Weddings With Uncertain Prospects—Mergers Under Asymmetric Information

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Problem

Merger decisions are influenced by asymmetric information about the other party’s characteristics.

Example 1: Dynegy & Enron
“Enron might need a new paint job and some new tyres, but its engine is sound.” (C. Watson, CEO Dynegy, November 2001)

Example 2: Hypobank und Hypovereinsbank
It took HVB more than two years “to discover the full horror of its partner’s balance sheet.” (The Economist, July 20, 2000)

Natural Questions
• Does the presence of (mutual) uncertainty affect the merger pattern?
• If so, is the market for firms a “lemons market” (Akerlof 1970)?
This Paper

1. Provides the first analysis of mergers with two-sided asym. information.
2. Characterizes the Bayes. equilibria of a reduced-form merger game.
3. Analyzes a Cournot example with linear demand.

Main Results
- The presence of uncertainty generally does affect the merger pattern.
- The “lemons market” rationale may be misleading (info, low types)

“Goodies”
- Merger pattern depends on: merger type, profit sharing, uncertainty
- Sheds some light on the “Merger Puzzle” (Scherer 2002).
Setup

“Type” (Quality or State) of a Firm
• objective (one-dimensional), e.g. marginal cost, fixed cost
• state variable $z_i$

Uncertainty
• firms know their own state $z_i$
• other party’s state $z_j, j \neq i$, is unknown
• ex-ante-probability of $z_i$ is given by the distribution $F_i$, with density $f_i$
• compact support $\mathcal{Z}_i \equiv [z_i, \bar{z}_i]$
• $F_i$ and $f_i$ are common knowledge
• firms may be heterogenous ex ante ($F_i \neq F_j$)
Assumptions on the Merger Game

• oligopoly with exogenous number of firms \((n \geq 2)\)
• two firms \(i = 1, 2\) with type \(z_i \in \mathcal{Z}_i\) play the merger game
• reduced form profits:

\[
\begin{align*}
\pi_i(z_i, z_j) & : \quad \text{stand-alone profit of firm } i \\
\pi^M_i(z_i, z_j) & : \quad \text{post-merger profit of firm } i \\
\pi^M(z_i, z_j) & = \sum_i \pi^M_i(z_i, z_j) : \quad \text{post-merger profit of the merged entity}
\end{align*}
\]

• \textbf{A1}: \(\pi_i\) is non-decreasing in \(z_i\)
• \textbf{A2}: \(\pi^M\) is non-decreasing in \(z_i\) and \(z_j\)
• merger decision summarized by

\[
\begin{align*}
s_i = \begin{cases} 
1, & \text{accept merger} \\
0, & \text{decline merger}
\end{cases}, \quad i = 1, 2.
\end{align*}
\]

• merger occurs if and only if \(s_1 = s_2 = 1\).
Merger Returns

Definition

\[ g_i(z_i, z_j) \equiv \pi_i^M(z_i, z_j) - \pi_i(z_i, z_j) \]

Remarks

- **A1** and **A2** impose little structure on merger returns
- merger returns depend on profit sharing between merging firms

The Profit Sharing Problem

No commonly accepted theory of profit sharing between merging firms.

Our Approach

- whatever the bargaining process: require that there is no full disclosure
- compare three plausible ways of profit sharing (in the example)
3 Profit Sharing Rules

**Fixed Profit Shares.** Firm $i$ obtains a predetermined share $\alpha_i \in [0, 1]$ of the merged entity’s total profit, i.e. \( \pi_i^M(z_i, z_j) = \alpha_i \pi^M(z_i, z_j) \).

**Joint Surplus Sharing.** Firm $i$ obtains its stand-alone profit plus a predetermined share $\beta_i(z_i, z_j) \in [0, 1]$ of the total change in profits, i.e.
\[
\pi_i^M(z_i, z_j) = \pi_i(z_i, z_j) + \beta_i(z_i, z_j) \left[ \pi^M(z_i, z_j) - \pi_i(z_i, z_j) - \pi_j(z_j, z_i) \right].
\]

**Cash Payment.** The owners of one firm, say firm 2, are compensated by the cash payment $p > 0$ for the takeover by the other firm, i.e.
\[
\begin{align*}
\pi_1^M(z_1, z_2) &= \pi^M(z_1, z_2) - p; \\
\pi_2^M(z_2, z_1) &= p.
\end{align*}
\]
Preliminaries for Bayesian Equilibria

Expected Merger Returns
Facing firm $j$ with strategy $s_j$, firm $i$’s expected merger returns are given by

$$G_i(z_i; B_j, f_j) \equiv \int_{B_j} g_i(z_i, z_j) f_j(z_j) dz_j,$$

where $B_j \equiv B_j(s_j) \equiv \{z_j \mid s_j(z_j) = 1\}$ is the set of types for which $j$ consents.

Single Crossing
$G_i(z_i; B_j, f_j)$ is (downward) single crossing in own type $z_i$ if, for given $(B_j, f_j)$, it crosses the $z_i$-axis at most once.
Main Result

Suppose $G_i(z_i; B_j, f_j)$ is downward single crossing in $z_i$ for all $B_j \subset Z_j$ and all $f_j$. Then every Bayesian Equilibrium $(s_1^*, s_2^*)$ in pure strategies where firms merge with strictly positive probability satisfies the cut-off-property, that is, there are cut-off values $z_i^* \in Z_i$ such that

$$s_i^*(z_i) = \begin{cases} 
1, & \text{if } z_i \leq z_i^*; \\
0, & \text{if } z_i > z_i^*; 
\end{cases} \quad i = 1, 2.$$

Intuition

- Types below the cut-off level will consent to the merger.
- For types above the cut-off level, a merger is not profitable in expectation.
Main Application

If \( g_i(z_i, z_j) \) is monotone decreasing in \( z_i \), then every Bayesian Equilibrium satisfies the cut-off property.

Intuition
If higher types have less to gain for arbitrary realizations of types, they clearly must gain less in expectation.

Remark
To characterize the Bayesian Equilibrium of the merger game, it often suffices to check whether merger returns are monotone decreasing in own type. (Yet, monotonicity is less prevalent than one would expect!)
Implications for the “Merger Puzzle”

Low types are more likely to merge than high types.

The “Merger Puzzle”
“[...] many mergers, and perhaps even the majority, turn out to have disappointing and sometimes even catastrophic results.” (Scherer 2002, 1)

What the Cut-Off Equilibrium Suggests
If firms are drawn from identical distributions, merged firms perform badly because of a selection effect.

Note of Caution
If firms are drawn from different distributions (ex ante heterogeneity), then a “low-type” consenting firm may have a higher type than a “high-type” rejecting firm! (illustration)
Equilibrium With Heterogeneity
The No-Merger Equilibrium

Each strategy pair \((s_1, s_2)\) where no type consents to the merger is a Bayesian Equilibrium of the merger game.

Intuition
If both firms believe that the other firm will reject (no matter what its type is), it is a weakly best response never to consent, and beliefs are correct in equilibrium.

Multiple Equilibria?
• there may be multiple equilibria
• cut-off equilibria with \(\mathbb{P}[B_i] > 0\) (Pareto) dominate the no-merger equ.
Further Results

The following results are not discussed in detail in this presentation:

Existence
We provide sufficient conditions for the existence of a non-degenerate Bayesian cut-off equilibrium.

Non-Existence
We provide sufficient conditions for the non-existence of a Bayesian equilibrium where firms merge with strictly positive probability.

Generalizations
We provide a generalization of our results that allows for merger returns that are non-monotone in firm types (Essentially Monotone Decreasing functions, EMD).
The Cournot Example

Demand

\[ P(Q) = a - bQ, \quad \text{where } Q \equiv \sum_k q_k, \quad k = 1, \ldots, 3 \]

Firm Types

\[ z_i \equiv -c_i, \quad i = 1, 2; \]

\[ Z = Z_1 = Z_2 = [\underline{z}, \overline{z}] . \]

Parameter Values

- \( a = 200, b = 1, c_3 = 100; \)
- \( \gamma \in [0, 20] \) defines the support of the uniform distribution of types as

\[ Z = [- (100 + \gamma), - (100 - \gamma)]; \]

(an increase in \( \gamma \) amounts to a mean-preserving spread (Laffont 1983)).
Marginal Costs in the Cournot Model
## Merger Pattern in the Cournot Model

<table>
<thead>
<tr>
<th>Profit Sharing</th>
<th>Uncertainty</th>
<th>Joint Surplus</th>
<th>Cash Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Share</td>
<td>High ($\gamma = 20$)</td>
<td>$\emptyset$</td>
<td>$\emptyset$</td>
</tr>
<tr>
<td></td>
<td>Medium ($\gamma = 5$)</td>
<td>$\emptyset$</td>
<td>$\emptyset$</td>
</tr>
<tr>
<td></td>
<td>Low ($\gamma = 2$)</td>
<td>$\emptyset$</td>
<td>$\emptyset$</td>
</tr>
</tbody>
</table>

### Rationalization Merger

$$z^m = \max(z_1, z_2)$$
Main Findings for the Cournot Model

Rationalization Mergers (marginal cost $z^m = \max(z_1, z_2)$)
- **Fixed Profit Sharing Rule**: No mergers
- **Joint Surplus Sharing**: Increasing uncertainty incr. chances of mergers
- **Cash Payment**: Increasing uncertainty increases the chances of mergers

Synergy Mergers with Fixed Profit Shares (marginal cost $z^m = \bar{z}$)
- generally cut-off equilibria
- transactions come about even for low uncertainty

Summing Up
Critical for the merger pattern:
(1) the merger’s effect on marginal cost (rationalization v. synergy)
(2) the profit sharing rule
(3) the amount of uncertainty
Generalization I: Increasing Returns Functions

Assumptions

- firm types are relation-specific (i.e. $\pi_i$ is independent of $(z_i, z_j)$)
- $\pi^M(z_i, z_j)$ is monotone increasing in both $z_i$ and $z_j$

Example

Firms provide complementary assets that are essential to carry out a common project but have no outside value.

Implications

- $g_i(z_i, z_j) = \pi_i^M(z_i, z_j) - \pi_i$ is mon. increasing (rather than decreasing)
- high types gain more than low types in expectation
- equilibrium is of the opposite cut-off type: only high types consent
Generalization II: Non-Monotone Returns Functions

Problem
Merger returns may be non-monotone in firm types.

Our Approach
Consider a class of merger returns functions that are **Essentially Monotone Decreasing** (EMD).

Functions that satisfy EMD
- monotone decreasing functions
- functions that have the same sign independent of own type
- a large class of single-peaked functions
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\[
g_i(z_i, z_j)
\]
EMD: Formal Definition

The function \( g_i \) is EMD if the following conditions are satisfied:

- **EMD1**: \( \forall z_2 \geq z_1 : \mu(A(z_1)) = 0 \Rightarrow \mu(A(z_2)) = 0 \) (rejection area)
- **EMD2**: \( \forall z_1 \leq z_2 : \mu(D(z_2)) = 0 \Rightarrow \mu(D(z_1)) = 0 \) (accept. area)
- **EMD3**: The restriction of \( g_i \) to the subset \( C \subset Z_i \), \( g_i|_C(z_i,z_j) \), is non-increasing in \( z_i \) for \( \mu \)-almost all \( z_j \in Z_j \).
- **EMD4**: \( \forall z_1^*, z_2^* \in C \) \( z_1^* > z_2^* \) non-increasing in \( z_i \) for \( \mu \)-almost all \( z \in Z_i \).

Thus, if the following conditions are satisfied:

- **EMD**: For \( i = 1 \) or \( i = 2 \),
  
  \[
  \begin{align*}
  (\forall z \in D) n^1 & \leq 0 = ((\forall z)(1)) n^2 : z > z^* \\
  (\forall z \in A) n^1 & \leq 0 = ((\forall z)(1)) n^2 : z < z^*
  \end{align*}
  \]

The function \( g_i \) is EMD if the following conditions are satisfied:

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Conclusion

Main Results

- The rationale of the lemons market may be misleading
- Crucial: (1) merger type, (2) profit sharing rule, (3) uncertainty
- The cut-off nature of the equilibrium helps explain the “Merger Puzzle”
- The results generalize to (somewhat) non-monotone merger returns

Future Research

- Apply results to other types of mergers (vertical/conglomerate)
- What if merger returns are not single-crossing?
- Apply results to other types of bilateral transactions (e.g. Joint Ventures)