Incomplete Information and IO:
Buyer/ Countervailing Power, Coordinated Effects

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Introduction

1. Consensus in IO and Antitrust: accounting for Incomplete Information is important but challenging
2. Workhorse monopoly and oligopoly models: $\langle 1, \infty \rangle$ and $\langle n, \infty \rangle$

Today:

- Convince you that *incomplete information*, modeled as independent private values, is
  - tractable
  - suited to analyze $\langle 1, n \rangle$ (and possibly $\langle m, n \rangle$) problems
  - a disciplined approach to the profit-welfare tradeoff

Outlook

1. Buyer power
2. Countervailing power
   - vertical integration
   - investment
3. Further avenues
   - coordinated effects
   - $\langle m, n \rangle$ problems (first steps)

Motivation

- Notions of buyer and countervailing power figure prominently in antitrust debates

  Countervailing power: "If pre-merger prices are distorted from competitive levels by market power on the opposite side of the market, a merger may actually move prices closer to competitive levels and increase market efficiency." (ACCC 1999)

- Long history: "the oldest of economic problems—that of the mitigation or regulation of economic power" (Galbraith 1954)
- Embraced as if it had "talismanic power" (Steptoe 1993)
- Controversial since beginning because there is no
  - "explanation ... why bilateral oligopoly should in general eliminate, and not merely redistribute, monopoly gains" (Stigler 1954)
  - and it is "difficult to model bilateral monopoly or oligopoly" (New Palgrave – Snyder)

Results

- Buyer power is distinct from *countervailing power* and does *not* eliminate merger harm to the buyer
- Social-surplus-increasing countervailing power requires a reduction and not elimination of *buyer power*
- No basis for the presumption that vertical integration increases social surplus
- With *incomplete information*, equilibrium investments are efficient if bargaining is efficient

Buyer power

Based on: *Merger Review for Markets with Buyer Power*, JPE 2019.

Proposed merger of Halliburton and Baker Hughes

HALLIBURTON

BAKER HUGHES Schlumberger

Shell

bp ExxonMobil

What do seemingly powerful buyers do?

- Real-world:
  - Dell, HP: online auctions plus face-to-face negotiations for inputs
  - Shell, Exxon-Mobil, BP: auctions plus negotiations for oil field services
  - governments
- Natural model:
  - buyer uses procurement mechanism
  - buyer power is the ability to use an "optimal" procurement
  - merger (without cost synergies): merged entity's cost is the minimum of the two merging suppliers' costs

Setup

Pre-merger

- Each of $n \geq 2$ suppliers draws its cost c_i independently from distribution G with support $[\underline{c}, \overline{c}]$
- One buyer with value $v > \underline{c}$

Post-merger (merger occurs before cost realizations)

- Merged entity's cost c is drawn from the distribution of the minimum

$$\hat{G}(c) = 1 - (1 - G(c))^2 = G(c)(2 - G(c))$$

- Rivals still draw their costs from G

This talk

- Pre-merger, suppliers are ex ante symmetric ($G_i = G$ for all i)
- Most results extend well beyond (highlight exceptions along the way)

Setup (cont.)

Buyer

- Buyer knows G (and $\hat{G}$), but not the realized costs
- Buyer power: optimal—i.e., expected profit-maximizing—procurement
- No buyer power: efficient procurement (SPA with reserve $\min\{v, \overline{c}\}$)

Summary of buyer power results

- Mergers always harm the buyer.
- Without buyer power, mergers
  - are always profitable (and equivalent to perfect collusion)
  - are neutral for rivals
- With buyer power and pre-merger symmetry, mergers
  - are not always profitable (while perfect collusion is)
  - benefit rivals (and entrants)
- Cost synergies reduce buyer harm but squeeze information rents, eventually making mergers unprofitable.
- Merger makes acquiring buyer power more profitable

Optimal procurement

- Pre-merger (symmetry)
  - select the bidder with the lowest cost
  - make a take-it-or-leave-it offer of the optimal reserve
  - dynamic implementation:
    - descending clock auction with optimal reserve
- Post-merger (merged entity has a better distribution)
  - select the bidder with the lowest *virtual* cost, where the merged entity is "handicapped" (must submit a distinctly lower price to win)
  - take-it-or-leave-it offer (lower reserve for the merged entity)
  - dynamic implementation:
    - clock auction with handicapping and supplier-specific reserves

Illustration: Uniform Distribution

- $\Gamma(c) = c + G(c)/g(c)$ and $\hat{\Gamma}(c) = c + \hat{G}(c)/\hat{g}(c)$ are the virtual cost functions.
- Optimal take-it-or-leave-it offers satisfy

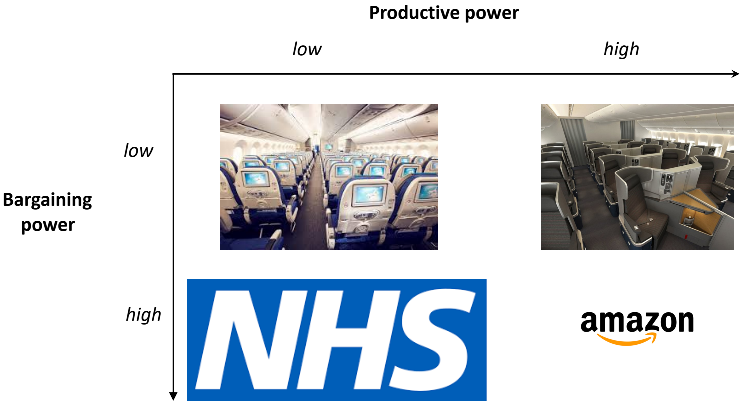
$$v = \Gamma(p) \quad \text{and} \quad v = \hat{\Gamma}(\hat{p})$$

Uniform example:

- $G(c) = c$ for $c \in [0, 1]$, implying $\hat{G}(c) = c(2 - c)$ and

$$\Gamma(c) = 2c < 2c + \frac{1}{1-c} = \hat{\Gamma}(c)$$

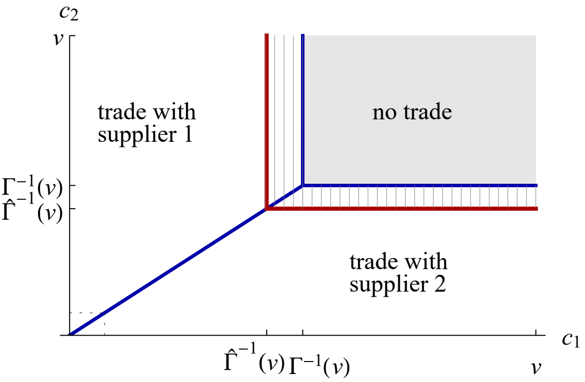
  and $p > \hat{p}$, i.e., merged firm will be discriminated against
- This is *completely* general; published paper assumes $\Gamma(c)$ and $\hat{\Gamma}(c)$ are increasing, but that does not matter for most results


Productive power
low
high
Bargaining power
low
high
NHS
amazon

Effects of merger with buyer power: two suppliers

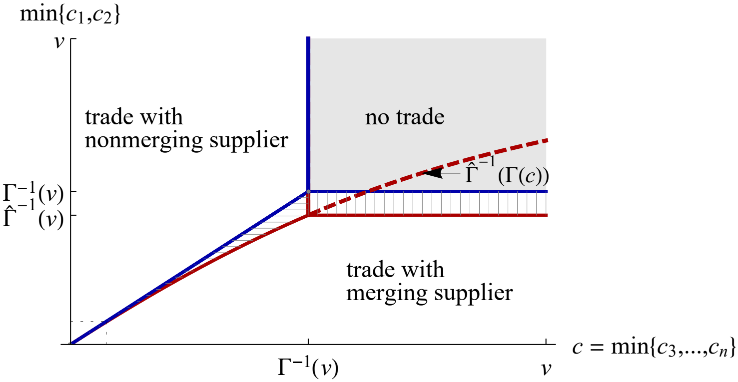
- Merger induces a more aggressive reserve—greater exertion of monopsony power

Effects of merger: $n = 2$



- Price discrimination induces (or increases) inefficiency, shifting some trades away from the merged entity and towards nonmerging suppliers (also more aggressive reserve)

Effects of a merger with $n \geq 3$



Surplus and quantity effects of a merger

Proposition

	Efficient procurement	*With buyer power*
quantity:	$\Delta Q = 0$	$\Delta Q \leq 0$
social surplus:	$\Delta SS = 0$	$\Delta SS < 0$
buyer surplus:	$\Delta BS < 0$	$\Delta BS < 0$
comparison:	$\Delta BS_{\text{efficient}} < \Delta BS_{\text{with power}} < 0$	

With power, $\Delta Q < 0$ unless $n \geq 3$ and reserve never binding (trade always occurs).

Note: A buyer-power based merger defense is self-defeating when authorities take a social-surplus perspective

Bulow & Klemperer 1996

- Would a buyer prefer

  "no merger + no power" or "merger + power"?

- Bulow-Klemperer: IID, designer prefers

  "$n + 1$ bidders + no power" over "n bidders + power"

- Analogy is incomplete:
  - a merger only eliminates a *bid*, not a cost draw (or supply unit)

- **Result**: For v not too large, the buyer prefers

  "merger + power"

Incentives to enter

Entry is viewed as potentially counteracting merger harm

- With buyer power, following a merger, the merged entity is handicapped in the procurement
- Outsiders need only beat the merged entity's handicapped virtual cost
- An outsiders can win with a higher costs than pre-merger

$\Longrightarrow$ Merger increases the profitability of entry

- Merged entity's cost is $(1-s)$ times minimum of the costs of the two merging suppliers, with $s \in [0,1]$ commonly known:

$$c = (1-s)\min\{c_1, c_2\}$$

  - costs are lower
  - buyer faces reduced uncertainty about costs/smaller information rent for merged firm
  - even a buyer without power sets a more aggressive reserve
- **Results**
  - cost efficiencies always benefit buyers
  - cost efficiencies are a double-edged sword for merging suppliers
  - merging suppliers may benefit from small cost efficiencies, but always lose from large cost efficiencies

Mergers incentivize the acquisition of buyer power

- Suppose that a buyer can choose to exercise buyer power at some cost
- Then a merger between symmetric suppliers increases the value of exercising this power
  - value of buyer power pre merger: $BS^1_{pre} - BS^0_{pre}$
  - value of buyer power post merger: $BS^1_{post} - BS^0_{post}$
  - note that $0 > \Delta BS^1 > \Delta BS^0$, so

$$BS^1_{post} - BS^0_{post} > BS^1_{pre} - BS^0_{pre}$$

- Rather than being a countervailing power, acquisition of buyer power would be a reaction to a merger, potentially raising new issues for (dynamic) merger review

Merits of IPV setting

- Profit-social surplus tradeoff without restricting contracts/mechanisms
- Monopoly pricing predictions:
  - perfect price discrimination is *not* possible
  - uniform pricing is *optimal* when revenue is concave
  - without concave revenue, rationing (and opaque pricing) are optimal (for some specifications, even if induces resale); see Loertscher and Muir (2020).
- To our knowledge, IPV model is the only setting that has these properties

Limitations of buyer power setup

1. No social surplus increasing countervailing power
2. Suppliers have no power
3. Buyer power is 0 or 1 and does not change with merger (except that buyer may be more inclined acquire it, adding insult to injury for social surplus)

Next: relax

Countervailing Power

Based on: *Countervailing Power, Integration, and Investment under Incomplete Information*, Working Paper, 2020.

Motivation

- Shift of bargaining powers through merger/integration is a plausible possibility
- Bargaining/auctions is the one setting where IO economists have departed from $\langle n, \infty \rangle$ setup
  - bargaining has come to forefront of applied work
  - mostly assumes complete information (e.g., Nash, Nash-in-Nash)
- Incomplete information bargaining:
  - whether outcome is efficient is endogenous
  - sharp (sometimes extreme) contrast with complete information bargaining
    - vertical integration
    - investment

Bilateral trade model as a starting point

- Myerson-Satterthwaite (1983) model of bilateral trade:

$$\text{supplier: } c \sim [\underline{c}, \overline{c}] \qquad \text{buyer: } v \sim [\underline{v}, \overline{v}]$$

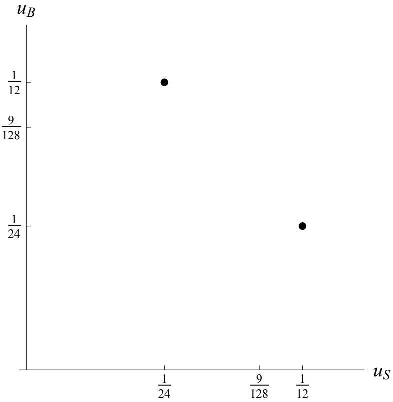
- First-best: max social surplus s.t. IC, IR
- Second-best: max social surplus s.t. IC, IR, no deficit

- First-best is possible with no deficit if and only if $\overline{c} \leq \underline{v}$ (nonoverlapping supports)
- First-best is requires a deficit otherwise (overlapping supports)
- To avoid a deficit, must sacrifice efficiency

- Incomplete information bargaining
  - we reinterpret Myerson-Satterthwaite
    - as a model of bilateral monopoly with bargaining weights, as does Williams (JET, 1987)
    - and augment it to allow multiple suppliers
  - maximizing one trader's surplus harms the other traders *and* reduces social surplus relative to second-best (or first-best)

bilateral trade setup, $[\underline{v}, \overline{v}] = [\underline{c}, \overline{c}] = [0, 1]$, uniform

- Buyer optimal
  - tioli offer $v/2$
  - $u_B = 1/12$, $u_S = 1/24$
- Supplier optimal
  - tioli offer $(c+1)/2$
  - $u_B = 1/24$, $u_S = 1/12$
- What about intermediate bargaining power?



- Can do better!
- Ex: Chatterjee-Samuelson 1983 k-double auction with $k = 1/2$
  - $u_B = u_S = 9/128$

Illustration: Bilateral trade

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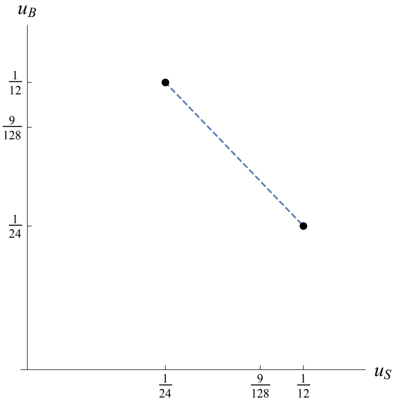

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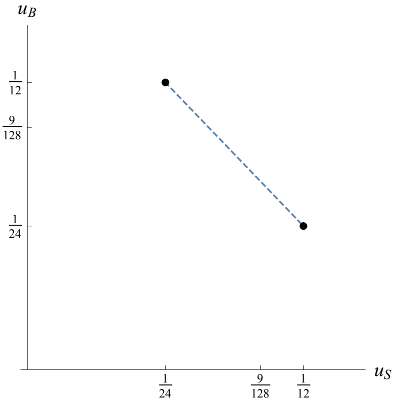

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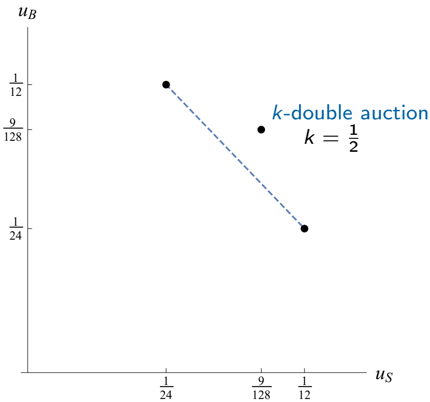

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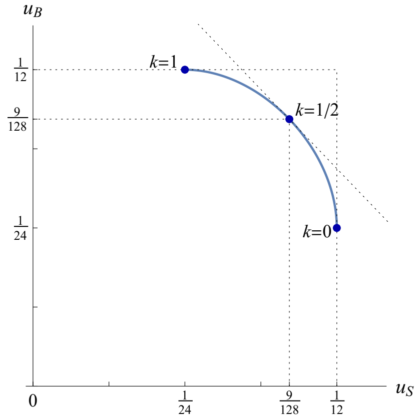
k-double auction

trade iff $p_B \geq p_S$
at price $kp_B + (1-k)p_S$

$p_B(v) = \frac{(1-k)k}{2(1+k)} + \frac{v}{1+k}$
$p_S(c) = \frac{1-k}{2} + \frac{c}{2-k}$

trade iff $v \geq c\frac{1+k}{2-k} + \frac{1-k}{2}$



Incomplete information bargaining

Bargaining weights: $\mathbf{w} = (w_B, w_1, ..., w_n) \in [0,1]^{n+1}$

Weighted welfare:

$$w_B \cdot (\text{buyer surplus}) + \sum_{i \in \mathcal{N}} w_i \cdot (\text{supplier } i\text{'s surplus})$$

Incomplete information bargaining:

maximizes expected weighted welfare
s.t. IC, IR, and no deficit

formal definitions

Equivalence between IIB and Pareto undominated outcomes

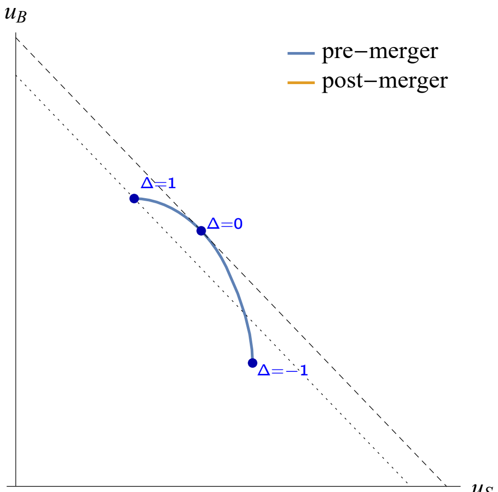
- Let $\mathcal{M}$ be the set of IC, IR, no-deficit mechanisms

Proposition 2

Incomplete information bargaining payoffs coincide with the Pareto undominated payoffs for $\mathcal{M}$.

Countervailing power

A merger with equalization of bargaining power can increase social surplus
Δ is bargaining differential between buyer and suppliers
1 buyer, 2 pre-merger suppliers



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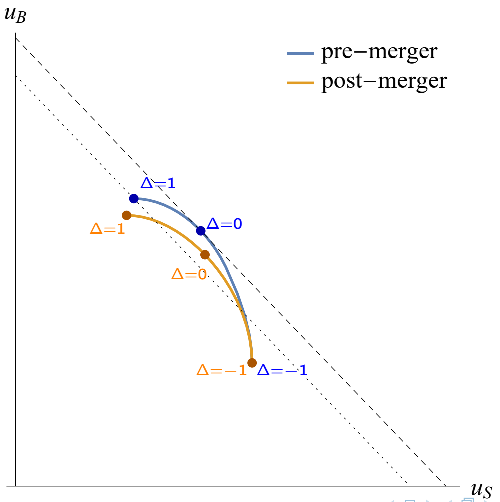

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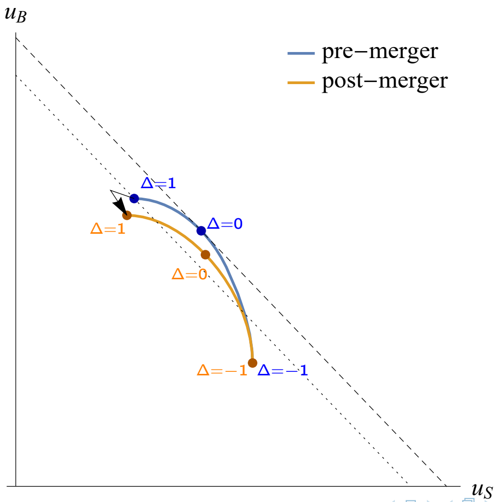

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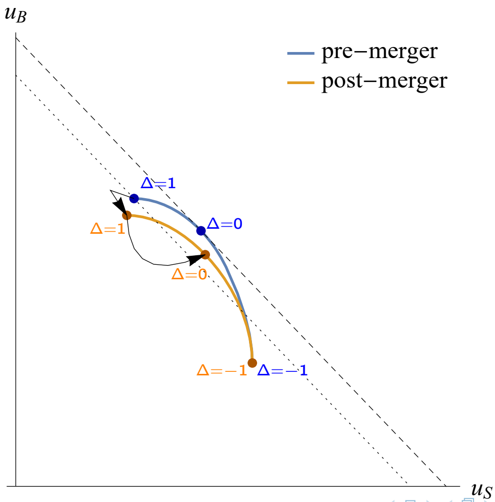

Summary of countervailing power results

Corollary 2

A merger combined with an equalization of bargaining weights between the buyer and seller sides of the market is no more harmful to expected social surplus than the same merger with no change in bargaining weights and, in some settings, increases expected social surplus, including sometimes to the first-best.

- Points to the relevance of allowing the possibility that a merger changes the price-formation process

Countervailing power defense: necessary conditions

- Social-surplus policy objective (rather than just buyer surplus)
  - a merger with countervailing power is doubly bad for the buyer—competition among suppliers is reduced *and* the remaining suppliers have increased bargaining power
- Pre-merger buyer power
  - buyer must have greater bargaining power than the suppliers, so that increased supplier power is movement towards equalization
- Retention of some post-merger buyer power
  - buyer power would need to diminish, but not vanish—so that society is not simply trading a dominant buyer for dominant suppliers

EC merger guidelines: "a merger of two suppliers may reduce buyer power if it thereby removes a credible alternative" "it is not sufficient that buyer power exists prior to the merger, it must also exist and remain effective following the merger"

Countervailing power defense: Evidence required

How could one ascertain that a buyer has bargaining power?

- Buyer uses procurement methods that result in suppliers other than the lowest-cost supplier winning, such as handicaps or preferences for certain suppliers
- Buyer purchases in separate markets and the distribution of the reserve prices differs across the two markets
  - a buyer without power would optimally set a reserve equal to its value
- Observe ties in procurement outcomes and randomization over winners with positive probability
  - with power, randomization arises with suppliers with symmetric, nonregular distributions
  - without power, regardless of regularity, purchase from lowest-cost supplier

- At heart of incomplete information bargaining is the fact that whether or not *bargaining* (or market) outcome is efficient is endogenous as it depends on
  - market structure
  - bargaining weights
  - distributions
- Sharp contrast with *complete* information bargaining, where efficiency is usually imposed by decreet (e.g. Nash, Nash-in-Nash, Shapley)
- Motivates to explore deeper the implication of IIB for pertinent issues in IO
  - vertical integration
  - investment

Vertical integration

Vertical integration

- Vertical integration is traditionally viewed favorably
  - eliminates double marginalization
  - AT&T - Time Warner
- Ignores potential effects on the price formation process
- Incomplete information bargaining sheds new light on the effects of vertical integration

Vertical Integration

- Setup:
  - buyer vertically integrates with supplier 1, drawing its cost c_1 for internal production from G_1
  - integrated firm has no agency problem (or can resolve it efficiently)
  - integrated firm's willingness to pay is $\min\{v, c_1\}$
  - fixed bargaining weights

Vertical integration

Proposition 6

If there is 1 supplier and $\underline{v} < \overline{c}$, then vertical integration increases social surplus.

- Vertical integration resolves a Myerson-Satterthwaite problem

Vertical integration

Proposition 7

If there are 2 or more suppliers and $\underline{v} \geq \overline{c}$, then VI decreases social surplus.

- Vertical integration creates a Myerson-Satterthwaite problem
- Integrated firm sometimes sources internally even though an independent supplier has a lower cost

Social surplus decreasing vertical integration

- Vertical integration is often thought to be efficiency enhancing
- With IIB, vertical integration makes what was an efficient procurement problem with (essentially) one-sided private info into a bilateral trade problem
  - Myerson-Satterthwaite: impossibility of efficient trade
  - integrated firm inefficiently favors its integrated supplier
- Result that vertical integration decreases social surplus extends beyond the single-unit setup (Delacrétaz et al., 2019)
- Highlights importance of endogenizing the *efficiency* of bargaining

Incentives for investment

Incentives for investment

- Investment incentives feature prominently (and controversially) in concurrent debates (e.g., Dow-DuPont merger)
- Central role in the theory of the firm in the Grossman-Hart-Moore tradition
  - G-H-M assume efficient, complete information bargaining
  - this creates a hold-up on investment
- We show
  - private information protects agents from hold-up
  - investments are efficient if bargaining is
  - predictions could not differ more starkly from complete information models

- Setup: Every agent $j \in \{B, 1, 2, ..., M\}$ can make investment e at cost $C_j(e)$ with $C_j' > 0$ and $C_j'' > 0$
- Investment $\hat{e} \geq e$ improves distributions in the ("correct") FOSD sense:

$$F(v, \hat{e}) \leq F(v, e) \quad \text{for all} \quad v \in [\underline{v}, \overline{v}]$$

and

$$G_i(c, \hat{e}) \geq G_i(c, e) \quad \text{for all} \quad c \in [\underline{c}, \overline{c}]$$

As in Grossman-Hart-Moore, noncontractable

Proposition 8

Efficient bargaining under incomplete information implies efficient investments.

Under additional conditions, the converse is also true, that is, efficient investments imply efficient bargaining.

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Investment and incomplete information bargaining

- Intuition and Sketch of Proof:
  - consider the dominant strategy implementation (IPV)
  - efficiency and DIC require that every agent be the residual claimant to the social surplus his reported type creates—equivalent to VCG mechanism
  - but VCG has a deficit if $\underline{v} < \overline{c}$
- Same condition as for efficient investments in Hatfield-Kojima-Kominers 2018; relates to Lauermann 2013

Investment and vertical integration

- For bilateral trade and $\underline{v} < \overline{c}$, investments will be efficient if and only if there is vertical integration
  - vertical integration promotes efficient investment
- In contrast, with 2 suppliers and $\underline{v} \geq \overline{c}$, investments are efficient without, but not with vertical integration
  - vertical integration disrupts efficient investment

▸ investment in quality

Further avenues

Further avenues

- Offers plenty of avenues for further work
- Here we explore and discuss two:
  - coordinated effects: incomplete information makes collusion sometimes but not always profitable
  - $\langle m, n \rangle$ models: straightforward in principle (except for mergers...)

Coordinated effects

Based on: *Coordinated Effects*, Working Paper, 2020.

Coordinated effects of mergers among suppliers

Coordinated effects

- Merger changes "the nature of competition in such a way that firms that previously were not coordinating their behavior, are now significantly more likely to coordinate" (EC HMG)
- Competitive effects of a merger that arise in this way are referred to as coordinated effects
- "An acquisition eliminating a maverick firm in a market vulnerable to coordinated conduct is likely to cause adverse coordinated effects" (US HMG)

How to model coordinated effects?

- Important, central concern
  - "long been at the core of U.S. merger policy" (Kolasky 2002)
  - "the ultimate issue" (Judge Richard Posner 1986)
- Challenging
  - unclear how to model imperfect coordination
  - key role (but vague/elusive definition) of *mavericks*
    - some advocate a *maverick-centered approach* on grounds that in "many settings, regulators reliably can identify an industry maverick that prevents or limits coordination" (Baker 2002)

- Coordination is the use of a bidder selection scheme that suppresses all but one of the coordinating bidders' bids
- Maverick if coordination by others is not feasible with the maverick present, but would be if the maverick were eliminated

Key results for coordinated effects

- Mergers can, but need not, increase the risk for coordination
  - even when the merger involves a maverick
  - the incorporation of a maverick's production capability is not the same as its elimination
- Mergers that increase symmetry among coordinating firms increase the risk for coordination

Coordination in a procurement setting

- Without coordination:
  - suppliers bid against one another

Q: How can suppliers in a procurement coordinate?

In particular, without sharing their private information and without transfers (i.e., without explicit collusion)?

- Bidder selection scheme
  - one selected coordinating bidder gets to bid
  - other coordinating bidders suppress their bids

When will this type of coordination work?

- Each coordinating bidder must be willing to participate
- Baker (2002): "Coordinating firms may not be able to allocate monopoly rents they achieve in a manner satisfactory to all the participants, because they may be unable to compensate each other directly."
  - each bidder must be selected "often enough"
  - example: if firm A's profits are 10 without coordination and 30 with coordination when it is selected, it needs to be selected over 33% of the time
    - critical share is 33%
- Coordination can work exactly when the critical shares sum to less than one

Coordination and critical shares

- Consider a set K of potential coordinators
- Each coordinator i prefers coordination if and only if

$$\underbrace{s_i}_{\text{prob. of selection}} \cdot \underbrace{\Pi_i^K}_{\text{payoff if selected}} > \underbrace{\Pi_i}_{\text{payoff without coord.}}$$

Critical shares and the coordinated effects index

- That is, letting

$$s_i^K = \frac{\Pi_i}{\Pi_i^K}$$

be i's *critical share*, i prefers coordination if and only if the selection probability exceeds the critical share,

$$s_i > s_i^K.$$

- Only possible if

$$CEI_K \equiv 1 - \sum_{i \in K} s_i^K > 0$$

a

Coordinated effects index (CEI)

Given a set K of potentially coordinating suppliers:

- We say that the market is:
  - **at risk** if $CEI_K > 0$: coordination probabilities exist such that all suppliers in K prefer coordination
  - **not at risk** if $CEI_K \leq 0$: no coordination probabilities exist such that all suppliers in K prefer coordination
- CEI test has power, i.e., some but not all markets are at risk

CEI quantitative interpretation

- A larger, positive CEI indicates an increase in risk
  - more leeway for coordination to remain profitable in the face of coordination costs
  - can use coarser, less sophisticated coordination devices (if the CEI is close to 1, simple rotation suffices)

Resonance with existing literature

An acquisition eliminating a maverick firm in a market vulnerable to coordinated conduct is likely to cause adverse coordinated effects. (US HMG)

Simply *defining* a maverick has been challenging

- Despite the prominence of mavericks, the definition has remained vague
  - "a firm that has often resisted otherwise prevailing industry norms to cooperate on price setting or other terms of competition" (US HMG)
  - "a firm that declines to follow the industry consensus and thereby constrains effective coordination" (Kolasky, 2002)
  - the relatively "more rivalrous" firm (Kwoka, 1989)
  - "a firm that has a drastically different cost structure, production capacity or product quality, or that is affected by different factors than other market participants" (Ivaldi, Jullien, Rey, Seabright and Tirole, 2003)
  - a small firm?

Definition of a maverick

Definition

Given a set of coordinators K, an outside supplier is a maverick with respect to K if

$$CEI_K \leq 0 \quad \text{(not at risk)}$$

and when the maverick is eliminated from the market

$$CEI_K > 0 \quad \text{(at risk)}.$$

- By this definition, *eliminating* a maverick puts a market at risk
- But the *acquisition* of a maverick is *not* the same as the elimination of the maverick's production capability
  - the acquisition of a maverick can increase or decrease the CEI

Ivaldi et al. (2012) argue

- that the industry was vulnerable to coordination by the "Big 4"
- and that the #5 firm, Mazars, was not a maverick

CEI-test concurs with Ivaldi et al.

- Use power based parameterization $G_i(c) = 1 - (1 - c)^{\alpha_i}$ and market shares to estimate α_i
- Mazars is *not* a maverick (because market is already at risk with it)

▸ Application

		Market share
Big 4	Ernst & Young	29.8%
Big 4	KPMG	22.2%
Big 4	Deloitte	21.4%
Big 4	PWC	17.2%
	Mazars	7.3%
	Others	2.1%
	Total	100%

Towards $\langle m, n \rangle$ models

- So far: $\langle 1, n \rangle$
- Conceptually, setup extends directly to $\langle m, n \rangle$
- Issue: mergers (horizontal and vertical) create an entity with two-dimensional types (two costs or values, or one value and one cost)
- Myersionian mechanism design not amenable to *multi-dimensional* types
- Need: Way to transform multi-dimensional into one-dimensional types

Problem and proposed modeling approach

- Example: Vertical integration
  - suppose a buyer with distribution F and a supplier with distribution G integrate
  - single-unit demand and supply
  - integrated firm's willingness to pay is $x = \min\{v, c\}$ with distribution $L(x) = 1 - (1 - F(x))(1 - G(x))$
  - its reservation price for selling is $y = \max\{v, c\}$ with distribution $H(y) = F(y)G(y)$
- Proposed approach
  - let y be distributed according to $H(y)$
  - for given y, x is deterministically given by the function

$$x = L^{-1}(H(y)).$$

  - so marginal distributions are the same as without integrated
  - but integrated firm's private information only pertains to y

Related literature

Related literature (1/2)

- Private information recognized as an obstacle to achieving efficient outcomes
  - Stigler 1961,1964, Myerson 1981
  - Myerson-Satterthwaite 1983, Williams 1987, Gresik-Satterthwaite 1989
- Myersonian IPV setup provides a tractable model and methodology:
  - risk neutral buyers and suppliers
  - types: independent, one-dimensional, continuous private information
  - IC, IR, deficit-free market mechanisms
- Not only are these assumptions sufficient to generate a profit-efficiency tradeoff in a tractable and disciplined way, but
- They are also the unique (known) assumptions that do so, i.e., they are themselves not arbitrary

Related literature (2/2)

- Countervailing power & buyer power
  - Galbraith 1952, Stigler 1954, Snyder 1996,2008, Nocke-Thanassoulis 2014, Carprice-Rey 2015, Loertscher-Marx 2019
- Vertical integration and foreclosure
  - internal vs external frictions: Ordover-Saloner-Salop 1990, Salinger 1988, Hart-Tirole 1990, Nocke-Rey 2018, Rey-Vergé 2019, Allain-Chambolle-Rey 2016
- Incentives for investment
  - incomplete information models: Vickrey 1961, Clarke 1971, Groves 1973, Green-Laffont 1977, Holmstrom 1979, Hatfield-Kojima-Kominers 2018
  - complete information models: Grossman-Hart 1986, Hart-Moore 1990
  - recent work: Federico-Langus-Valletti 2017,2018, Jullien-Lefouili 2018
- Upsurge of interest in bargaining
  - Larsen 2020, Backus-Blake-Larsen-Tadelis 2020, Backus-Blake-Tadelis 2019, Zhang-Manchanda-Chu 2019, Decarolis-Rovigatti 2020
  - Crawford-Yurukoglu 2012, Ho-Lee 2017, Crawford-Lee-Whinston-Yurukoglu 2018, Collard-Wexler, Gowrisankaran & Lee 2019, Rey-Vergé 2019

Conclusion

Conclusion

- Incomplete information setup—(nearly) ideal framework for IO economists concerned with:
  - tradeoffs between social surplus and rent extraction
  - price formation and its efficiency properties
  - dependence on bargaining power of agents
- Naturally get:
  - social surplus increasing countervailing power
  - socially harmful vertical integration
  - relation between incentives to invest and efficiency of price formation that differs from complete information
- Future research
  - multiple buyers, multiple suppliers (raising rivals' costs in VI)
  - what determines bargaining power?
    - can be independent of prices and distributions
    - reflected in process, not level of prices
    - determines scope for countervailing power

Payoffs and welfare

Given mechanism $\langle \mathbf{Q}, \mathbf{M} \rangle$ and type realizations $(v, \mathbf{c})$:

- Feasibility:

$$Q_i(v, \mathbf{c}) \in [0, 1] \quad \text{and} \quad Q_B(v, \mathbf{c}) = \sum_{i \in \mathcal{N}} Q_i(v, \mathbf{c})$$

- Ex post surplus of the buyer:

$$U_{B;\mathbf{Q},\mathbf{M}}(v, \mathbf{c}) \equiv v \min\{1, Q_B(v, \mathbf{c})\} - M_B(v, \mathbf{c})$$

- Ex post surplus of supplier i:

$$U_{i;\mathbf{Q},\mathbf{M}}(v, \mathbf{c}) \equiv M_i(v, \mathbf{c}) - c_i Q_i(v, \mathbf{c})$$

Payoffs and welfare

- Ex post revenue to the mechanism:

$$R_{\mathbf{M}}(v, \mathbf{c}) \equiv M_B(v, \mathbf{c}) - \sum_{i \in \mathcal{N}} M_i(v, \mathbf{c})$$

- Ex post welfare (social surplus):

$$W_{\mathbf{Q}}(v, \mathbf{c}) \equiv \sum_{i \in \mathcal{N}} (v - c_i) Q_i(v, \mathbf{c})$$

- Ex post weighted welfare:

$$W^{\mathbf{w}}_{\mathbf{Q},\mathbf{M}}(v, \mathbf{c}) \equiv w_B U_{B;\mathbf{Q},\mathbf{M}}(v, \mathbf{c}) + \sum_{i \in \mathcal{N}} w_i U_{i;\mathbf{Q},\mathbf{M}}(v, \mathbf{c})$$

$\langle \mathbf{Q}, \mathbf{M} \rangle$ that solves

$$\max \mathbb{E}_{v,\mathbf{c}}[W^{\mathbf{w}}_{\mathbf{Q},\mathbf{M}}(v,\mathbf{c})] \text{ s.t. IC, IR, and } \mathbb{E}_{v,\mathbf{c}}[R_{\mathbf{M}}(v,\mathbf{c})] \geq 0$$

Interim expected quantities and payments

$$\hat{q}_B(z) \equiv \mathbb{E}_{\mathbf{c}}\left[Q_B(z,\mathbf{c})\right] \qquad \hat{q}_i(z) \equiv \mathbb{E}_{v,\mathbf{c}_{-i}}\left[Q_i(v,z,\mathbf{c}_{-i})\right]$$
$$\hat{m}_B(z) \equiv \mathbb{E}_{\mathbf{c}}\left[M_B(z,\mathbf{c})\right] \qquad \hat{m}_i(z) \equiv \mathbb{E}_{v,\mathbf{c}_{-i}}\left[M_i(v,z,\mathbf{c}_{-i})\right]$$

IC:
$$\hat{u}_B(v) \equiv \hat{q}_B(v)v - \hat{m}_B(v) \geq \hat{q}_B(z)v - \hat{m}_B(z)$$
$$\hat{u}_i(c) \equiv \hat{m}_i(c) - \hat{q}_i(c)c \geq \hat{m}_i(z) - \hat{q}_i(z)c$$

IR:
$$\hat{u}_B(v) \geq 0,\ \hat{u}_i(c) \geq 0$$

return

Notation: virtual types

- Define virtual value and virtual cost functions by

$$\Phi(v) \equiv v - \frac{1-F(v)}{f(v)} \text{ and } \Gamma_i(c) \equiv c + \frac{G_i(c)}{g_i(c)}$$

- Assume regularity throughout, i.e., all virtual type functions are increasing (analogous to monotone MR and MC)

- Define weighted virtual type functions for $a \in [0,1]$ somewhat unusually, but conveniently, by

$$\Phi_a(v) \equiv v - (1-a)\frac{1-F(v)}{f(v)} \text{ and } \Gamma_{i,a}(c) \equiv c + (1-a)\frac{G_i(c)}{g_i(c)}$$

Allocation rule

Lemma 1

With incomplete information bargaining with weights $\mathbf{w}$, for each supplier i, $Q_i^{\mathbf{w}} \in \{0,1\}$ with

$$Q_i^{\mathbf{w}}(v,\mathbf{c}) = 1 \quad \text{iff} \quad \Gamma_{i,w_i\beta^{\mathbf{w}}}(c_i) = \min_{j\in\mathcal{N}} \Gamma_{j,w_j\beta^{\mathbf{w}}}(c_j) \leq \Phi_{w_B\beta^{\mathbf{w}}}(v).$$

Here, $\beta^{\mathbf{w}}$ is largest value in $[0, \frac{1}{\max \mathbf{w}}]$ such that $\mathbf{Q}^{\mathbf{w}}$ satisfies the no-deficit constraint

details

Payoffs

- Expected budget surplus, not including fixed payments:

$$\pi^{\mathbf{w}} \equiv \sum_{i \in \mathcal{N}} \mathbb{E}_{v,\mathbf{c}} \left[\overbrace{\left(\Phi(v) - \Gamma_i(c_i)\right)}^{\text{budget surplus}} \cdot Q_i^{\mathbf{w}}(v, \mathbf{c}) \right]$$

- If $\beta^{\mathbf{w}} < 1/\max \mathbf{w}$, then $\pi^{\mathbf{w}} = 0$
- If $\beta^{\mathbf{w}} = 1/\max \mathbf{w}$, then $\pi^{\mathbf{w}} \geq 0$, and the mechanism allocates $\pi^{\mathbf{w}}$ to agents with the max bargaining weight
- Shares $\eta \in [0,1]^{n+1}$: $\eta_i = 0$ if $w_i < \max \mathbf{w}$ and $\sum_{i \in \mathcal{N}} \eta_i = 1$
  - no social surplus effects (like Nash bargaining weights)

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Payoffs

Proposition 1

Incomplete information bargaining with bargaining weights $\mathbf{w}$ and shares $\boldsymbol{\eta}$ generates expected payoffs

$$u_B(\mathbf{w}, \boldsymbol{\eta}) = \eta_B \pi^{\mathbf{w}} + \mathbb{E}_v \left[\sum_{i \in \mathcal{N}} \int_{\underline{v}}^{v} \mathbb{E}_{\mathbf{c}} \left[Q_i^{\mathbf{w}}(x, \mathbf{c}) \right] dx \right]$$

and, for $i \in \mathcal{N}$,

$$u_i(\mathbf{w}, \boldsymbol{\eta}) = \eta_i \pi^{\mathbf{w}} + \mathbb{E}_{c_i} \left[\int_{c_i}^{\overline{c}} \mathbb{E}_{v, \mathbf{c}_{-i}} \left[Q_i^{\mathbf{w}}(v, x, \mathbf{c}_{-i}) \right] dx \right].$$

return

Investment in quality

- Can allow investment by suppliers in quality
- Supplier i makes investment $\theta_i \geq 0$ in the quality of its product
- Buyer has value $\theta_i v$ for supplier i's product
- Both the planner and supplier i only value i's investment when i trades
- Continue to get efficient investment in Nash eqm
- Contrasts with Che-Hausch's (1999) results on "cooperative" (vs. "selfish") investments

return

Sufficient conditions for converse result in Proposition 9

Sufficient conditions for the converse result are:

- for all $i \in \{B\} \cup \mathcal{N}$,

$$\Psi_i'(0) = 0 \text{ and for } e > 0, \;\; \Psi_i'(e) > 0 \;\text{ and }\; \Psi_i''(e) > 0; \quad (1)$$

- for all $i \in \mathcal{N}$, $c \in (\underline{c}, \overline{c})$, and $v \in (\underline{v}, \overline{v})$,

$$\frac{\partial G_i(c; e)}{\partial e} > 0 \;\text{ and }\; \frac{\partial F(v; e)}{\partial e} < 0; \quad (2)$$

- and either the type distributions have overlapping supports, $\underline{v} < \overline{c}$, or for all $i \in \mathcal{N}$ and all $c \in [\underline{c}, \overline{c}]$,

$$G_i(c; \overline{e}_i) \equiv G(c). \quad (3)$$

return

Allocation rule

- Using IC, can write $\mathbb{E}_{v,\mathbf{c}}[W^{\mathbf{w}}_{\mathbf{Q},\mathbf{M}}(v,\mathbf{c})]$ and $\mathbb{E}_{v,\mathbf{c}}\,[R_{\mathbf{M}}(v,\mathbf{c})]$ in terms of virtual types and the allocation rule $\mathbf{Q}$

- Lagrangian has terms involving fixed payments plus:

$$\mathbb{E}_{v,\mathbf{c}}\left[\sum_{i\in\mathcal{N}}[w_B(\overbrace{v-\Phi(v)}^{\text{buyer surplus}})+w_i(\overbrace{\Gamma_i(c_i)-c_i}^{\text{supplier } i \text{ surplus}})+\underset{\substack{\uparrow\\ \text{multiplier on}\\ \text{no deficit}}}{\rho}\sum_{i\in\mathcal{N}}(\overbrace{\Phi(v)-\Gamma_i(c_i)}^{\text{budget surplus}})]Q_i(v,\mathbf{c})\right]$$

- maximize wrt Q_i "pointwise"

- ρ is shadow cost of budget surplus
  - $\rho \geq \max \mathbf{w} > 0$

- optimum has smallest ρ such that no deficit is satisfied

- $\beta^{\mathbf{w}} = 1/\rho$

return

Allocation rule

- Using IC, can write $\mathbb{E}_{v,\mathbf{c}}[W^{\mathbf{w}}_{\mathbf{Q},\mathbf{M}}(v,\mathbf{c})]$ and $\mathbb{E}_{v,\mathbf{c}}[R_{\mathbf{M}}(v,\mathbf{c})]$ in terms of virtual types and the allocation rule $\mathbf{Q}$
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return

Details

- Risk neutrality: Maskin-Riley 1984, Matthews 1984 show optimal mechanisms depend on nature of risk aversion (not easily characterized, may require payments to/from losers)
- Independence: Crémer-McLean 1985,1988 show no profit-efficiency tradeoff with correlation
- Private values: Mezzetti 2004,2007 show additional/arbitrary restrictions may be required for tractability and/or profit-efficiency tradeoff with interdependent values
- One-dimensional types: otherwise optimal mechanism is not known (e.g., Daskalakis-Deckelbaum-Tzamos 2017)
- Continuous types: otherwise no payoff-equivalence theorem

return

Resonance with existing literature and perceived wisdom

- Markets with sufficient outside competition have a CEI < 0
- The CEI is largest for the coordination by the largest suppliers
- The CEI is weakly lower for a first-price vs second-price auction (assuming symmetric suppliers)
- Greater symmetry among coordinators increases the CEI

▸ return

Application: The 2006 French audit industry

- Calibrate "power-based" cost distributions $G_i(c) = 1 - (1 - c)^{\alpha_i}$ to revenue shares
- Two-unit demand (from two different suppliers)

Application: The 2006 French audit industry

		revenue shares	critical shares	$CEI_{\text{Big 4}}$
Big 4	Ernst & Young	29.8%	13%	0.57
Big 4	Deloitte	21.4%	10%	↑
Big 4	KPMG	22.2%	11%	positive
Big 4	PWC	17.2%	9%	
	Mazars	7.3%		
	Grant Thornton	0.4%		
	BDO	0.2%		
	Constantin	0.3%		
	6 others	0.2% each		
	Total	100%		

- Concur with Ivaldi et al. (2012):
  - Market *is* (already) at risk for coordination by the Big 4
  - Thus, Mazars is *not* a maverick

return