Product market competition and the severity of distressed asset sales

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Product Market Competition and the Severity of Distressed Asset Sales

Vinicius Carrasco
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Pablo Salgado

SEM, Paris
Ship Graveyard

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Motivation

- Debtors provide creditors with right to foreclose on the debtor’s assets in default ([Hart and Moore(1994)]);

- Costly solution:
  - Creditors are unlikely to possess necessary knowledge ([Shleifer and Vishny(1992)]);

- Why do firms not take further actions to minimize ex-post costs of financial distress...
  - reallocating capital across industries in anticipation of costly foreclosures?

- What leads to excessive continuation?

- Answer: contest for the gains from market concentration.
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Solution: Reduce capacity

Industry report on shipping industry,
“few are willing to take actions. This is so since shipowners are so selfish that they wish to benefit from others’ scrapping.”

Ernst & Young:
“ship values fell, leaving many owners with debt that outweighted their asset’s values, and technically breaching loan-to-value covenants - an industry standard banking covenant.”
Shipping Industry

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Theoretical Literature Review

- [Shleifer and Vishny (1992)]: GE model: endogenous liquidation price;


- [Fischer et al. (1989) Fischer, Heinkel, and Zechner], [Leland (1994)], and [Leland and Toft (1996)]: endogenous default and contingent claims;

- [Dupuis and Wang (2002)] and [Hugonnier et al. (2011) Hugonnier, Malamud, and Morellec]: liquidity constraints in dynamic stochastic optimization problems;

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Model - Basic Assumptions

- Dynamic / continuous time;
- Two firms;
- Downward-sloping inverse demand curve

\[ P = xD(Q) \]

where \( Q \in \{1, 2\} \), \( D'(\cdot) < 0 \) and \( x \) is an industry-wide shock.

- Aggregate industry shock follows diffusion process

\[ dx = \mu(x)dt + \sigma(x)dB \]

\[ dx \sim \mathcal{N}(\mu(x)dt, \sigma^2(x)dt) \]

- Example: Geometric Brownian Motion \( dx = \mu x dt + \sigma x dB \).
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All agents are risk-neutral: discount rate $r$.

By definition, the division’s fundamental value when $Q$ firms are active is

$$\Pi(x_t, Q) \equiv \mathbb{E}_t \left[ \int_t^\infty e^{-r(s-t)} x_s D(Q) ds \right].$$

Fundamental value is always positive (there are no production costs).
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$$

- Fundamental value is always positive (there are no production costs).
Firms are levered: must return $M$ to debtholders when $x$ first falls to $x_C < x_0$;
Model - Basic Assumptions

- When $x$ reaches $x_C$ firm transfers assets to creditors in exchange for debt forgiveness;

- Nevertheless, firm try to redeploy asset in anticipation of violation of covenant;

- When found, buyer makes take-it or leave-it offer to buy division for $\phi x + M$. 
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Market Illiquidity

- No centralized market for corporate assets (industrial plants and oil tankers; not blue chip stocks);

- *Market illiquidity:* firms must search for buyers;

- When searching, over period \([t, t + dt]\), firm
  - incurs a cost of \( cdt \) and
  - meets a buyer with probability \( \lambda dt \)

- Firm \( i \) can only redeploy assets at random times \( T_1^i < T_2^i < \cdots < T_n^i < \cdots \),
  - \( \{T_1^i, \cdots, T_n^i - T_{n-1}^i, \cdots \} \) are i.i.d. with an exponential distribution with intensity \( \lambda \)
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Example of Diffusion Path
Assumption 1:

\[ r(M + \phi x) < xD(2) \quad \forall x \geq x_c \]

Assumption 1 implies

\[ (M + \phi x) < \Pi(x, 2) < \Pi(x, 1), \]

so that prices fetched at sale is below fundamental value.
Asset Illiquidity

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Assumption 2: Aggregate revenues given by $R(Q) = QD(Q)$ are increasing in $Q$. In particular $D(1) < 2D(2)$.

- Absent financial constraints, duopoly is socially preferred market structure.
Market Structure

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Benchmark - Efficient Divestiture

- Central planner
  - maximizes sum of firm value;
  - search effort on the part of firms and;
  - whether firms should accept a bid once a buyer is found.

- Work backwards:
  - initially: one division left;
  - then: two divisions.
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Search completely characterized by $u \in \{0, 1\}$:

$$J_M(x; u) \equiv \mathbb{E}^x,u \left[ \int_0^{\tau \wedge \tau_C} e^{-rt} (x_t D(1) - c u_t) dt + e^{-r\tau} \phi x_{\tau} \mathbf{1}_{\{\tau < \tau_C\}} \right],$$

where $\tau = \tau(u)$ is time where buyer is found and $\tau_C$ is hitting time of $x$ at $x_C$.

$$m(x) = \sup_u J_M(x, u)$$
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$$m(x) = \sup_u J_M(x, u)$$
Better to work with HJB Equation.

In the search region:

\[ m(x) = (xD(1-c))dt + e^{-rdt}\lambda dt\phi E^x[(x+dx)] + e^{-rdt}(1-\lambda dt)E^x[m(x+dx)] \]

Using Itô's Lemma:

\[ m(x) = xD(1-c) + (1-rdt)\lambda dt\phi(x+dx) + (1-rdt)(1-\lambda dt)(m(x) + \mathcal{L}m(x)dt) \]

where

\[ \mathcal{L}g = \frac{1}{2}g''\sigma^2 + g'\mu. \]
Better to work with HJB Equation.

In the search region:

\[ m(x) = (xD(1) - c) dt + e^{-rdt} \lambda dt \phi \mathbb{E}^x[(x + dx)] + e^{-rdt}(1 - \lambda dt) \mathbb{E}^x[m(x + dx)] \]

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\[ m(x) = xD(1-c) + (1-rdt) \lambda dt \phi(x+dx) + (1-rdt)(1-\lambda dt)(m(x) + Lm(x) dt) \]

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\[ Lg = \frac{1}{2} g'' \sigma^2 + g' \mu. \]
Better to work with HJB Equation.

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Canceling terms of order less than $dt$

$$rm(x) = xD(1) - c + \mathcal{L}m(x) + \lambda[\phi x - m(x)],$$

**INTUITION:**

$$r = \frac{xD(1) - c + \mathcal{L}m(x) + \lambda[\phi x - m(x)]}{m(x)}$$

In absence of search

$$rm(x) = xD(1) + \mathcal{L}m(x)$$
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Optimal Search Region under Monopoly

no search
\[ \lambda[\phi x - m(x)] < c \]

search
\[ \lambda[\phi x - m(x)] > c \]
Optimal Search Region under Monopoly

\[ \lambda[\phi x - m(x)] < c \] no search

\[ \lambda[\phi x - m(x)] = c \] by continuity

\[ \lambda[\phi x_M - m(x_M)] = c \]

\[ \lambda[\phi x - m(x)] > c \] search

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Efficient Search When Two Firms are Active

The value function is:

\[ d(x) \equiv \sup_w \mathbb{E}^{x,w} \left[ \int_0^{\tau \wedge \tau_C} e^{-rs}(2x_t D(2) - cw_t)dt + e^{-r\tau}(\phi x_\tau + m(x_\tau))1_{\{\tau < \tau_C\}} \right], \]

where \( w \in \{0, 1, 2\}. \)

By similar reasoning:

\[ rd(x) = 2xD(2) + Ld(x) + 2\{\lambda[m(x) + \phi x - d(x)] - c\}1_{\{x \leq x_D\}} \forall x \geq x_C. \]

Optimal threshold is given by:

\[ \lambda[m(x_D) + \phi x_D - d(x_D)] = c. \]
Efficient Search When Two Firms are Active

The value function is:

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Optimal Search Region under Duopoly

- no search (Duopoly)
- search by both firms (Monopoly)
- search by both firms (Inactive)
Some Comments

- Social planner
  - fully internalizes benefits of exit in the form of reduced competition;
  - is indifferent between which firm exits; has a state contingent preference over market structure;
  - Maximizes contact intensity (linearity of HJB equation).
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Comparative Statics

Proposition

The following comparative statics results hold:

1. $x_D$ is increasing and $x_M$ is decreasing in $D(1)$;
2. $x_M$ and $x_D$ are increasing in the outsider valuation $\phi$
3. $x_M$ and $x_D$ are decreasing in search costs $c$;
4. The optimal threshold levels $x_M$ and $x_D$ vary non-monotonically with respect to $\lambda$;
5. The average price of the first (second) division sold is increasing (decreasing) in $D(1)$;
6. The probability of the first (second) division ending up at the hand of creditors is decreasing (increasing) in $D(1)$.
Example: Brownian Motion

Thresholds x Monopoly Rents

Thresholds x Meeting Intensity

$\times_D : \text{Red} \quad \times_M : \text{Blue}$
Duopoly: Markov Perfect Equilibrium

- Equilibrium Concept: Markov Perfect Equilibrium (MPE)
- Trade-Off
  - Early initiation of search: higher liquidation value (lower chance of covenant violation);
  - Incentives to outlast rivals: win contest for monopolistic position.
Equilibrium Concept: Markov Perfect Equilibrium (MPE)

Trade-Off

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MPE in Threshold Strategies

Lemma

*Any Markov Perfect Equilibrium is in threshold strategies.*

IMPORTANT: Simple characterization of strategies.
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*Any Markov Perfect Equilibrium is in threshold strategies.*

**IMPORTANT:** Simple characterization of strategies.
Asymmetric Equilibrium

no search

search by 1 firm (Leader)

search by both firms (Leader and Follower)
Asymmetric Equilibrium: Follower

\[ rf(x) = xD(2) + \mathcal{L}f(x) \]

\[ rf(x) = xD(2) + \mathcal{L}f(x) + \lambda[m(x) - f(x)] \]

\[ \lambda[\phi x_F - f(x_F)] = c \]

\[ rf(x) = xD(2) + \mathcal{L}f(x) + \lambda[m(x) - f(x)] + \lambda[\phi x - f(x)] - c \]
Asymmetric Equilibrium: Follower

rf(x) = xD(2) + \mathcal{L}f(x)

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r_f(x) = xD(2) + \mathcal{L}f(x) + \lambda[m(x) - f(x)] + \lambda[\phi x - f(x)] - c

x_F = BR(x_L)
Game of Strategic Substitutes

Proposition

The best response function $BR(\cdot)$ is decreasing in rival’s strategies. The search game played by firms is one of strategic substitutes.

Intuition: Firm $A$ searches $\rightarrow$ positive externality (over $dt$) on firm $B$ of

$$\lambda[m(x) - g_B(x)].$$

Increases value of firm $B$ $\rightarrow$ more attractive for her to remain operational.
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The Equilibrium Set $\mathcal{E}$
Characterizing the Equilibrium Set $\mathcal{E}$ (in pictures)

*Best Response Functions*

- $\mathcal{E}$ is non-empty, symmetric, an anti-chain, and contains a unique symmetric equilibrium
Inefficiency of Competitive Equilibrium

Proposition

Let \((x_F, x_L)\) and \((x_S, x_S)\) belong to \(E\), where \(x_F < x_L\). It is always the case that \(x_M < x_F < x_S < x_L < x_D\). Furthermore, compared to the efficient benchmark,

(i) the average prices fetched for the first division that is liquidated are too low, and

(ii) divisions ends up at the hand of financiers, their lowest valuation users, too often.
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Comments

- Irrespective of type of equilibria: too little search. Why?
  - firms do not internalize their departure;
  - Social planner cares about market structure (duopoly x monopoly)
  - firms care about identity of monopolist.

- Equilibrium divestiture prices are depressed below efficient benchmark;

- Assets end up at the hand of creditors more often than in the efficient benchmark.
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The following comparative static results hold for the symmetric equilibrium:

1. $x_S$ is decreasing in the rents associated to a monopoly given by $D(1)$;
2. $x_S$ is increasing in the outsider valuation $\phi$ and decreasing in search costs $c$;
3. In the symmetric equilibrium, threshold levels vary non-monotonically with respect to $\lambda$;
4. In the symmetric equilibrium, average liquidation prices of the first division sold are decreasing in $D(1)$.
Thresholds and Prices

Thresholds x Monopoly Rents

Mean x Price Intensity

\( x_D : \text{Red} \quad x_M : \text{Blue} \quad x_S : \text{Green} \)
Price Discount

Discounts \times Monopoly Rents
Conclusion

▶ Financial distress associated to fire-sales should be greater in industries where monopoly rents are larger

▶ Product market structure should impact many of the firm’s most important decisions:
  ▶ more concentrated industries should have lower leverage;
  ▶ finance through soft securities;
  ▶ lower rate of asset divestitures;
  ▶ fewer instances of covenant violations


▶ Interaction between diverse forms of illiquidity, by showing how asset illiquidity depends on market illiquidity
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