Renegotiation & Relationships in Supply Chain Management

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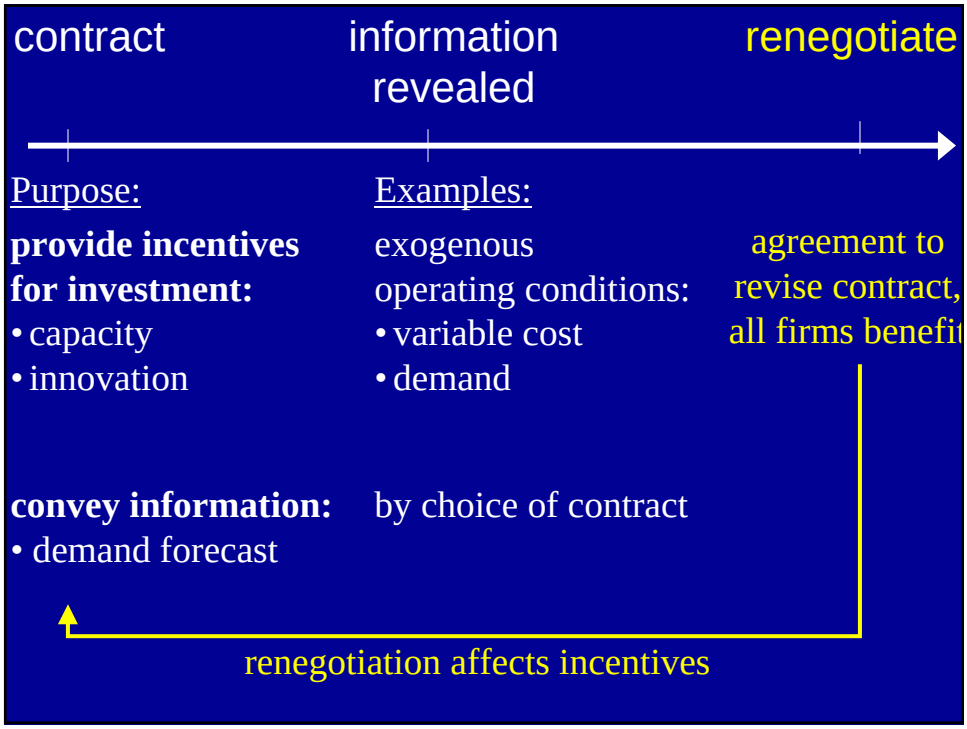
Questions

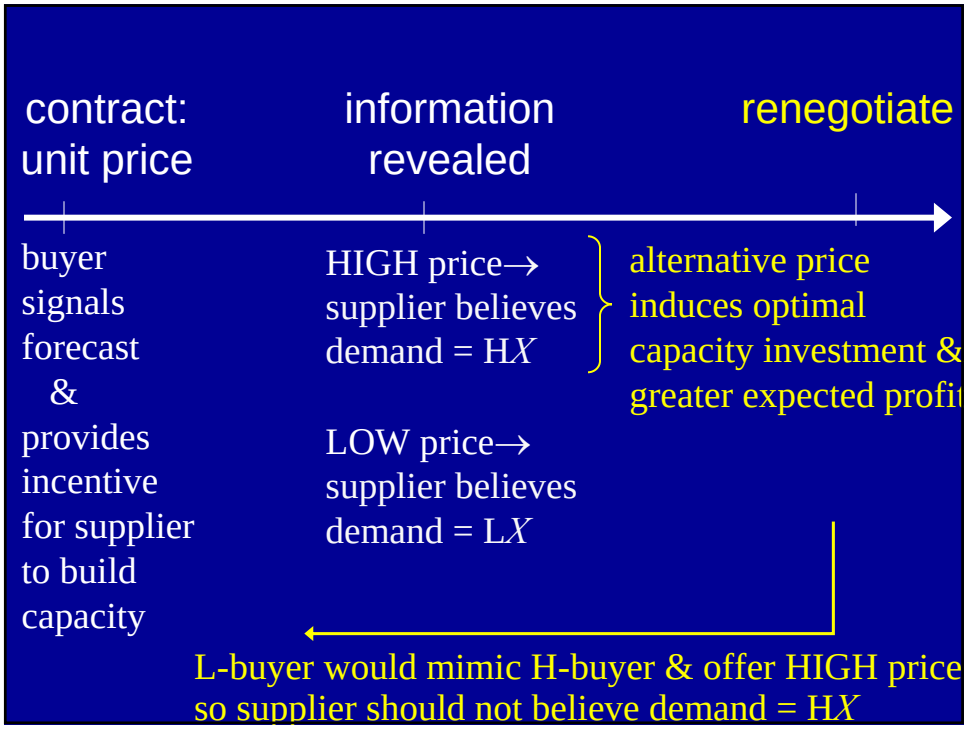
1. Under what circumstances are supply contracts renegotiated ?
2. In what context is incorporating renegotiation important for fidelity of model ?
3. What managerial insights can be obtained by modeling renegotiation ?



Contracting for Supply: Sharing Demand Forecasts

(*Cachon and Lariviere, 2001*)

- Supplier must build capacity before demand is realized
  - prior: buyer's demand $= \begin{cases} HX & \text{with probability } \rho \\ LX & \text{with probability } 1\text{-}\rho \end{cases}$
- Buyer knows demand forecast {H,L}
- H-Buyer offers **higher price** to signal H $\rightarrow$ supplier builds **more capacity than with common forecast information**



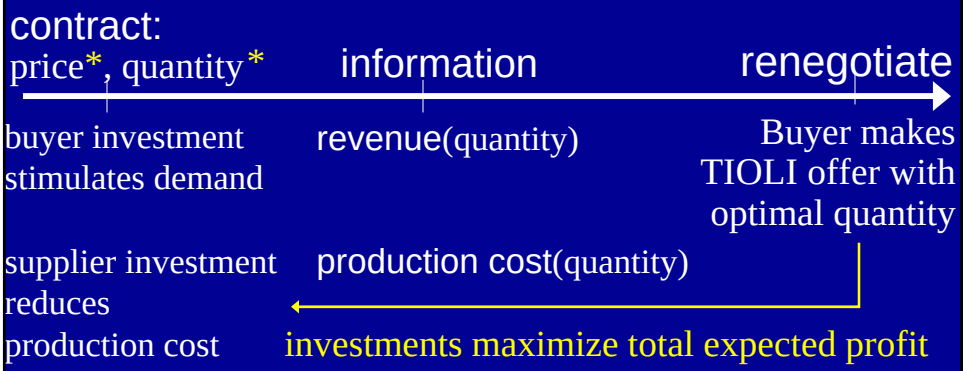
Signalling and Renegotiation (*Beaudry & Poitevin, 1993*)

- Allow infinitely many rounds of contracting + renegotiation
  - buyer makes TIOLI offers ?
  - then, supplier builds capacity
- Equilibrium outcome in 2 Offers
  1. Pooling: L- and H-buyer offer same terms
  2. Separation: too-high price & capacity for H-buyer
- Equilibrium outcome depends on supplier's prior ρ
- Renegotiation results in greater expected profit for both firms

Renegotiation Design (*Aghion, Dewatripont & Rey 1994*)

Give all bargaining power in renegotiation to one firm

- penalty for delay in bargaining (e.g. financial "hostage")



Simple Contract + Renegotiation is OPTIMAL

Economics Lit. on Procurement with Renegotiation

Incentives for Investment

- simple contract + renegotiation is optimal *ADR 94*
  Chung 91, Noldeke & Schmidt 98, Edlin & Reichelstein 96
- NO contract > incomplete contract for cooperative investment, e.g. quality
  Che & Hausch 99

common information

Pre-contractual Private Information

- signalling *Beaudry & Poitevin 93*
- informed principal *Maskin&Tirole 90, 91*
- supplier cost reduction *Laffont&Tirole 90*
- delay in outsourcing *Hart & Tirole 88*

Capacity Allocation: Are Simple Contracts + Renegotiation Optimal ?

Model: Supplier with N buyers
- contract for capacity
- investments in capacity & innovation
- renegotiate capacity allocation

Theory: Court remedy for breach affects
- renegotiation
- investments
- optimal contract structure
- profitability

Court Remedy for Breach of Contract

Expectation Damages	Specific Performance
pay $ to put injured firm in same financial position as if contract were performed	must perform contract (prohibitively large $ penalty)
supplier can deliver < Q and pay for lost revenue or substitute capacity	supplier must deliver Q unless buyer agrees to less
routine	increasingly common in procurement

Are Simple Contracts + Renegotiation Optimal ?

Contract quantity Q_i $i=1..N$

↓

Buyers invest e_i in R&D, manufacturer builds capacity c

↓

$P_e(\omega)$ → Demand is realized $R_i(q;\omega)$

↓

Renegotiate if contract is inefficient: $R_i'(Q_i;\omega) > R_j'(Q_j;\omega)$

↓

Optimal allocation of capacity: $\max_{\Sigma q_i \le c} \sum_{i=1}^{N} R_i(q_i;\omega)$

how firms share gain from renegotiation depends on breach remedy

Contract Design Problem

Firms choose $\{Q_i\}_{i=1..N}$ to:

$$\max\{E_e[\max_{\Sigma q_i \le c} \Sigma_{i=1}^{N} R_i(q_i)] - \Sigma_{i=1}^{N} g_i(e_i) - kc\}$$

subject to

Buyer i invests in innovation e_i to:

$$\max\{E_e[R_i(Q_i) + x_i] - g_i(e_i)\}$$

profit from renegotiation depends on breach remedy

Supplier invests in capacity c to:

$$\max\{E_e[\max_{\Sigma q_i \le c} \Sigma_{i=1}^{N} R_i(q_i) - \Sigma_{i=1}^{N} R_i(Q_i) - \Sigma_{i=1}^{N} x_i] - kc\}$$

SP: $c \ge \Sigma Q_i$

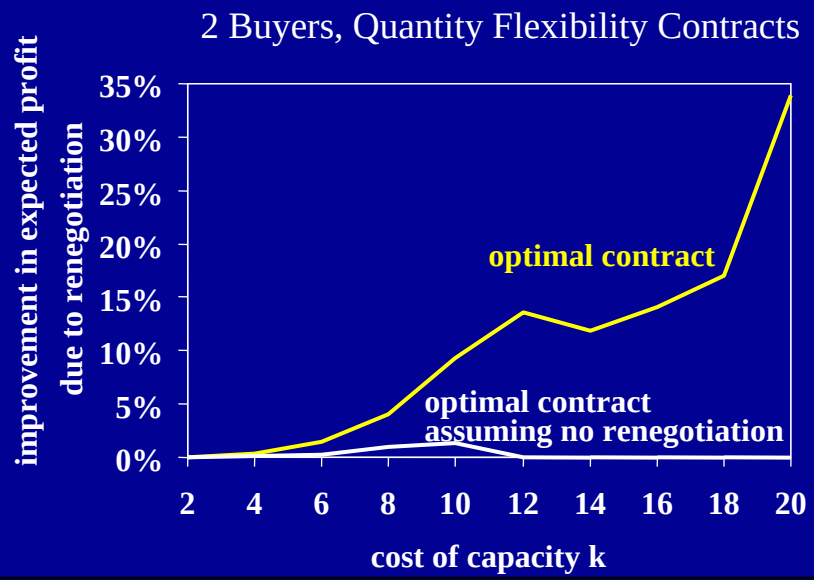
system gain from renegotiation

Are Simple Contracts + Renegotiation Optimal ?

	Expectation Damages	Specific Performance
dominant (TIOLI) supplier	**optimal investment**	excess capacity, too little innovation
buyers have some bargaining power	too little capacity, excess innovation	**optimal investment** *

* *requires separability condition*

Renegotiation Increases Total Expected Profit …if the contract is designed for renegotiation



Summary

- Simple contract + renegotiation may be optimal
- Outcome of renegotiation depends on:
  - court remedy for breach of contract
  - contract design (e.g. financial “hostages”)
  - information asymmetry

Questions

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Discussion Questions

How, fundamentally, does repeated interaction change how firms in a supply chain behave?

What kinds of research approaches can deepen our understanding of this phenomenon?

What are the important research questions our community should address?

Agenda

How Relationships Transform Supply Chains

- Example: Delivery Performance
- Overview of Initial Research
- Discussion

Delivery Performance - Motivation

- Buyers provide specific instructions for delivery (e.g., time, packaging, labeling)
- Buyers penalize suppliers for asserted delivery noncompliance through "charge backs"
- Difficult or impossible for third party to verify delivery compliance

Delivery Performance - Model

In each period t supplier chooses delivery effort $e_t \mu [0,1]$ (the probability of on-time delivery)

$g(e_t)$ = supplier's cost of effort; convex, increasing

$r(e_t)$ = buyer's expected revenue

Relational contract specifies

formal payment f_t

discretionary payment d_t for on-time delivery

supplier strategy: effort e_t, whether to transact

buyer strategy: whether to transact,
make discretionary payment

A relational contract is *self-enforcing* if it describes a subgame perfect Nash equilibrium

Delivery Performance Commonly Observed – Optimal Relational Contract Design Problem

Because firms can split profit via transfer payments, objective is to maximize system profit
Firms cooperate if and only if other firm has cooperated in all previous periods

$$\max_{\{e,f,d\}} \{r(e) - g(e)\}$$

subject to $e \in \arg\max_{\hat{e}} \{\hat{e}d - g(\hat{e})\}$ — supplier chooses designated effort

$r(e) - f - ed \geq b$ — buyer participates

profit without cooperation

$f + ed - g(e) \geq s$ — supplier participates

$$-d + \frac{\delta}{1-\delta}[r(e) - f - ed] \geq \frac{\delta}{1-\delta} b$$ — buyer makes discretionary payment

Delivery Performance Commonly Observed – Optimal Relational Contract

$$S^c = \max_{e} \{r(e) - g(e)\}$$

subject to $\frac{\delta}{1-\delta}[r(e) - g(e) - (b \,.\, s)] \geq g'(e)$

Let e^c denote the solution to the above and
e^* denote the solution for the integrated system
An optimal relational contract is
$e_t = e^c$
$d_t = g'(e^c)$
$f_t = s \,.\, g(e^c)\ 0\ e^c\ g'(e^c)$
Supplier underinvests: e^c . e^*
e^c and S^c are increasing in g and
decreasing in $(b \,.\, s)$

Delivery Performance Privately Observed – Optimal Relational Contract Design Problem

$$\max_{\{e,f,d,\tau\}} \left\{ \frac{r(e)-g(e)}{1-\delta[1-(1-e)\tau]} \right\}$$

subject to $r(e) - f - ed \geq 0$

$$f + ed - g(e) \geq 0$$

Only buyer observes delivery performance
Termination relational contract:
- Buyer reports delivery performance truthfully
- Following report of unsuccessful delivery, buyer refuses to make discretionary payment & firms terminate relationship with probability τ

For simplicity assume $b = s = 0$

$$-d + \frac{\delta[r(e)-f-ed]}{1-\delta[1-(1-e)\tau]} = (1-\tau)\frac{\delta[r(e)-f-ed]}{1-\delta[1-(1-e)\tau]}$$

buyer reports truthfully

$$e \in \arg\max_{\hat{e}} \left\{ f + \hat{e}d - g(\hat{e}) + [1-(1-\hat{e})\tau]\frac{\delta[r(e)-f-ed]}{1-\delta[1-(1-e)\tau]} \right\}$$

supplier chooses designated effort

Delivery Performance Privately Observed – Optimal Relational Contract

$$S^p = \max_{\{e,\tau\}} \left\{ \frac{r(e)-g(e)}{1-\delta[1-(1-e)\tau]} \right\}$$

subject to $e \in \arg\max_{\hat{e}} \left\{ [1-(1-\hat{e})\tau]\frac{\delta[r(e)-g(e)]}{1-\delta[1-(1-e)\tau]} - g(\hat{e}) \right\}$

Let (e^p, τ^p) denote the solution to the above
An optimal relational contract is
- $(e_t, \tau_t) = (e^p, \tau^p)$
- $d_t = \delta\tau^p [r(e^p) - f_t]/[1-\delta(1-\tau^p)]$
- $f_t \in [\{[1-\delta(1-\tau^p)]g(e^p) - \delta e^p \tau^p r(e^p)\}^+, [1-\delta[1-(1-e^p)\tau^p)], r(e^p)]$

Private monitoring necessitates termination: $\tau^p > 0$

Common monitoring (e.g., RFID, 3PL) increases profit: $S^c > S^p$
but may lead to lower delivery effort: $e^c < e^p$

Economics Literature

Levin (2003)	Optimal relational contracts in principal-agent setting ▪ Under common monitoring, stationary contract optimal ▪ Under private monitoring in which informed party does not maintain private information from period to period, termination contract optimal
Abreau, Milgrom, Pearce (1991) Kandori and Matsushima (1998)	Under private monitoring, can improve on termination contracts where performance is reviewed every period Instead, review performance every T periods Lengthening review period improves incentives by allowing more accurate performance assessment, provided δ is sufficiently large

Overview of Initial Research

	Topic	Description	Insights
Cohen, Ho, Ren, Terwiesch (2003) Terwiesch, Ren, Ho, Cohen (2004)	Sharing demand forecasts	Privately informed buyer shares non-binding forecast with supplier	Empirically, suppliers penalize buyer for unreliable forecasts by providing lower service level
Plambeck and Taylor (2004)	Joint production	Success of production process depends on efforts of buyer and supplier	Optimal relational contract has simple form (correlated termination), even allowing for Markovian dynamics

Overview of Initial Research (cont.)

	Topic	Description	Insights
Tunca and Zenios (2004)	Auctions vs. Relationships	Suppliers sell low-quality products in auction Supplier sells high-quality product through long-term relationship	Presence of auction may facilitate or undermine ability of supplier to sell high-quality product
Taylor and Plambeck (2003)	Innovative product procurement	Being unable to contractually commit to purchase, buyer instead promises to do so	Type of promise buyer should make depends on exogenous factors

Limitations of Formal Contracts

At least is some cases, contractual commitments to purchase are not enforced:

"Long-term agreements are not worth the paper they're written on"

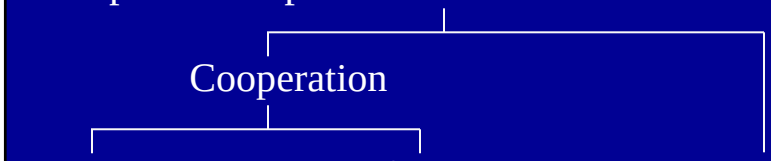
"We can go sue our customers, but that's not the smartest option"

because enforcement is costly and acrimonious:

short-term gain for supplier is outweighed by long-term future loss from damaged relationship

To what extent is firm behavior is driven by long-term relationships rather than the coercive power of court system?

Impact of Repeated Interaction in Contracting



Investments
- In capabilities (capacity, reducing production cost)
- Effort to increase value, quality of product

Information Sharing
- Capabilities (capacity, costs)
- Market conditions

Learning
- Infer capabilities of other firm
- Understanding exogenous factors

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