The Entry Incentives of Complementary Producers: A Simple Model with Implications for Antitrust Policy*

Juan S. Lleras
University of California, Berkeley

Nathan H. Miller
U.S. Department of Justice

August 16, 2010

Abstract

We model competition between two firms in a vertical upstream-downstream relationship. Each firm can pay a sunk cost to enter the other's market. For equilibria in which both firms enter, the downstream price can be lower than the joint profit maximizing level, and coordination (e.g., through merger) can be anticompetitive.

Keywords: vertical merger; entry incentives; complementary products
JEL classification: L12, L41, L42

*Lleras: jslleras@econ.berkeley.edu. Miller: nathan.miller@usdoj.gov. We thank Ronald Drennan, Patrick Greenlee, Bob Majure, Mikko Packalen, Alex Raskovich, and Jeremy Verlinda for valuable comments. The views expressed are not purported to reflect those of the U.S. Department of Justice.

1 Introduction

It is a well-known principle of economics that a producer of one product benefits from enhanced competition among producers of complementary products. Yet the implications of this principle for antitrust policy are less well developed in the academic literature. We explore these implications using a popular theoretical model in which two firms exist in a vertical upstream-downstream relationship – the upstream firms sets the price of an intermediate product and the downstream firm then sets the price of the final product.

We augment the model by permitting each firm to enter the other's market. Entry is costly and constrains prices in the affected market. The model takes the form of a two-stage game – the firms make entry decisions in the first stage and set prices in the second stage. We demonstrate that equilibria exist in which one or both firms choose to enter. Double-marginalization is mitigated in these equilibria. Further, if both firms enter then the downstream price can be lower than the joint profit maximizing level. The results imply that coordination (e.g., through merger) between two firms in a vertical relationship can be anticompetitive provided that each firm exerts competitive pressure in the other's market.

We develop two auxiliary results. First, we show that entry may be profitable for one or both firms even when entry would be unprofitable for a hypothetical third party; the distinction is due to the positive effect on margins in the complimentary market. In that sense, each firm in the vertical relationship can be uniquely positioned to compete in the other's market. Second, we show that entrants need not be fully efficient relative to the incumbent firms for coordination to be anticompetitive. Indeed, some level of entrant inefficiency is needed to support an equilibrium in which both firms enter the other's market; the presence of fully efficient entrants would prevent the firms from recouping the sunk cost of entry through their margins in their original markets.

Finally, we endogenize the merger decision and demonstrate that anticompetitive mergers occur in equilibrium if (1) integration costs are not too large and (2) entrants substantially constrain the prices of the incumbent firms. When these conditions are met, integration protects the incumbents' margins in the upstream and downstream markets.

Our work contributes to a burgeoning theoretical literature that examines competition among producers of complementary products. Packalen (2009) examines a model in which complementary producers can induce third-party entry, and similarly demonstrates that coordination between the producers can be anticompetitive. Packalen does not obtain the auxiliary results. Other recent contributions examine scenarios in which one producer can intensify competition in a complementary market (e.g., Farrell and Katz 2000, Chen and

Nalebuff 2006, Cheng and Nahm 2007, Casadesus-Masanell, Nalebuff, and Yoffie 2007). We refer the reader to Packalen (2009) for a more thorough review of this literature.

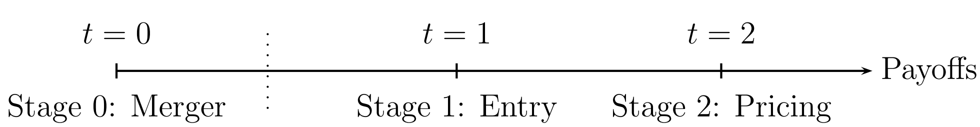
Our work also has implications for the theory of divided technical leadership. The theory, as espoused by Bresnahan and Greenstein (1999), states that the struggle for technical leadership among complementary firms can induce entry, technology races, and "epochal" competition. By contrast, our results suggest that firms may establish follower positions in complementary markets, even if those positions are weak and mainly serve to constrain pricing. Thus, for example, our results could rationalize Microsoft's recent launch of Bing in the market for online consumer search, insofar as the existence of a Google competitor creates positive externalities for Microsoft's positions in operating systems and applications.

2 Model

2.1 The game

The model is a two-stage game featuring two firms in a vertical upstream-downstream relationship. In the first stage, the firms simultaneously decide whether to enter the other's market. If neither firm enters then both firms are monopolists in their respective markets. In the second stage, the firms set prices and payoffs are realized. The solution concept we employ is pure-strategy subgame perfect Nash equilibrium (SPNE). We compare the outcomes of this game against an alternative scenario in which the two firm merge prior to the entry stage. In this alternative scenario, entry does not occur and the firms price to maximize joint profits. We illustrate the timing of the model in Figure 1. In section 3 we study the three-stage game starting at $t = 0$, where the merger stage is part of the firms' decision.

Figure 1: Timing of Actions



We represent the entry stage as the following non-cooperative normal 2x2 game:

		Upstream Firm	
		Enter	Do Not Enter
Downstream Firm	Enter	π_D^{UD}, π_U^{UD}	π_D^U, π_U^U
	Do Not Enter	π_D^D, π_U^D	π_D^N, π_U^N

We refer to the outcome of the game as (σ_U, σ_D) where σ_U and σ_D are the actions of the upstream and downstream firms, respectively. Payoffs correspond to the Nash equilibrium of the subsequent pricing stage. We denote the payoffs of player x when there is entry in market y as π_x^y. As an example, π_D^{UD} represents the profits of the downstream firm when there is entry in both the upstream and downstream markets. The exception is π_x^N, which denotes payoffs when there is no entry.

2.2 Payoffs

In the pricing stage, the upstream firm sets a price p_U for the intermediate product and the downstream firm sets a price p_D for the final product. The firms both face a constant marginal cost c_0, which we normalize to zero. Demand for the final product is $q(p_D) = \alpha - \beta p_D$. Variable profits are given by $\pi_U = p_U q(p_D)$ and $\pi_D = (p_D - p_U)q(p_D)$, where π_U and π_D denote the variable profits of the upstream and downstream firms, respectively. Each firm can pay a sunk cost $f \geq 0$ to enter the other's market. Entrants are technologically inefficient and face a constant marginal cost $c \in \left[0, \frac{\beta}{2}\right]$.[1,2]

A single Nash equilibrium exists for each of the four possible outcomes of the entry stage. We sketch these equilibria in turn:

i) Neither firm enters. Variable profits are $\pi_U^N = \frac{\alpha^2}{8\beta}$ and $\pi_D^N = \frac{\alpha^2}{16\beta}$ and the downstream price is $p_D = \frac{3\alpha}{4\beta}$.

ii) The upstream firm enters the downstream market. The downstream firm prices to just undercut the entrant's marginal cost. Variable profits are $\pi_U^D = \frac{\alpha^2}{4\beta} - \frac{\alpha c}{2} + \frac{\beta c^2}{4}$ and $\pi_D^D = \frac{\alpha c}{2} - \frac{\beta c^2}{2}$. The downstream price of $p_D = \frac{\alpha}{2\beta} + \frac{c}{2}$ reflects the upstream price and a downstream markup of c.

[1] The upper bound on entrant inefficiency rules out payoffs that are of little theoretical interest.

[2] Leaving the strict confines of the model momentarily, we note that these assumptions on price competition imply that entry by a hypothetical third party would not be profitable. The third party entrant would earn zero variable profits and could not recoup the sunk costs of entry. The two incumbents that we model are therefore "natural monopolists." We exclude third party entry from the model in the interest of brevity.

iii) The downstream firm enters the upstream market. The upstream firm prices to just undercut the entrant's marginal cost. Variable profits are $\pi_U^U = \frac{\alpha c}{2} - \frac{\beta c^2}{2}$ and $\pi_D^U = \frac{\alpha^2}{4\beta} - \frac{\alpha c}{2} + \frac{\beta c^2}{4}$. The downstream price of $p_D = \frac{\alpha}{2\beta} + \frac{c}{2}$ reflects an upstream price of c and a downstream markup.

iv) Both firms enter. The firms price to just undercut the entrants' marginal costs. Variable profits are $\pi_U^{UD} = \pi_D^{UD} = 2\alpha c - 4\beta c^2$. Downstream prices are $2c$.

In the alternative merger scenario, the firms set a downstream price of $\frac{\alpha}{2\beta}$, which maximizes joint profits. Outcomes of the two-stage game are characterized by double-marginalization whenever the downstream price exceeds this level. We refer to the vertical merger as anti-competitive if the pure-strategy SPNE of the two-stage game produces a downstream price lower than the joint profit maximizing level.

2.3 Solutions

The solution concept is pure-strategy SPNE. The symmetry of the game guarantees the existence of at least one such equilibrium:

Proposition 1. *There exists at least one pure-strategy SPNE equilibrium in the 2x2 game.*

Proof. The proof is by contradiction. We exploit the equalities $\pi_D^{UD} = \pi_U^{UD}$, $\pi_D^U = \pi_U^D$, $\pi_U^U = \pi_D^D$, and $\pi_U^N = 2\pi_D^N$. Suppose there are no pure strategy Nash equilibria. Since (Enter, Enter) is not an equilibrium, it must be that $\pi_U^U > \pi_U^{UD}$. Given this, and the supposition that (Enter, Do Not Enter) is not an equilibrium, it must be that $\pi_D^N > \pi_U^D$. This implies that (Do Not Enter, Do Not Enter) is an equilibrium. □

We evaluate the equilibria graphically in Figure 2 for specific parameter combinations. We consider the demand parameters $\alpha = 10$ and $\beta = 1$, and focus on the two-dimensional parameter space defined by $c \in [0, 5]$ and $f \in [0, 30]$. The solid lines delineate five regions, and we examine each region in turn.

Region I is defined by the parameter space over which (Enter, Enter) is a unique equilibrium. Within this region, the upstream firm uses entry to constrain the prices of the downstream firm, and vice-versa. The firms recoup the sunk cost of entry in the subsequent price competition because entrants only partially dampen the margins of the incumbents. The bounds on the region are intuitive. Sunk costs cannot be too great, and entrants must be efficient enough to constrain prices but not so efficient that margins are eliminated. Region 1 is important for antitrust policy because downstream prices are lower than the joint profit

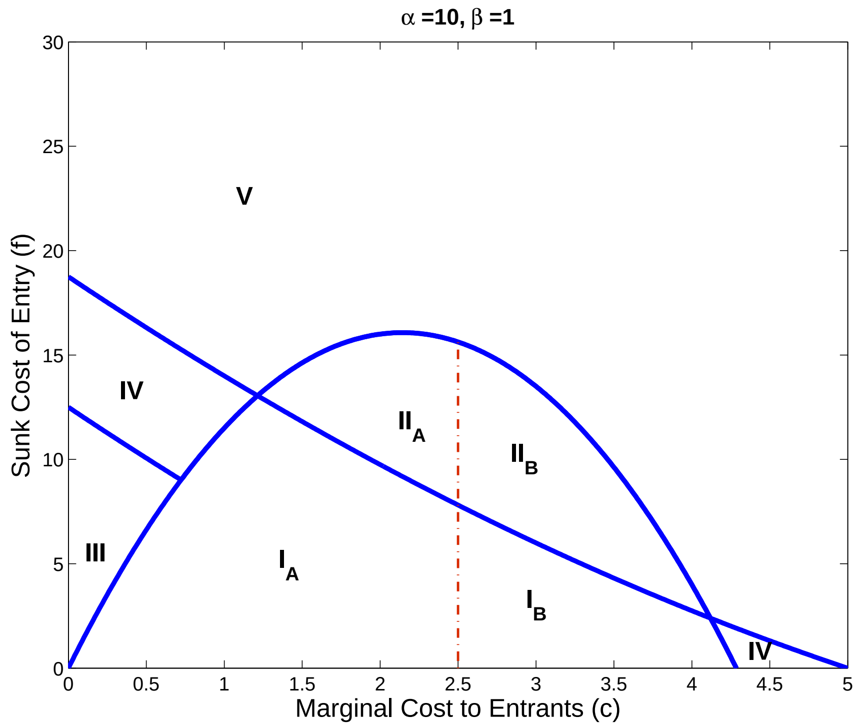


Figure 2: Equilibrium Regions

maximizing level for entrant marginal costs that are sufficiently low ($c < \frac{\alpha}{4\beta}$). We plot this threshold with a dotted line. The sub-regions I_A and I_B map the parameter regions in which the downstream price is lower and higher than the joint profit maximizing price, respectively, so that vertical merger is anticompetitive in sub-region I_A.

We now discuss the other regions plotted in Figure 2:

- Region II is defined by the parameter space over which (Enter, Enter) and (Do Not Enter, Do Not Enter) are the two equilibria. The latter equilibrium yields higher profits for both firms. However, if both firms enter then prices can be lower or higher than the joint profit maximizing level.

- Region III is defined by the parameter space over which (Enter, Do Not Enter) and (Do Not Enter, Enter) are the two equilibria. The efficiency of the entrants creates a situation in which each firm can recoup the sunk costs of entry only if the other firm does not enter. Downstream prices exceed the joint profit maximizing level.

- Region IV is defined by the parameter space over which (Do Not Enter, Enter) is the unique equilibrium (i.e., the downstream firm enters the upstream market). Absent entry, the upstream firm earns greater margins than the downstream firm due to its ability to set a take-it-or-leave-it price. These margins induce the downstream firm to enter. Downstream prices exceed the joint profit maximizing level.

- Region V is defined by the parameter space over which (Do Not Enter, Do Not Enter) is the unique equilibrium. Sunk costs are high and entrants are inefficient. Downstream prices exceed the joint profit maximizing level.

3 Endogenous Mergers

We now endogenize the merger decision at $t = 0$. We let joint profits under merger be $\pi^M = \frac{\alpha^2}{4\beta} - M$, where $\frac{\alpha^2}{4\beta}$ is the revenue realized at the joint profit maximizing price and M is an integration cost. We assume that merger occurs if these joint profits are greater than the joint profits available from the SPNE of the subsequent entry game.

A comparison of π^M to the payoffs outlined in Section 2.2 yields the conditions under which merger occurs: First, if (Enter, Enter) is the SPNE of the entry game then merger occurs if and only if $M < \frac{\alpha^2}{4\beta} - 4\alpha c + 8\beta c^2 + 2f$. Second, if (Enter, Do Not Enter) or (Do Not Enter, Enter) is SPNE of the entry sub-game from section 2 then merger occurs if and only if $M < \frac{\beta}{4}c^2 - f$. Finally, if (Do Not Enter, Do Not Enter) is the SPNE of the entry sub-game then merger occurs if and only if $M < \frac{\alpha^2}{16\beta}$.

We evaluate these conditions equilibria graphically in Figure 3. We set the integration costs of merger at $M = 3$ and again consider the demand parameters $\alpha = 10$ and $\beta = 1$. Figure 3 depict the equilibria for the game, where in the first stage firms choose to merge or to compete. The solid lines delineate the five SPNE of the entry-subgame regions defined in Section 2.3, and the shaded portions represent the parameter space over which merger occurs in the three-stage game. We discuss each region in turn.

- Regions I and II are defined by the parameter space over which (Enter, Enter) is an SPNE of the entry game. Merger occurs when the sunk costs of entry are relatively high and the marginal costs of the entrants are either high or low. Intuitively, merger is preferred if (1) the entrants are efficient enough to substantially constrain the prices of incumbents, or (2) entrants are so inefficient that they fail to mitigate double-marginalization. Merger is anticompetitive in the former case.

- Regions III and IV are defined by the parameter space over which one of the firms enters the other's market. Merger is preferred to entry as a mechanism to reduce double-marginalization when the integration costs are small relative to entry costs and when entrants are relatively inefficient.

- Region V is defined by the parameter space over which (Do Not Enter, Do Not Enter) is the SPNE of the entry game. Merger is preferred to the entry game throughout the region because losses due to double-marginalization exceed the costs of integration.

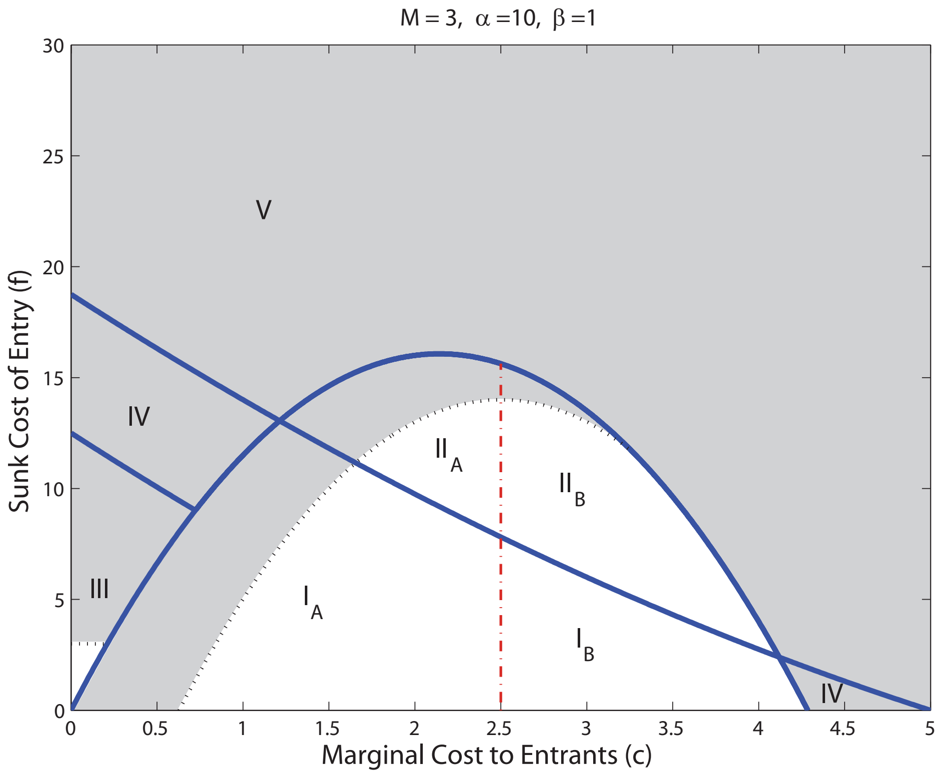


Figure 3: Equilibrium Regions with Endogenous Merger

4 Discussion

We formalize the intuition that firms in a vertical relationship have an incentive to introduce competition into the others' markets, and that the elimination of this incentive (e.g., through coordination/merger) can be anticompetitive. We employ the simplest possible modeling framework because the intuition itself is straight-forward. Extensions to the model could generate additional results – one could incorporate more general functional forms, a tradeoff between entry costs and entrant efficiency, and/or first-mover advantages. We leave these extensions to future work.

References

[1] **Bresnahan, Timothy, and Shane Greenstein.** 1999. Tecnological Competition and the Structure of the Computer Industry. *Journal of Industrial Economics*, 47(1): 1-40.

[2] **Casadesus-Masanell, Ramon, Barry Nalebuff, and David Yoffie.** 2007. Competing Complements. Unplublished.

[3] **Chen, Keith and Barry Nalebuff.** 2006. One-Way Essential Complements. Cowles Foundation Discussion Paper No. 1588.

[4] **Cheng, Leonard and Jae Nahm.** 2007. Product Boundary, Vertical Competition, and the Double-Mark-up Problem. *RAND Journal of Economics*, 38(2): 447-466.

[5] **Farrell, Joseph and Michael Katz.** 2000. Innovation, Rent Extraction, and Integration in Systems Markets. *Journal of Industrial Economics*, 48(4): 413-432.

[6] **Packalen, Mikko** 2009. Complements and Potential Competition. Unplublished.