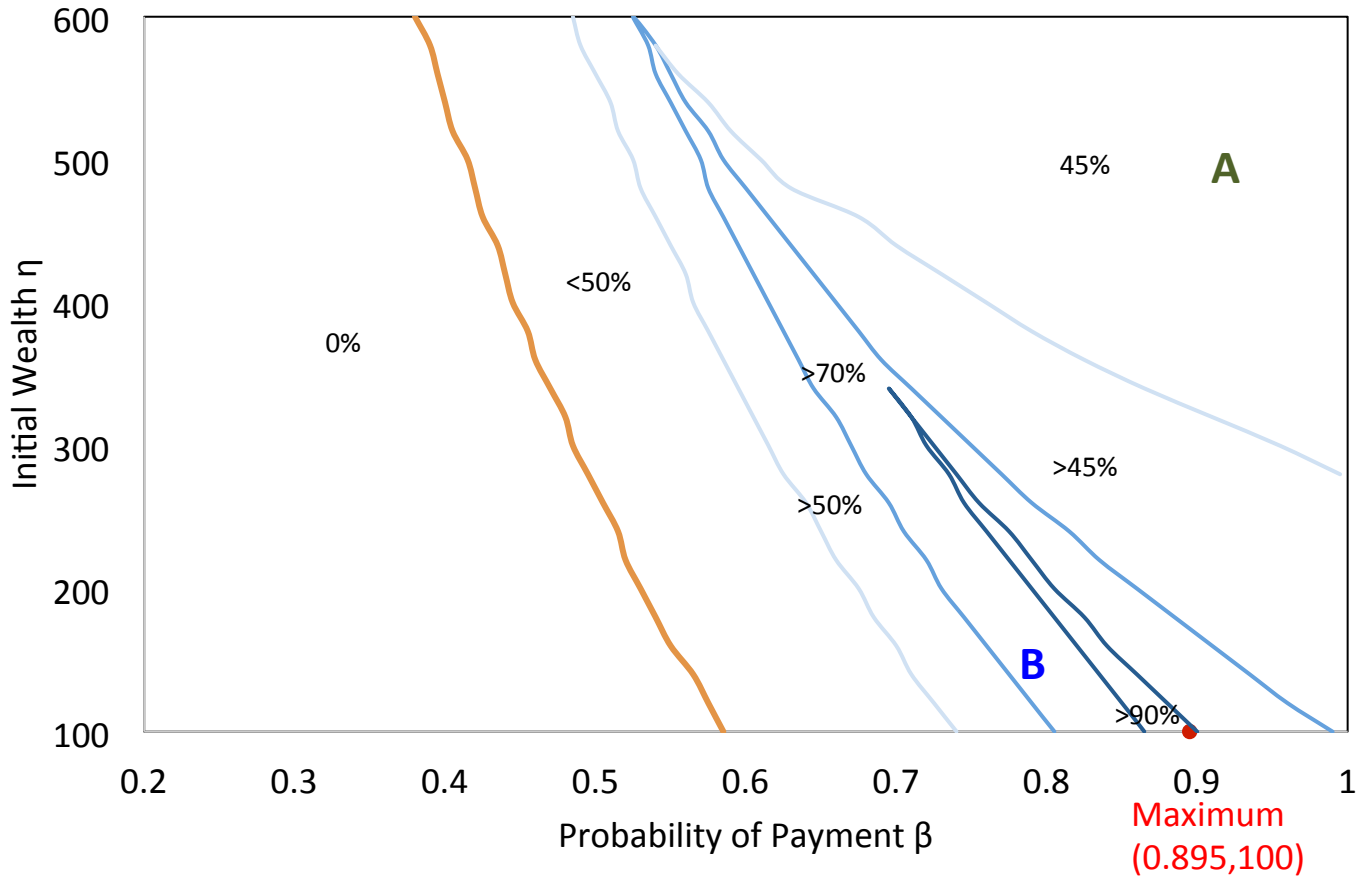
May add salvage value for excess inventory, π_c will have an additional positive term

Interesting Results

- What type of retailer would supplier prefer to finance through Trade credit?
  - Think from two dimensions: initial wealth (η) and payment probability (β)
  - Retailer A with η=500k, β=95% or Retailer B with η=150k, β=80%?
  - Answer is Retailer B!

Interesting Results

Supplier's profit under Trade Credit with different types of retailer

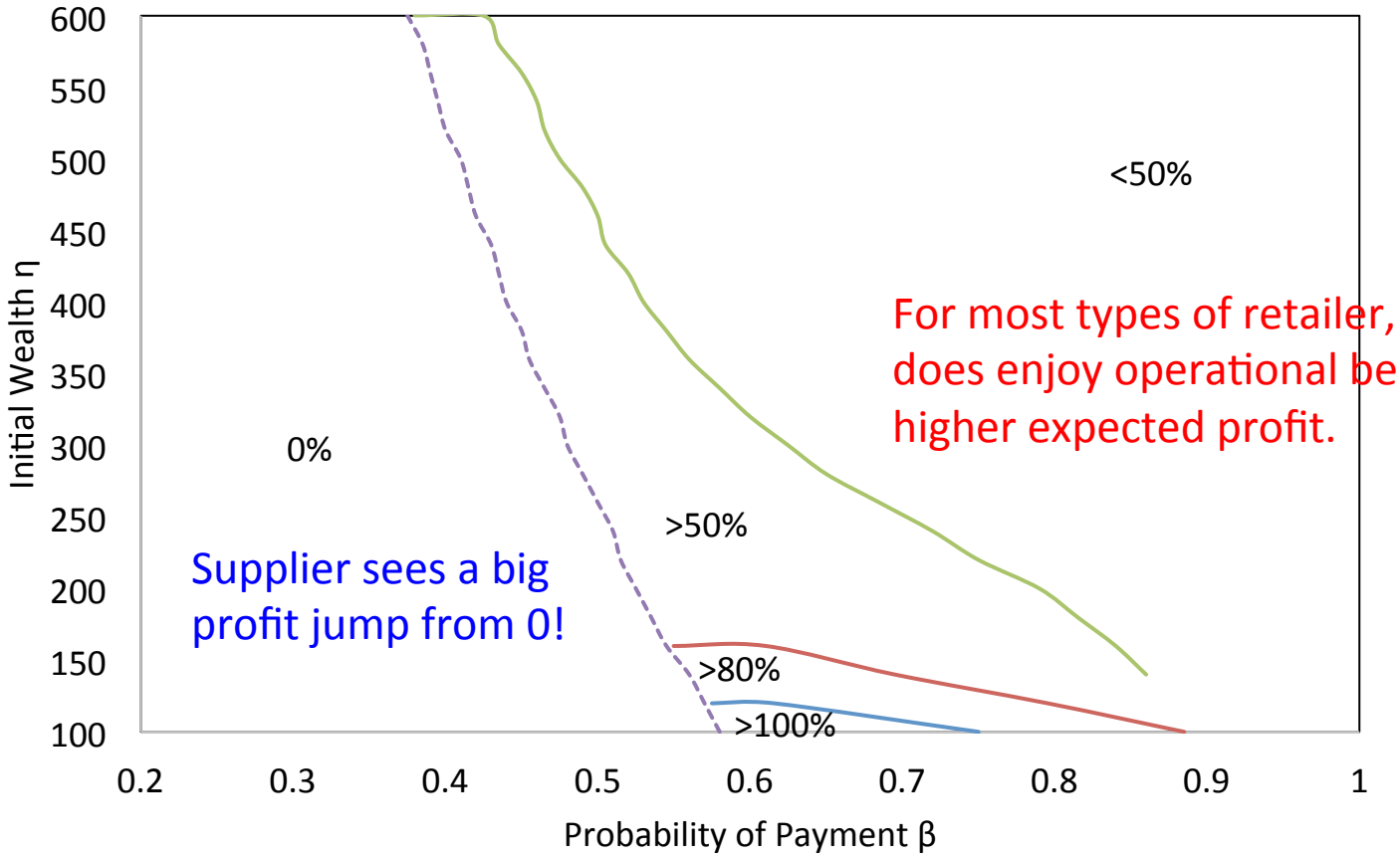


Interesting Results

- What type of retailer would supplier prefer to finance through Trade credit?
  - Prefer poor, but credible retailers
  - Insights: Since poor retailers are more likely to default (thus paying $pD+\eta$, independent of q), they will lower supplier's profit margins, but order more.
  - Quantity benefit > profit-margin disadvantage!

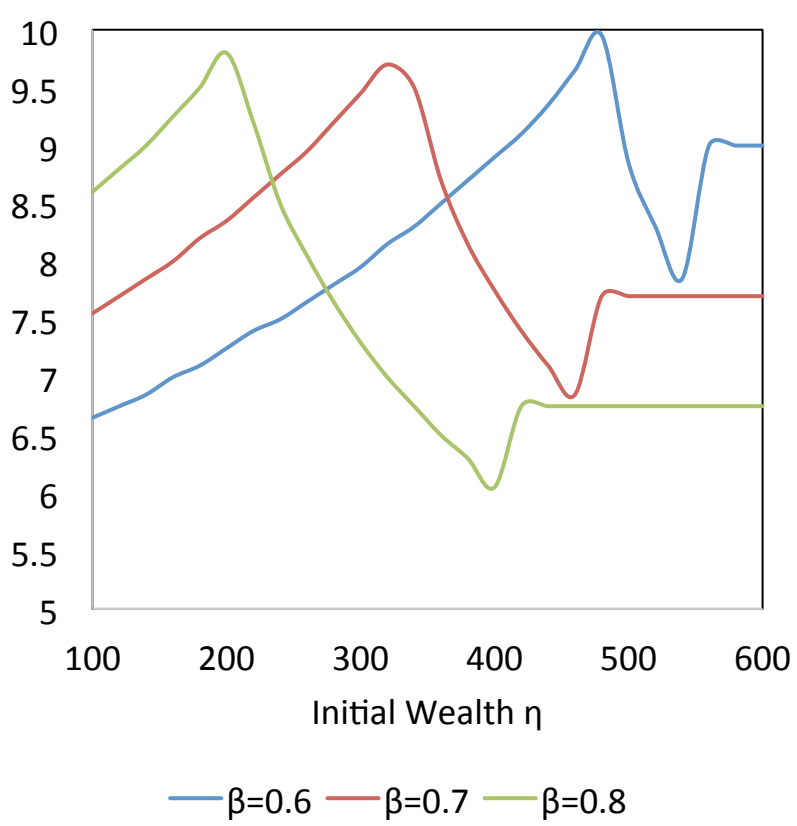
TC or SCF?

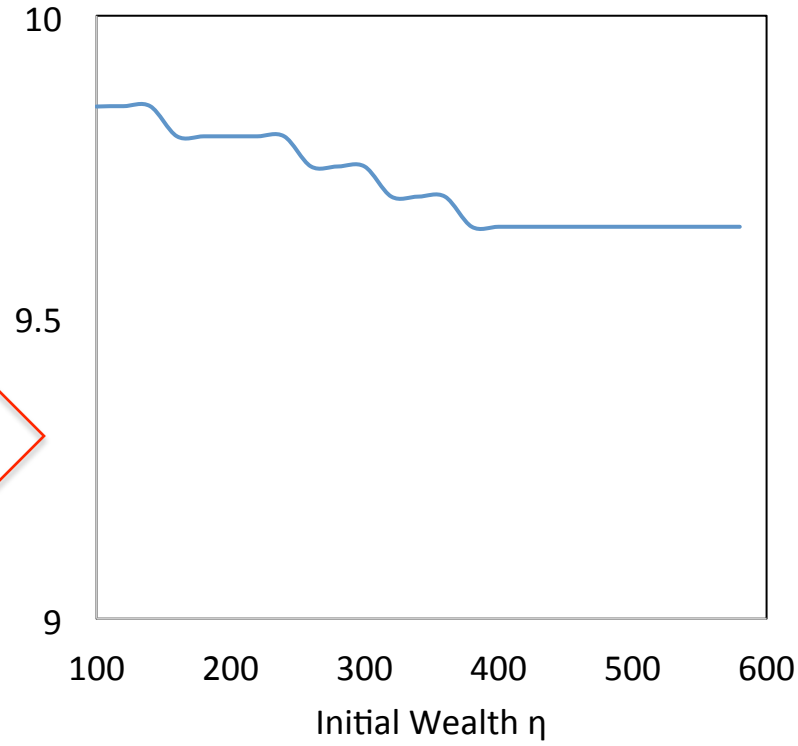
Supplier's profit under TC/Supplier's profit under SCF



Operational Change: Wholesale Price

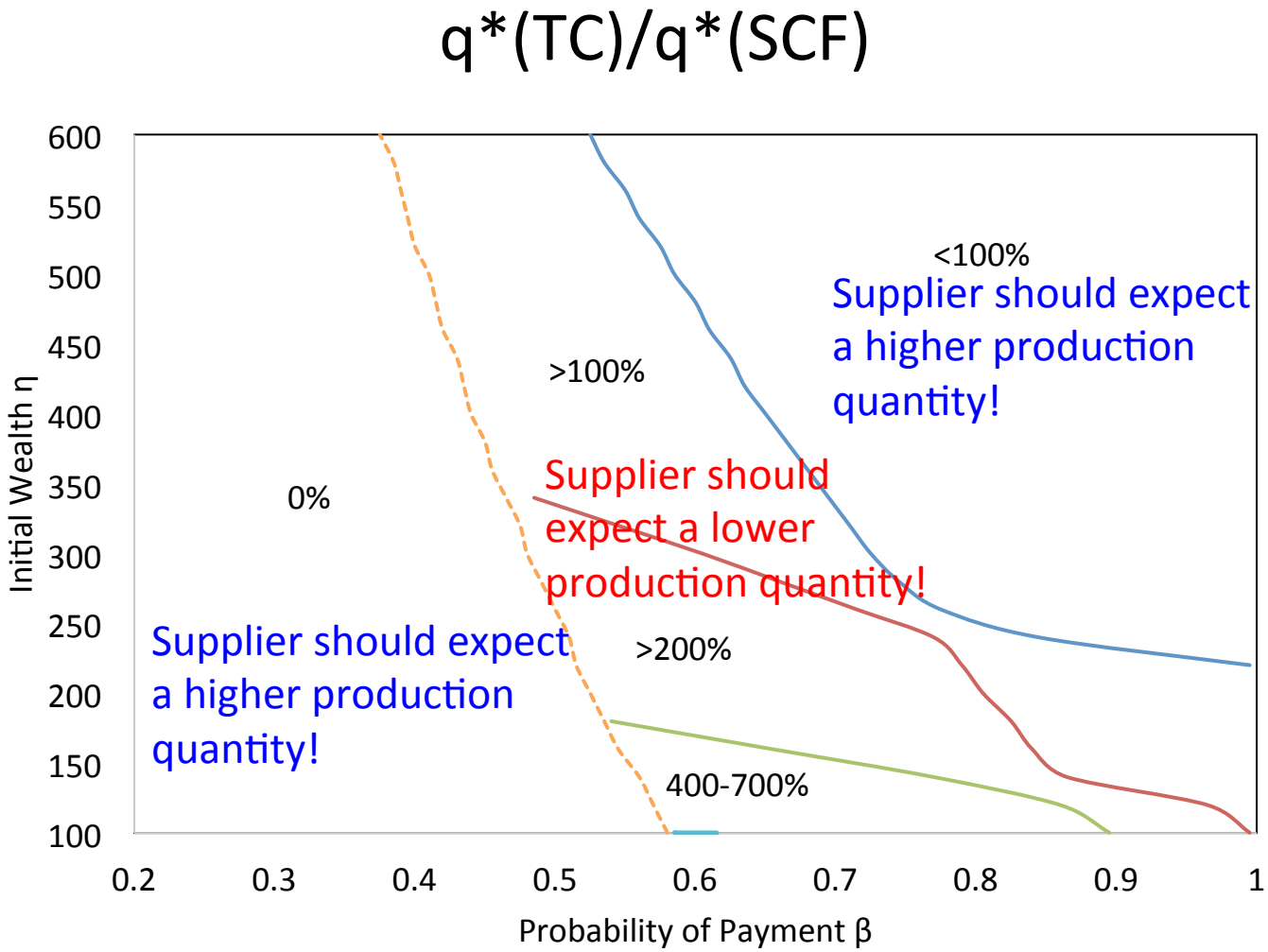
Optimal wholesale price for TC vs SCF





Supplier should raise wholesale price!

Operational Change: Order Quantity



How should supplier compare TC with SCF?

- TC (direct finance)
  - Bear retailer's default and credibility risks => indirectly bear demand risk
    - Pros: encourage a bigger order quantity
  - Supplier and retailer share demand risk
- SCF (indirect finance)
  - Shield from retailer's default and credibility risks
    - Pros: better control of profit margin
  - Buyback excess inventory => supplier directly bear demand risk alone

Any questions?

How should supplier compare TC with SCF?

- TC (direct finance)
  - Bear retailer's default and credibility risks => indirectly bear demand risk
    - Pros: encourage a bigger order quantity
- SCF (indirect finance)
  - Shield from retailer's default and credibility risks
    - Pros: better control of profit margin
  - Buyback excess inventory => directly bear demand risk
- Retailer's default risk and credibility risk have same type of effect on order quantity

$$sgn\left(\frac{dq^*(w_t)}{d\beta}\right) = sgn\left(\frac{dq^*(w_t)}{d\eta}\right)$$

Relevant Literature

- Supplier Finance
  - Trade credit:
    - "…industries with higher dependence on trade credit financing exhibit higher rates of growth in countries with weaker financial institutions." – Fisman and Love (2003)
    - "The retailer, if offered an optimally structured trade credit contract, will always prefer supplier financing to bank financing." – Kouvelis and Zhao (2012)
  - Buyback contract:
    - It improves supply chain efficiency (increases the supply chain profit) and some buyback prices create win-win situation for supplier and retailer – Pasternack (1985)

Relevant Literature

- SCF
  - Buyer intermediated Finance (BIF)
    - Use JD.com (the buyer) as an example to analyze the interaction between product defect and BIF -- Tunca and Zhu (2015) working paper
  - SCF with Buy-back contracts
    - Use Cherry auto (the seller) as an example to analyze the impact of SCF on operational decisions – Tunca and Zhu (2015) working paper