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

Simon Loertscher & Leslie M. Marx

AEW Seminar

30 July 2020
Consensus in IO and Antitrust: accounting for *Incomplete Information* is important but challenging.

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
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)
- **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

Proposed merger of Halliburton and Baker Hughes
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 $[c, \bar{c}]$
- One buyer with value $v > c$

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)
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 $\min\{v, \bar{c}\}$)
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
Discrimination against strong agents

Productive power

Bargaining power

<table>
<thead>
<tr>
<th>Low</th>
<th>High</th>
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<tbody>
<tr>
<td>NHS</td>
<td>Amazon</td>
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</table>

Loertscher & Marx

30 July 2020
Merger induces a more aggressive reserve—greater exertion of monopsony power.

\[ \Gamma^{-1}(v) \Gamma^{-1}(v) \]

Effects of merger: \( n = 2 \)

- Trade with supplier 1
- Trade with supplier 2
- No trade
Price discrimination induces (or increases) inefficiency, shifting some trades away from the merged entity and towards nonmerging suppliers (also more aggressive reserve)

\[ c = \min\{c_3, \ldots, c_n\} \]
Surplus and quantity effects of a merger

**Proposition**

<table>
<thead>
<tr>
<th>Efficient procurement</th>
<th>With buyer power</th>
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<tbody>
<tr>
<td>quantity:</td>
<td></td>
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<tr>
<td>$\Delta Q = 0$</td>
<td>$\Delta Q \leq 0$</td>
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<tr>
<td>social surplus:</td>
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<tr>
<td>$\Delta SS = 0$</td>
<td>$\Delta SS &lt; 0$</td>
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<tr>
<td>buyer surplus:</td>
<td></td>
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<tr>
<td>$\Delta BS &lt; 0$</td>
<td>$\Delta BS &lt; 0$</td>
</tr>
<tr>
<td>comparison:</td>
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<tr>
<td>$\Delta BS_{efficient} &lt; \Delta BS_{with power} &lt; 0$</td>
<td></td>
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</tbody>
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*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.
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”
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

⇒ Merger increases the profitability of entry
Cost synergies

- 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

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:
  
  supplier: \( c \sim [c, \bar{c}] \)  
  buyer: \( v \sim [\nu, \bar{v}] \)

- 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 \( \bar{c} \leq \nu \) (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)
Illustration: Bilateral trade

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

- Buyer optimal
  - buyer offer \(\frac{\underline{v}}{2}\)
  - \(u_B = \frac{1}{12}, u_S = \frac{1}{24}\)

- Supplier optimal
  - supplier offer \(\frac{c + 1}{2}\)
  - \(u_B = \frac{1}{24}, u_S = \frac{1}{12}\)

- What about intermediate bargaining power?

- Can do better!
  - ex: Chatterjee-Samuelson 1983 \(k\)-double auction with \(k = \frac{1}{2}\)
  - \(u_B = u_S = \frac{9}{128}\)
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- **Buyer optimal**
  - tioli offer \(\nu/2\)
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bilateral trade setup, \([v, \bar{v}] = [c, \bar{c}] = [0, 1]\), uniform

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

Weighted welfare:

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

Incomplete information bargaining:

maximizes expected weighted welfare

s.t. IC, IR, and no deficit
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 $\mathcal{M}$. 
A merger with equalization of bargaining power can increase social surplus. \( \Delta \) is bargaining differential between buyer and suppliers.

1 buyer, 2 pre-merger suppliers

\[
\Delta = 1
\]

\[
\Delta = 0
\]

\[
\Delta = -1
\]
A merger with equalization of bargaining power can increase social surplus. 

\[ \Delta \] is bargaining differential between buyer and suppliers.

1 buyer, 2 pre-merger suppliers.

\[
\begin{align*}
\text{pre-merger} & : u_S = \Delta, \quad u_B = 0 \\
\text{post-merger} & : u_S = 0, \quad u_B = -\Delta \\
\end{align*}
\]
A merger with equalization of bargaining power can increase social surplus. \( \Delta \) is bargaining differential between buyer and suppliers.  
1 buyer, 2 pre-merger suppliers.
A merger with equalization of bargaining power can increase social surplus
\( \Delta \) is bargaining differential between buyer and suppliers
1 buyer, 2 pre-merger suppliers

\[
\begin{align*}
\Delta = 1 & \quad u_B > u_S \\
\Delta = 0 & \quad u_B = u_S \\
\Delta = -1 & \quad u_B < u_S
\end{align*}
\]
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”
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 decree (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 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
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
Proposition 6
If there is 1 supplier and \( \nu < \bar{c} \), then vertical integration increases social surplus.

- Vertical integration resolves a Myerson-Satterthwaite problem
Proposition 7

If there are 2 or more suppliers and $v \geq \bar{c}$, 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
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
Investment

- **Setup:** Every agent \( j \in \{B, 1, 2, \ldots, M\} \) 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.
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.
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 $v < \bar{c}$

Same condition as for efficient investments in Hatfield-Kojima-Kominers 2018; relates to Lauermann 2013
For bilateral trade and $v < \bar{c}$, investments will be efficient if and only if there is vertical integration

- vertical integration promotes efficient investment

In contrast, with 2 suppliers and $v \geq \bar{c}$, investments are efficient without, but not with vertical integration

- vertical integration disrupts efficient investment
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

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 and mavericks in a procurement setup

- **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

$$S_i \cdot \Pi^K_i > \Pi_i$$

where $S_i$ is the probability of selection and $\Pi^K_i$ is the payoff if selected.
That is, letting

\[ s^K_i = \frac{\Pi_i}{\Pi^K_i} \]

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

\[ s_i > s^K_i. \]

Only possible if

\[ CEI_K \equiv 1 - \sum_{i \in K} s^K_i > 0 \]
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
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)
An acquisition eliminating a maverick firm in a market vulnerable to coordinated conduct is likely to cause adverse coordinated effects. (US HMG)
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

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

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

and when the maverick is eliminated from the market

$$\text{CEI}_K > 0 \quad \text{(at risk)}.$$
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 $\alpha_i$
- Mazars is not a maverick (because market is already at risk with it)

<table>
<thead>
<tr>
<th></th>
<th>Market share</th>
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<tbody>
<tr>
<td>Big 4</td>
<td>Ernst &amp; Young 29.8%</td>
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<tr>
<td>Big 4</td>
<td>KPMG 22.2%</td>
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<td>Big 4</td>
<td>Deloitte 21.4%</td>
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<tr>
<td>Big 4</td>
<td>PWC 17.2%</td>
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<tr>
<td>Mazars</td>
<td>7.3%</td>
</tr>
<tr>
<td>Others</td>
<td>2.1%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
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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
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
Private information recognized as an obstacle to achieving efficient outcomes

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

- Vertical integration and foreclosure

- Incentives for investment

- Upsurge of interest in bargaining
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 $\langle Q, M \rangle$ and type realizations $(v, c)$:

- Feasibility:

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

- Ex post surplus of the buyer:

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

- Ex post surplus of supplier $i$:

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

- Ex post revenue to the mechanism:

\[ R_M(v, c) \equiv M_B(v, c) - \sum_{i \in \mathcal{N}} M_i(v, c) \]

- Ex post welfare (social surplus):

\[ W_Q(v, c) \equiv \sum_{i \in \mathcal{N}} (v - c_i) Q_i(v, c) \]

- Ex post weighted welfare:

\[ W_{Q,M}^w(v, c) \equiv w_B U_{B;Q,M}(v, c) + \sum_{i \in \mathcal{N}} w_i U_{i;Q,M}(v, c) \]
\[ \langle Q, M \rangle \text{ that solves} \]

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

Interim expected quantities and payments

\[
\hat{q}_B(z) \equiv \mathbb{E}_c [Q_B(z, c)] \quad \hat{q}_i(z) \equiv \mathbb{E}_{v,c_{-i}} [Q_i(v, z, c_{-i})]
\]
\[
\hat{m}_B(z) \equiv \mathbb{E}_c [M_B(z, c)] \quad \hat{m}_i(z) \equiv \mathbb{E}_{v,c_{-i}} [M_i(v, z, c_{-i})]
\]

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:

\[
\hat{u}_B(v) \geq 0, \quad \hat{u}_i(c) \geq 0
\]
Define **virtual value** and **virtual cost** functions by

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

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

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

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

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

Here, $\beta^w$ is largest value in $[0, \frac{1}{\max \mathbf{w}}]$ such that $Q^w$ satisfies the no-deficit constraint.
Expected budget surplus, not including fixed payments:

$$\pi^w \equiv \sum_{i \in N} \mathbb{E}_{v,c} \left[ (\Phi(v) - \Gamma_i(c_i)) \cdot Q^w_i(v, c) \right]$$

- If $\beta^w < 1/\max w$, then $\pi^w = 0$
- If $\beta^w = 1/\max w$, then $\pi^w \geq 0$, and the mechanism allocates $\pi^w$ to agents with the max bargaining weight

Shares $\eta \in [0,1]^{n+1}$: $\eta_i = 0$ if $w_i < \max w$ and $\sum_{i \in N} \eta_i = 1$

- no social surplus effects (like Nash bargaining weights)
Payoffs

- Expected budget surplus, not including fixed payments:

\[
\pi^w \equiv \sum_{i \in N} E_{v,c} \left[ \left( \Phi(v) - \Gamma_i(c_i) \right) \cdot Q^w_i(v,c) \right]
\]

- If \( \beta^w < 1 / \max w \), then \( \pi^w = 0 \)

- If \( \beta^w = 1 / \max w \), then \( \pi^w \geq 0 \), and the mechanism allocates \( \pi^w \) to agents with the max bargaining weight

- Shares \( \eta \in [0, 1]^{n+1} \): \( \eta_i = 0 \) if \( w_i < \max w \) and \( \sum_{i \in N} \eta_i = 1 \)
  - no social surplus effects (like Nash bargaining weights)
Proposition 1

Incomplete information bargaining with bargaining weights \( w \) and shares \( \eta \) generates expected payoffs

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

and, for \( i \in \mathcal{N} \),

\[
 u_i(w, \eta) = \eta_i \pi^w + \mathbb{E}_{c_i} \left[ \int_{c_i}^{\bar{c}} \mathbb{E}_{v, c_{-i}} \left[ Q_i^w(v, x, c_{-i}) \right] dx \right].
\]
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
Sufficient conditions for the converse result are:

- for all $i \in \{B\} \cup \mathcal{N}$,
  
  $\Psi'_i(0) = 0$ and for $e > 0$, $\Psi'_i(e) > 0$ and $\Psi''_i(e) > 0$; (1)

- for all $i \in \mathcal{N}$, $c \in (c, \bar{c})$, and $\nu \in (\nu, \bar{\nu})$,
  
  $\frac{\partial G_i(c; e)}{\partial e} > 0$ and $\frac{\partial F(\nu; e)}{\partial e} < 0$; (2)

- and either the type distributions have overlapping supports, $\nu < \bar{c}$, or for all $i \in \mathcal{N}$ and all $c \in [c, \bar{c}]$,
  
  $G_i(c; \bar{e}_i) \equiv G(c)$. (3)
Allocation rule

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

- Lagrangian has terms involving fixed payments plus:

$$
\mathbb{E}_{v,c} \left[ \sum_{i \in \mathcal{N}} [w_B (v - \Phi(v)) + w_i (\Gamma_i(c_i) - c_i)] + \rho \sum_{i \in \mathcal{N}} (\Phi(v) - \Gamma_i(c_i))]Q_i(v,c) \right]
$$

  - maximize wrt. $Q_i$ [“pointwise”]
  - $\rho$ is shadow cost of budget surplus
    - $\rho \geq \max w > 0$
  - optimum has smallest $\rho$ such that no deficit is satisfied
  - $\beta^w = 1/\rho$

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Using IC, can write $E_{v,c}[W_{Q,M}^w(v,c)]$ and $E_{v,c}[R_M(v,c)]$ in terms of virtual types and the allocation rule $Q$.

Lagrangian has terms involving fixed payments plus:

$$E_{v,c}\left[\sum_{i \in N}[w_B(v - \Phi(v)) + w_i(c_i - c_i) + \rho \sum_{i \in N}(\Phi(v) - \Gamma_i(c_i))]Q_i(v,c)\right]$$

- maximize wrt $Q_i$ “pointwise”
- $\rho$ is shadow cost of budget surplus
  - $\rho \geq \max w > 0$
- optimum has smallest $\rho$ such that no deficit is satisfied
- $\beta^w \equiv 1/\rho$
- **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
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
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