Leverage, Price Competition, and Predation

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Table of Contents

Overview

How does financial structure affect a firm's output decisions?

1. Brander and Lewis (1986) Model: The increase in debt leads to stronger competition, i.e., the output level increases in debt level.
   - Under the Cournot assumptions: Firms produce homogenous products, and the market price is the result of total supply.
2. Dasgupta and Titman (1998) Model: The increased leverage leads to a higher current price.
   - A firm's pricing decision can be viewed as a discounted cash flow problem.
   - Under the Bertrand assumptions: Firms simultaneously decide prices rather than quantities. Homogenous and perfectly substitute products. Firms capture all the demands.

Overview

What if firms can dynamically set their prices, i.e., firms react to each other's prices?

3. The Stackelberg Model: The appearance of corporate raiders leads to decreased prices and profits, facing increased leverage.
   - Regardless of the Nash model that assumes prices are set simultaneously.
   - In this paper, one anticipates another's reaction curve and sets its optimal price. Another observes the price and set its price accordingly.

Table of Contents

Motivation

- In financial theory: the product market is typically assumed to offer an exogenous random return.
- In the analysis of oligopoly: a firm's obligation to debt holders and the possibility of financial distress are usually ignored.

This paper wants to investigate the linkage between a firm's financial and output decisions.

- **Limited liability effect of debt financing**: as firms take more debt, they will be incentivized to pursue output strategies that raise returns in good states and lower returns in bad states.

Setting

This paper mainly focuses on the limited liability effect of debt financing.
Assumptions:

- The firm's capital stock is fixed (at least temporarily):
  - A Firm's capital investment varies endogenously with the firm's financial position and will affect the output decisions.
- The investment decision is made before the debt-equity mix is determined:
  - High-levered firms may lower the investments to minimize salvageable assets lost to debt-holders in the bankruptcy.

Setting

For concreteness, assume Cournot quantity competition in the output market.

- Firm 1 and 2 are rivals in an output market where they produce competing products q_1 and q_2.
- The operating profit of firm i: $R^i(q_i, q_j, z)$
- The effects of an uncertain environment on the fortunes of firm i: $z_i \in [\underline{z}, \overline{z}]$ with $f(z_i)$; z_i and z_j are i.i.d. Output decisions are made before the uncertainty is resolved.
- Debt level: D_i, is determined before output decisions.

Properties

1. $R^i_{ii} < 0, R^i_j < 0$, and $R^i_{ij} < 0$
2. $R^i_z > 0$; but R^i_{iz} unclear. The standard case is $R^i_{iz} > 0$

Expected Value of the Firm to the Shareholders

Given the debt level, the firm is assumed to choose output levels to maximize the expected value of the firm to the shareholders.

$$V^i(q_i, q_j; .) = \int_{\hat{z}_i}^{\bar{z}} \left(R^i(q_i, q_j, z_i) - D_i\right) f(z_i)\, dz_i, \tag{1}$$

where $\hat{z}_i$ is defined by

$$R^i(q_i, q_j, \hat{z}_i) - D_i = 0 \tag{2}$$

When $z_i = \hat{z}_i$, the firm meets its debt obligations with nothing left over.

Key Intuition

The central insight of this paper: higher debt levels tend, in the standard case ($R^i_{iz} > 0$), to increase a firm's desired output.

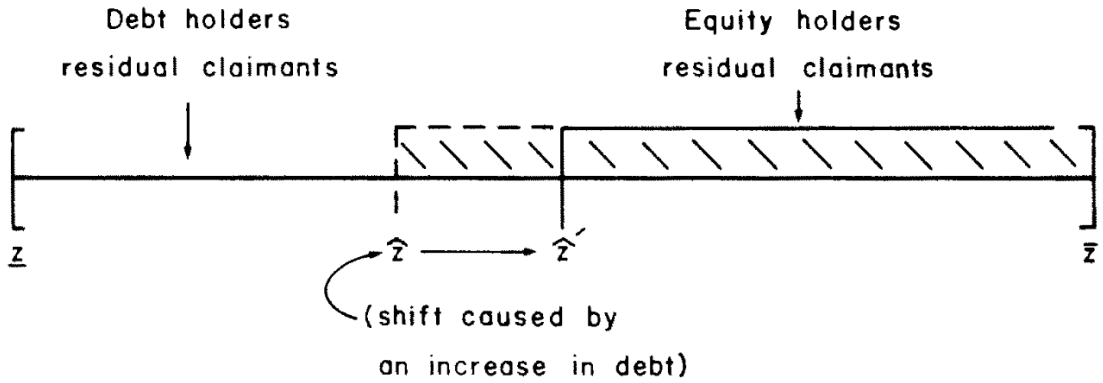


Figure: Division of state space into debt-relevant and equity-relevant regions

- As debt rises, low marginal value states become irrelevant, for in those states, the firm is turned over to the debtholders, and the equity holders get zero.

Equity Value Maximization

Assuming interior solution, the choice of output for firm i is obtained by

$$V_i^i = \int_{\hat{z}_i}^{\bar{z}} R_i^i \left(q_i, q_j, z_i\right) f\left(z_i\right) dz_i = 0 \tag{3}$$

The second order condition is: $V_{ii}^i < 0$
To solve the Cournot equilibrium, we require that,

$$V_{ij}^i < 0 \tag{4}$$

$$V_{ii}^i V_{jj}^j - V_{ij}^i V_{ji}^j > 0 \tag{5}$$

Equation (5) is equivalent to downward-sloping reaction functions. Equivalently, the expected marginal revenue declines when the output of other firms rises.

The Monopoly Case

Present the intuition rigorously using the monopoly case by setting $q_j = 0$ in Equation (3). Total differentiation of (3) w.r.t. q_i yields,

$$dq/dD = -V^i_{iD}/V^i_{ii} \tag{6}$$

The denominator is negative by second-order condition (4).
Then dq/qD has the same sign as V^i_{iD}: output rises with debt if increasing in debt causes marginal expected profits to increase.

The Monopoly Case

The expression for V_{iD}^{i} is given by

$$V_{iD}^{i} = -R_{i}^{i}\left(\hat{z}_{i}\right) / R_{z}^{i}\left(\hat{z}_{i}\right) f\left(\hat{z}_{i}\right) \tag{7}$$

- The denominator is positive: V_{iD}^{i} (and dq/dD) have the opposite sign to $R_{i}^{i}(\hat{z}_{i})$
- $R_{i}^{i}(\hat{z}_{i})$ is the marginal profit evaluated at the worst state of nature relevant to equity holders.
- R_{i}^{i} increases with z. $R_{i}^{i}(\hat{z}_{i})$ must be negative since a weighted average of R_{i}^{i} over $\hat{z}$ and better states is 0 from Eqt (3)

Symmetric Firms in Oligopoly

Proposition 1

Assume firms 1 and 2 are symmetric. Then the Nash equilibrium output level $q = q_i = q_j$ increases in the debt level $D = D_i = D_j$ when $R^i_{iz} > 0$ and decreases otherwise.

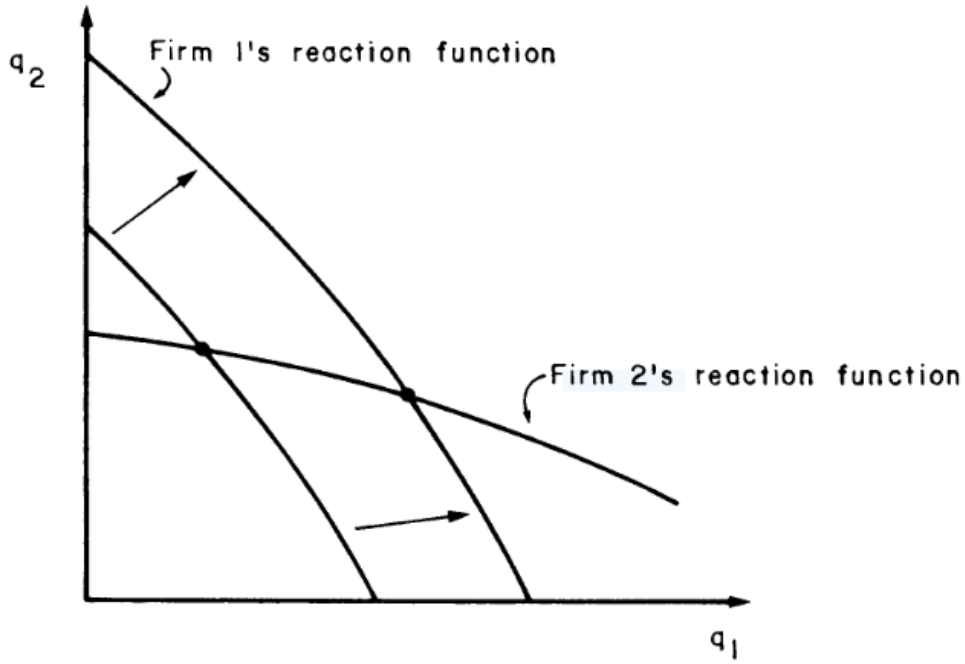
Corollaries 1 and 2

1. Assume firms 1 and 2 are symmetric. A completely equity-financed industry ($D = 0$) will produce a lower output than the corresponding leveraged industry ($D > 0$) when $R^i_{iz} > 0$
2. A necessary and sufficient condition for the financial structure to not affect the output market is $R^i_{iz} = 0$ for $i = 1, 2$.

Strategic Commitment of Financial Decisions

Proposition 2

Given $R^i_{iz} > 0$, a unilateral increase in firm i's debt D_i causes an increase in q_i and a decrease in q_j.



(a) $R^i_{iz} > 0$

Conclusion

1. Brander and Lewis's (1986) model suggests that increased debt commits the firm to being a more aggressive competitor.
   - Under the provisions of limited liability.
   - Under the Cournot quantity competition setting: an increase in a competitor's quantity typically lowers market prices, thereby reducing the profit of the other firm.
2. Showalter's (1995) extension of Brander and Lewis's (1986) model considers price competition and can explain the association between leverage increases and price increases but only in instances where bankruptcy is imminent.

Table of Contents

Motivation

Empirical evidence demonstrates that financing choices affect pricing and output choices. e.g., Phillips (1995) found that

- Fiberglass, insulation, and tractor-trailer industries follow that debt commits the leveraged firms to behave less aggressively (increased price but reduced output).
- The Gypsum industry follows an alternative way that an increase in debt leads to stronger competition (the price fell), which is more supportive of models by Brander and Lewis (1986).

The observation is that 1) firms that increase their leverage tend to increase their prices, that their competitors generally also increase their prices but not by so much; 2) an exception that price falls following the leverage when competitors are not highly leveraged.

Two-Period Model: Key Intuition

The pricing decisions can be viewed as discounted cash flow problems.

- When firms raise prices, they initially realize higher profits but lower market shares, which in turn implies lower profits in the future.
- The incentive to raise and lower prices is thus affected by the rate at which future profits are discounted, which in turn is related to capital structure choice.

Settings

- Firms A and B produce a similar but differentiated product.
- The firms compete based on price. Prices are set simultaneously.
- Customers are sensitive to price, and tend to favor the firm from which they purchased the product in the previous period, i.e., there are switching costs.
  - The model assumes that the demand for a firm's product in period 2 depends on its "customer base" in the first period.
  - The initial customer bases are exogenous, and only depend on first-period price.
- The firms are owned by risk-neutral entrepreneurs or, equivalently, are managed for the benefit of the risk-neutral shareholders.

Settings

The model is a two-period model:

- The firm selects the financial structures prior to period 1.
- Cash flows are realized at two points: at the end of period 1 and period 2.
- The firms are liquidated at the end of period 2, and generate a random liquidation value $\tilde{I}$.
  - The random liquidation is the only source of uncertainty in this model: to ignore the effect of imminent bankruptcy.

The All-Equity Firm

- First-period price: $x_1^i = x_1^i(p_1^A, p_1^B)$
- Second-period profits depend on the customer base attracted in the first period: σ^A and σ^B, where $\sigma^A + \sigma^B = 1$
- Second-period price: $x_2^i = x_2^i(\sigma^i)$. The overall second-period profit: $x_2 + \tilde{I}$

The ex-ante value of firm i,

$$V^i = x_1^i\left(p_1^A, p_1^B\right) + x_2^i\left(\sigma^i\left(p_1^A, p_1^B\right)\right) + E\tilde{I} - I \qquad (8)$$

The First-Period Price: A Trade-off

For all-equity firms, the first-period prices are given by the F.O.C.,

$$V_i^i = \frac{\partial x_1^i}{\partial p_1^i} + \frac{\partial x_2^i}{\partial \sigma^i} \cdot \frac{\partial \sigma^i}{\partial p_1^i} = 0, \quad i = A, B \tag{9}$$

The second-order condition is

$$V_{ii}^i < 0, \quad i = A, B \tag{10}$$

We assume that: $\frac{\partial x_2^i}{\partial \sigma^i} > 0$ and $\frac{\partial \sigma^i}{\partial p_1^i} < 0$

Equation (9) gives that the trade-off between periods 1 and 2 will depend on the discount rate.

The Effect of Outstanding Debt

Assume that the debt obligation d^A and d^B are determined exogenously and due at the end of period 2.
Assume that the new financing comes from junior debt at the end of period 1, and the newly issued debt (y) is priced competitively, we have,

$$I - x_1 = y\left[1 - F\left(d + y - x_2\right)\right] + \int_{d-x_2}^{d+y-x_2} \left(\tilde{I} + x_2 - d\right) dF \quad (11)$$

Firm's Two-Period Profit

Using Equation (11), the firm's two-period profit is

$$\begin{aligned}\Pi =& \int_{d+y-x_2}^{\bar{I}} \left(x_2 - d - y + \tilde{I}\right) dF \\ =& x_1 + \int_{d-x_2}^{\bar{I}} \left(\tilde{I} + x_2 - d\right) dF - I,\end{aligned} \tag{12}$$

At the beginning of period 2, firm A chooses p_2^A to maximize Equation (12), given d and y

$$\frac{\partial x_2^A\left(\sigma^A, p_2^A, p_2^B\right)}{\partial p_2^A} = 0 \tag{13}$$

- The second-period price is a function of the first-period market share, regardless of capital structure.
- This is because we assume that the marginal profit in the second period is known with certainty

Determine First-Period Price

To determine the first-period price, we take F.O.C., w.r.t. p_1^A

$$\Pi_A^A = \frac{\partial x_1^A}{\partial p_1^A} + \frac{\partial x_2^A}{\partial \sigma^A} \cdot \frac{\partial \sigma^A}{\partial p_1^A} \cdot \left[1 - F\left(d^A - x_2^A\right)\right] = 0 \tag{14}$$

S.O.C. requires that

$$\Pi_{AA}^A < 0 \tag{15}$$

Assume that $\Pi_{ij}^i > 0$ and $\Pi_{ii}^i \Pi_{jj}^j - \Pi_{ij}^i \Pi_{ji}^j > 0$ for $i = A, B$

Present Value Problem

Proposition 1

If firm A has existing senior debt and requires additional (lower priority) debt to finance new investment, its first-period price is increasing in the level of its existing debt. Firm B's price is also increasing in A's existing debt level. If firm B is equity financed, but otherwise identical to firm A, its price will be lower than firm A's price.

- Outstanding debt increases the cost of new borrowings and thus increases the rate at which second-period profits are discounted.
- A Higher discount rate decreases the current value of having a higher market share.

Brander & Lewis (1986) Model Revisit

Consider how the model would change if firms chose quantities rather than prices:

$$V_i^i = \frac{\partial x_1^i}{\partial q_1^i} + \frac{\partial x_2^i}{\partial \sigma^i} \cdot \frac{\partial \sigma^i}{\partial q_1^i} = 0, \quad i = A, B \tag{16}$$

- $\frac{\partial \sigma^i}{\partial q_1^i} > 0$: higher first-period quantity means higher first-period market share.
- Hence $\frac{\partial x_1^i}{\partial q_1^i} < 0$ to meet the F.O.C. (16): firm overproduce in the first period to grab market share.

Brander & Lewis (1986) Model Revisit

$$\Pi_A^A = \frac{\partial x_1^A}{\partial q_1^A} + \frac{\partial x_2^A}{\partial \sigma^A} \cdot \frac{\partial \sigma^A}{\partial q_1^A} \cdot \left[1 - F\left(d^A - x_2^A\right)\right] = 0 \qquad (17)$$

- With debt, the effect of the first term (the effect of quantity on overall profit) becomes more dominant. Since the first term is negative, the firm is incentivized to lower the output quantity.

Motivation

- The previous models do not capture the fact that prices sometimes drop following large increases in leverage.
- Consider the scenario: Firm R (the rival) observes that Firm A has substantially increased its leverage and notes that, as a result, Firm A will be less willing to protect its market share increased competition, since it discounts future profits at a higher rate.
- Observing this, Firm R lowers its price and steals some of Firm A's customers.

Motivation

Why the previous model does not capture the intuition of lowering prices facing increased competition:

- Nash equilibrium requires that firms set their price simultaneously.
- The intuition of lowering prices facing competition assumes that firms react to each other's prices and take into account the other firm's entire reaction curve rather than the price itself.

Settings

- The rival (Firm R), assumed to be the Stackelberg leader, anticipates Firm A's reaction curve and selects its price accordingly.
- Firm A, the Stackelberg follower, selects its price after observing its rival's price.

Intuition

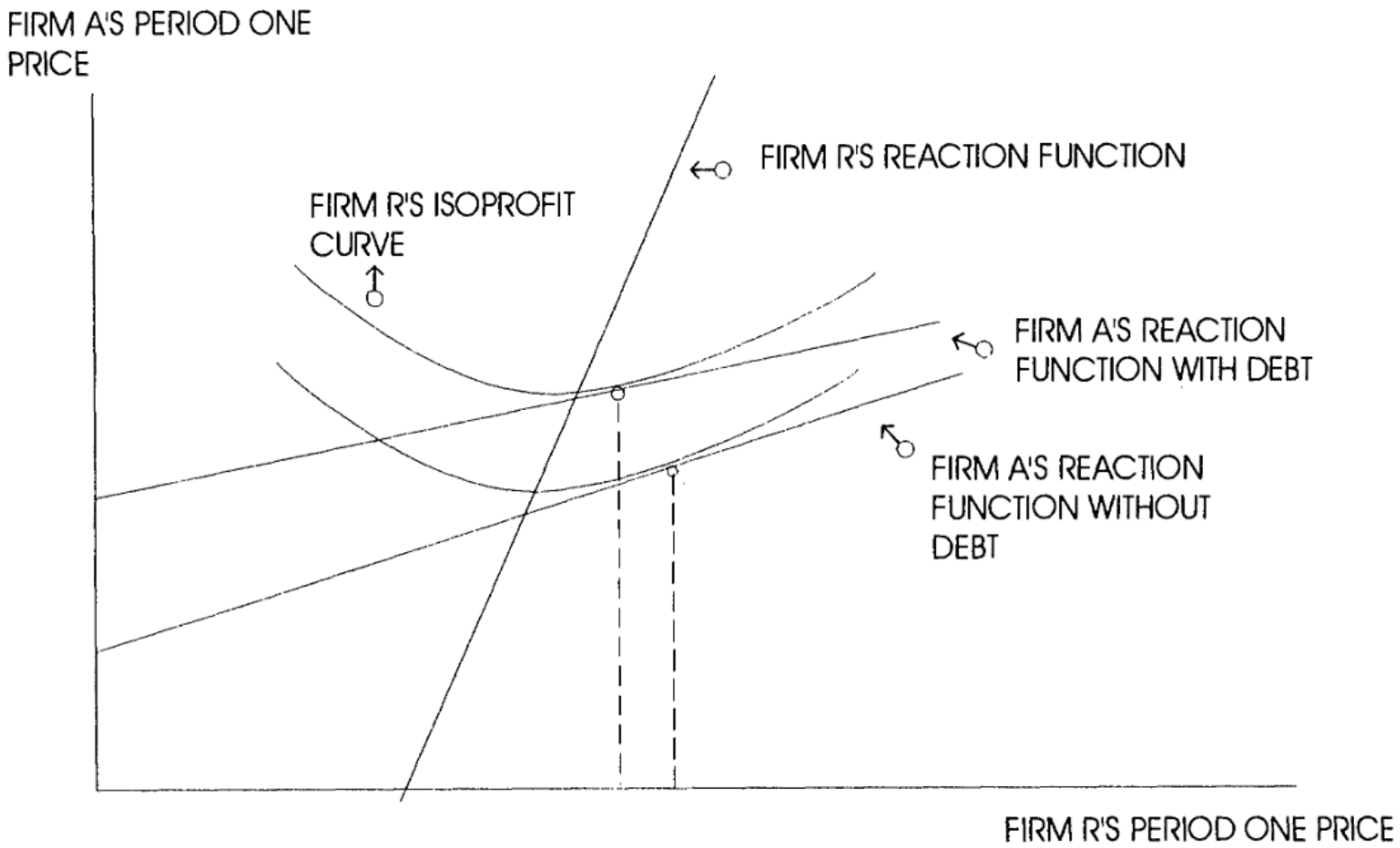


Figure: The Stackelberg Case

Conclusion

1. Under Nash equilibrium: Firms will price their products less aggressively at the earlier date, gaining market share at the expense of first-period profit.
   - Price will increase following the increased leverage, as the discount rate of future profits becomes higher,
   - since prices are strategic complements (increasing one's price will lead the customer to choose another),
   - the firm's rival will also increase its price.
2. This is not the case in the Stackelberg scenario:
   - One firm commits to a less aggressive pricing strategy, as the leverage increases.
   - The Stackelberg leader may see this as an opportunity to steal market share by setting lower prices, which places a higher value on the long-term benefits of increased market share.

Table of Contents

Do LBO Supermarket Charge More?

Chevalier (1995, JF) tries to understand how the leverage in the local market affects pricing decisions, and finds that

- Price rises following LBOs in local markets where the LBO firm's rivals are also highly leveraged.
- Price falls following LBOs in local markets where rival firms have low leverage and a single large competitor with low leverage controls a large share of the local market.
- Conditions of predation:
  - Only a (few) firms stand to reap most of the benefits of preying
  - The firm should have enough locations/stores to prey successfully.

LBOs and the Supermarket Industry

The entire body of research on the effects of LBOs suffers: a common factor might lead the firm to undertake the LBO and change its behavior (capital expenditure, R&D, etc.)

- None of the pricing changes continue a pre-LBO trend.
- The pricing effects appear within 6 months following the LBO.
- Prices rise in some markets while fall in others following an LBO, depending on the local rivary.

The US Supermarket Industry

Supermarket industry in the U.S.:

- Unconcentrated at the national level: 4 largest supermarket chains accounted for only 16% of US grocery sales in 1982.
- Highly concentrated at the local level: The average MSA had a four-firm supermarket concentration ratio of 58% in 1982.
- In the late 1980s, many supermarket chains merged or went private in LBO transactions. And LBO activity has not been concentrated in any single geographic region.

Most LBOs in the supermarket industry were not the result of unconstrained decisions by management and shareholders. Instead, they were taken in response to unwanted takeover attempts.

Empirical Methods

- Price: comes from ACCRA grocery price index, which compares the costs of specific grocery products in a city to the average cost of the same product in other cities.
- **Price change**: The price index for the city between the quarter before LBO and each of the six quarters following LBO.
- Controls: the change in the non-grocery components of the pricing index (control the overall changes in prices in the city); the change in the state's share of national employment (control the change in economy health).
- City-level regression to capture the competition in the local market.

Empirical Results: Local Market Competition

	Price Change over Quarters					
	−1 to +1	−1 to +2	−1 to +3	−1 to +4	−1 to +5	−1 to +6
Store share of LBO firm	0.038	0.013	−0.022	−0.006	0.058	−0.022
	(0.80)	(0.24)	(0.41)	(0.10)	(1.04)	(0.40)
Store share of prior LBO firms in city	0.0010	0.042	0.063	0.067	0.042	0.065
	(0.03)	(1.30)	(2.15)	(2.20)	(1.44)	(2.02)
Share of largest share non-LBO firm in city	−0.042	−0.016	−0.13	−0.14	−0.18	−0.13
	(0.94)	(0.30)	(2.67)	(2.66)	(3.71)	(2.60)
Change in state's share of national employment	0.51	0.15	−0.064	0.18	0.22	−0.0055
	(1.38)	(0.42)	(0.26)	(0.72)	(0.97)	−(0.027)
Change in ACCRA non-grocery price index	0.12	0.031	0.052	0.11	−0.011	0.14
	(0.81)	(0.20)	(0.46)	(0.88)	(0.17)	(1.27)
Constant	0.0048	−0.0026	0.021	0.016	0.023	0.022
	(0.40)	(0.17)	(1.64)	(1.16)	(1.70)	(1.61)
N	79	74	79	69	71	69
R^2	0.04	0.03	0.16	0.20	0.22	0.18

Empirical Results: Predation Hypothesis

Dependent Var: 1 if the LBO firm exits the market before the quarters examined and 1993.

	Quarters					
	−1 to +1	−1 to +2	−1 to +3	−1 to +4	−1 to +5	−1 to +6
Change in grocery price index	−5.61	−4.41	−10.59	−8.67	−13.55	2.59
	(1.14)	(1.03)	(2.25)	(1.78)	(2.58)	(0.42)
Change in state's share of national employment	−20.89	−2.937	0.003	3.391	9.683	11.217
	(1.21)	(1.61)	(1.00)	(0.35)	(1.01)	(1.33)
Change in nongrocery price index	−4.664	−0.870	0.64	6.16	0.24	5.54
	(0.73)	(0.16)	(0.90)	(1.16)	(0.10)	(1.08)
Constant	−0.72	−0.80	−0.955	−1.19	−1.19	−1.36
	(4.36)	(4.45)	(4.99)	(5.19)	(4.71)	−(5.29)
N	75	70	72	64	62	58

Figure: Determinants of Exit

Contribution and Comments

- Very little work that examines whether leveraged buyouts affect a firm's pricing and output behaviors.
- A surge of theoretical interest in the interaction between firm capital structure and product market competition.
- Predatory pricing violates antitrust laws, aiming to create a monopoly. However, the practice can be difficult to prosecute.