A Cournot-Based Proof of Concept for Equilibrium Vertical Foreclosure

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Abstract: The threat of a firm profitably leveraging its vertically integrated position and harming consumers (i.e., foreclosure) is a recurring policy concern. Current industrial organization textbooks, however, either treat the possibility of such anticompetitive tactics vaguely or follow the relatively complicated framework of Ordover, Saloner, and Salop (1990). I propose a two-level framework based on the Cournot duopoly model with which students are typically familiar. This framework encompasses the Chicago perspective under which a myopic vertically integrated firm first profits and then drives its rivals to merge, but it also permits the originally merging firm to strategically underproduce. Doing so deters a merger by rival firms, leaves the integrated firm with higher profits than other cases, and is harmful to consumers.

Keywords: Vertical merger, foreclosure, industrial organization, undergraduate teaching
JEL codes: A22, L42

The modern economy is thick with high-profile examples of vertical mergers between large firms. While all were ultimately given regulatory approval, each elicited notable protest. The events promoter and venue operator Live Nation merged with ticketing company Ticketmaster in 2010, prompting Bruce Springsteen to claim that the merger “return[s] us to a near monopoly situation in music ticketing.” After an FTC investigation, semiconductor

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1 I thank Becca Jorgensen and Mark Tremblay for their valuable feedback. Isabella Mancini provided excellent research assistance. All mistakes and omissions are my own.
producer Broadcom acquired networking switch company Brocade in 2016.³ Comcast completed its acquisition of NBC Universal from General Electric in 2013, and AT&T purchased Time Warner in 2018, both mergers in order to secure video content for outlets and establish video-streaming services (respectively now released as Peacock and HBO Max). The latter of those mergers prompted a Department of Justice antitrust lawsuit in November 2017 with a judicial ruling in favor of AT&T in June 2018.⁴, ⁵

The fact that such vertical mergers have met only mild regulatory resistance despite the popular concern that merged firms will leverage their integrated position to foreclose (deny rivals intermediate goods or market audiences) represents perhaps the most striking achievement of the so-called Chicago School within industrial organization and antitrust law (see Posner, 1978). The Chicago School maintains that vertical mergers are broadly efficiency enhancing, occurring only when the elimination of market transaction costs exceeds the costs of internal monitoring. The elimination of double marginalization (markup on markup) is a particular point of interest. Another Chicago argument is that foreclosure itself is not an obviously profitable strategy when compared to the prospect of selling to a rival. Finally, Chicago adherents argue that imposing double marginalization on a rival through vertical integration and foreclosure merely prompts the rival to make its own vertical acquisition and thereby eliminate the inefficiency. In all, vertical mergers begin from a presumption of being pro-competitive and thus good for consumers.

⁵ Slade (2020) provides a thorough overview of recent vertical mergers and related economists’ methods for study.
The logic of the Chicago School with respect to vertical mergers is so seductive that an 
attentive student might wonder why honest economists would ever take the other side of case. A 
number of theoretical papers over the last 35 years have sharpened the conditions under which 
vertical mergers may have anti-competitive effects. Salinger (1988) uses an N-firm Cournot 
model to detail conditions in which vertically integrated firms foreclosing their rivals may lead to 
a higher consumer price. While this model shows the possibility of an anti-competitive vertical 
merger, it fails to address the Chicago point that all firms are incentivized to vertically integrate 
which negates the original cost advantage from integration.6 Ordover, Saloner, and Salop (1990, 
hereafter OSS) address this and other concerns in their model of equilibrium vertical foreclosure. 
This model considers a successive duopoly with a homogeneous intermediate (upstream) product 
and differentiated final (downstream) products. OSS specifically has the vertically merged firm 
forgo short-term profits in order to deter the unintegrated retail rival from integrating with its 
supplier so that the merged firm can preserve its cost advantage in the long run.

OSS’s joint use of the differentiated Bertrand and Cournot frameworks and the generally 
high level of abstraction make the paper a difficult read for an advanced undergraduate in 
economics.7 Existing textbooks have likewise struggled to make this important theoretical result 
of foreclosure and raising rivals’ costs accessible to the undergraduate audience. Tirole (1988, 
pp. 193-196) broadly lays out the intuition of OSS (then only a mimeo) but provides no 
numerical example. Church and Ware (2000, pp. 631-2) offers a highly stylized quantitative 
vertical integration example that lacks the richness of OSS and omits any long-run consideration. 
Carlton and Perloff (2005, 4th ed., p. 375) merely states that OSS shows that vertical merger can

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6 Higgins (1999) argues that Salinger’s entire result hinges on an assumption of foreclosure that is not profit-
maximizing.
7 The authors admittedly include the “linear-linear” case in an appendix.

As far as I can tell, only Pepall, Richards, and Norman (2014, 5th ed., pp. 436-446) provides a numerical example of OSS, explicitly motivating it to address the long-run equilibrium question left by Salinger (1988). That textbook’s example is simplified as much as possible, but the model, and especially its combination of Bertrand and Cournot models, is still challenging to follow. Specifically, the incorporation of Bertrand first-order conditions deprives students of the familiar profit-maximization condition of “marginal revenue equals marginal cost” that a fully Cournot-based model provides.

In all, despite the progress made in industrial organization on the theoretical side, students still lack a straightforward example of logically consistent vertical foreclosure and consequently the intuition. While not beyond the abilities of the strongest undergraduates, the OSS model’s differentiated Bertrand framework, even in its simplest form, is still computationally daunting. It is this challenge that prompted the following Cournot-based model of vertical merger and foreclosure, a model that offers the same insights of OSS in a more accessible way.

The structure of this paper is as follows. I first specify the parameters of demand and cost and then consider the most straightforward cases of a cartel of two vertically integrated duopolies (essentially the two-plant monopoly case) and then a non-cooperative duopoly of vertically integrated firms (essentially the Cournot model). After exploring the effects of double
marginalization in a vertically disintegrated duopoly equilibrium, I turn to the case of a myopic firm that has vertically merged and then that of strategic firm that has done the same.

**The Model**

Following the literature, I maintain the same final good demand and underlying marginal cost throughout. Consumers have a linear market inverse demand for the homogeneous final product: \( P = A - bQ \). This final product is sold by a retail sector in which there are two sellers. Retail sellers share a common production fixed-proportion (one-to-one) technology by which they acquire (either internally or on a wholesale market) units to sell. Retailers incur no marginal cost beyond the cost to acquire the unit. There are likewise two manufacturers with an identical constant returns to scale production technology such that marginal cost is the constant \( c \) with \( A > c \) assumed to ensure the market’s existence. I assume that manufacturing marginal costs are unchanged by vertical structure to highlight the mechanisms of vertical foreclosure.

When retail and manufacturing are distinct (not integrated), I assume that the market sequence is that manufacturers first simultaneously choose levels of production, determining the common market-clearing wholesale price. Manufacturers therefore enjoy a first-mover advantage over retailers, eventually receiving a consequent higher share of profits. Retailers observe this wholesale price and make their purchase (production) choices which they then pass on to consumers. Given these assumptions, equilibrium retail prices paid by consumers always reflect a weighted average of the demand shift parameter \( A \) and the cost parameter \( c \), and so consumers prefer outcomes for which the weight on \( A \) is less.

For context in what follows, I begin by assuming a perfect cartel of two vertically integrated firms. Given the above assumptions on production, such an assumption will yield an
equilibrium in which industry profits are maximized. Industry-level cartel production, pricing, and profits are the standard monopoly outcomes:

\[ Q^{\text{Cartel}} = 0.5 \left( \frac{A - c}{b} \right), \quad p^{\text{Cartel}} = 0.5A + 0.5c, \quad \Pi^{\text{Cartel}} = 0.25 \left( \frac{A - c}{b} \right)^2 \]

These cartel profits therefore represent an upper bound to the profits available in the industry under any scenario.

The second case of two vertically integrated duopolists reduces to the standard Cournot outcome. Denoting industry-level (firm-level) variables with upper (lower) letters, production, pricing, and profits are:

\[ Q^{\text{VI, Duo}} = 0.6 \left( \frac{A - c}{b} \right), \quad p^{\text{VI, Duo}} = 0.3A + 0.6c, \quad \Pi^{\text{VI, Duo}} = 0.2 \left( \frac{A - c}{b} \right)^2 \]

As is standard, moving from monopoly to duopoly lowers the price paid by consumers and lowers industry profits. Firms recognize that, should the dis-integrated market participants fully integrate, these standard Cournot results are the outcomes in that equilibrium.

**Vertical Dis-Integration (Double Marginalization with Duopolies)**

The next case considers two competing retailers who purchase the intermediate good for wholesale price \( w \) from two competing manufacturers. It is standard in undergraduate industrial organization to discuss the simplest model of double marginalization in which a monopoly manufacturer sells to a monopoly retailer. The consequent results are that price is higher than that of an integrated monopolist and therefore that industry profits are not maximized. The below discussion of double marginalization in a duopoly setting is qualitatively similar with respect to the impact on final prices but substantially different with respect to industry profits. It is this
latter difference that enables the Cournot model to serve as proof of concept for vertical foreclosure.

I solve this case using backwards induction. Both retailers face the common wholesale price \( w \) in a standard Cournot game. Given the parallels, the retailer solutions mirror the Cournot solutions:

\[
Q = 0.6 \left( \frac{A - w}{b} \right), \quad q_i^R = 0.3 \left( \frac{A - w}{b} \right), \quad P = 0.3A + 0.6w
\]

Inverting the above market demand yields:

\[
w = A - \frac{3}{2} bQ = A - \frac{3}{2} b q_1^M - \frac{3}{2} b q_2^M
\]

Employing this inverse demand in the first manufacturer’s profit-maximization problem gives the first-order condition (FOC):

\[
\max_{q_i^M} \pi_i^M = \left( A - \frac{3}{2} b q_1^M - \frac{3}{2} b q_2^M - c \right) q_i^M, \quad \text{FOC}_1: A - 3b q_1^M - \frac{3}{2} b q_2^M - c = 0
\]

Imposing symmetry on this FOC facilitates the new equilibrium results.

\[
q_i^M = 0.2 \left( \frac{A - c}{b} \right) = q_i^R, \quad Q = 0.4 \left( \frac{A - c}{b} \right)
\]

\[
w = 0.3A + 0.6c, \quad P = 0.5A + 0.4c
\]

\[
\pi_i^M \approx 0.074 \left( \frac{A - c}{b} \right)^2, \quad \pi_i^R \approx 0.049 \left( \frac{A - c}{b} \right)^2, \quad \Pi \approx 0.247 \left( \frac{A - c}{b} \right)^2
\]

Double marginalization again leads to a higher retail price for consumers. Because duopoly competition had reduced price below its industry profit-maximizing level, though, double marginalization here increases industry profits to not far below the integrated cartel maximum.\(^8\)

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\(^8\) This feature of double marginalization in duopoly has been previously shown in Hamilton and Mqasqas (1996).
This intuition of how vertical integration and the consequent elimination of double marginalization can reduce industry profits is critical to supporting the final result.

**Partial Vertical Integration and Myopic Production**

The next case considers the scenario in which one manufacturer and one retailer merge, creating a vertically integrated firm. This firm is not subject to double marginalization and thereby has a cost advantage over its non-integrated retailer rival. This advantage is magnified by the fact that the remaining non-integrated manufacturer now faces no direct rivals, though it must still heed the now-integrated rival in the final good market.

Each retailer (integrated and non-integrated) bases its production decision on the marginal cost that it faces for its units sold. Letting Firm 1 denote the integrated firm and \( w_2 \) the wholesale price paid by the non-integrated retailer, the retail first-order conditions are:

\[
F_{OC1} : A - 2bq_1^R - bq_2^R = c,
\]

\[
F_{OC2}^R : A - bq_1^R - 2bq_2^R = w_2
\]

The first FOC can be simplified to a best-response function that, when substituted into Firm 2’s FOC, yields:

\[
q_2^R = \frac{A}{3b} + \frac{c}{3b} - \frac{2}{3b}w_2
\]

When this residual demand is inverted, it can be substituted into the non-integrated manufacturer’s profit-maximization problem, with first-order condition and solution:

\[
\frac{A}{2} + \frac{c}{2} - 3bq_2^M = c, \quad q_2^M = 0.16\left(\frac{A-c}{b}\right) = q_2^R
\]

The remaining equilibrium outcomes are:

\[
w_2 = 0.25A + 0.75c, \quad q_1 = 0.416\left(\frac{A-c}{b}\right)
\]

8
\[ Q = 0.583 \left( \frac{A-c}{b} \right), \quad P = 0.416A + 0.583c \]

\[ \pi_1 \approx 0.174 \frac{(A-c)^2}{b}, \quad \pi_2^M \approx 0.042 \frac{(A-c)^2}{b}, \quad \pi_2^R \approx 0.028 \frac{(A-c)^2}{b} \]

\[ \pi_2^M + \pi_2^R \approx 0.069 \frac{(A-c)^2}{b}, \quad \Pi \approx 0.243 \frac{(A-c)^2}{b} \]

This case confirms several features of the Chicago line of reasoning. First and foremost, the newly integrated firm earns higher profits in this scenario than when the firms exhibit no vertical integration (0.174 > 0.123 = 0.074 + 0.049). Second, prices are more reflective of cost than demand, and so consumers prefer this scenario to that of no vertical integration.9 Third, the non-integrated firms are clearly incentivized to integrate. Profits from the vertically integrated duopoly are higher than being non-integrated and competing against a vertically integrated rival (0.111 > 0.069).

The non-integrated firms find themselves in a repeated Prisoner’s Dilemma. To the extent that a vertically integrated firm fully exploits its cost-advantage against non-integrated rivals, it will drive those firms to integrate. Because of the previous result by which industry profits are higher under double marginalization in duopoly than under vertically integrated duopoly, a firm that sufficiently values its future profits will forgo the immediate increase in profits from vertical integration in order to maintain the higher long-run profits that arise by the industry remaining symmetrically non-integrated. Under the plausible twin assumptions that a firm anticipates that its vertical integration will prompt its rival to do likewise and that firms sufficiently value future

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9 This case is still less preferred by consumers than when both firms are vertically integrated.
profits, a firm limited to full exploitation of its cost advantage would not vertically integrate in the absence of additional efficiencies.\textsuperscript{10}

\textit{Partial Vertical Integration and Strategic Production}

The above reasoning suggests that vertical concerns regarding foreclosure are misplaced. The same preliminary results can be found in OSS (1990). That paper salvages the vertical foreclosure story by having the vertically integrated firm limit the monopoly power enjoyed by the remaining non-integrated manufacturer. OSS does so by having the integrated firm offer to sell to the non-integrated retailer at a price that is above cost but below the wholesale price that an unconstrained non-integrated manufacturer would set. The non-integrated manufacturer then sets its price immediately below that level. Doing so reduces the integrated firm’s cost advantage and the consequent profits of vertical integration, but it also reduces the incentives for the non-integrated firms to merge. The integrated firm can then set its phantom intermediate good price at a level such that the non-integrated firms are indifferent to their own vertical integration. At this price, the vertically integrated firm’s profits are higher than when no firms are vertically integrated or when both firms are vertically integrated.

The same logic can be applied to the Cournot framework employed above. In this case, the vertically integrated firm forgoes fully exploiting its advantage by producing less than myopic profit maximization requires. Contrary to Reiffen (1992)’s comment on OSS (1990), this is not a commitment advantage that is assumed to stem from vertical integration but rather the vertically integrated firm responding to its new incentives.\textsuperscript{11} The vertically integrated firm in this

\textsuperscript{10} Assuming a single period of the asymmetric advantage afforded by vertical integration and given an infinite stream of future profits based on the above specification, the discount factor $\beta$ need only be greater than 0.8 (comparably $r < 25\%$).

\textsuperscript{11} This is the same retort that OSS offered in their Reply (1992).
Cournot framework must then identify the amount of the market that it must cede to the non-integrated firms to keep them from vertically integrating.

As before, I begin with retail and work backwards. The vertically integrated firm is no longer maximizing immediate profits and so only the non-integrated retailer’s first-order condition is relevant:

\[ FOC_R: A - bq_R^2 - 2bq_2^R = w \]

Assuming total foreclosure \( q_2^M = q_2^R \), the non-integrated manufacturer perceives the above as its inverse demand and maximizes profits at:

\[ A - 4bq_2^M - bq_1^R = c, \quad q_2^M = \frac{A - c}{4b} - \frac{1}{4} q_1^R \]

The consequent wholesale and retail prices are:

\[ w_2 = \frac{1}{2} A + \frac{1}{2} c - \frac{1}{2} q_1^R, \quad P = \frac{3}{4} A + \frac{1}{4} c - \frac{3}{4} bq_1^R \]

The vertically integrated firm need only ensure that the combined non-integrated manufacturer and retailer profits are not less than profits available from vertical integration, which yields a symmetric Cournot duopoly. Those combined non-integrated profits are:

\[ \pi_2^R + \pi_2^M = (P - c)q_2^R = \left( \frac{3}{4} A - \frac{3}{4} bq_1^R - \frac{3}{4} c \right) \left( \frac{A - c}{4b} - \frac{1}{4} q_1^R \right) = \frac{3}{16b} (A - bq_1^R - c)^2 \]

so, referring back to the symmetric Cournot firm’s profits, the needed condition is:

\[ \frac{3}{16b} (A - bq_1^R - c)^2 \geq \frac{1}{9} \frac{(A - c)^2}{b}, \quad 27(A - bq_1^R - c)^2 \geq 16(A - c)^2 \]

Making this inequality strict yields the solution:

\[ q_1^R \approx 0.230 \left( \frac{A - c}{b} \right) \]

Such a choice by the vertically integrated firm then yields the following outcomes:
\[ q_2^M = q_2^R \approx 0.192 \left( \frac{A - c}{b} \right), \quad Q \approx 0.422 \left( \frac{A - c}{b} \right) \]

\[ w \approx 0.385A + 0.615c, \quad P \approx 0.578A + 0.422c \]

\[ \pi_1 \approx 0.133 \frac{(A - c)^2}{b}, \quad \pi_2^R \approx 0.037 \frac{(A - c)^2}{b}, \quad \pi_2^M \approx 0.074 \frac{(A - c)^2}{b} \]

These outcomes mirror the qualitative results of OSS. By construction, the non-integrated firms do not make themselves better off by vertically integrating, though they are modestly worse off than before any vertical integration occurred (0.111 < 0.123). The vertically integrated firm receives modestly higher profits than under the case in which no firms are vertically integrated (0.133 > 0.123). Critically, consumers are worst off under this scenario. Compared to the next-worst scenario of duopoly without any vertical integration, industry production is lower (0.422 < 0.444) and prices are higher (0.578A + 0.422c > 0.555A + 0.444c). These results are summarized in Table 1. [Table 1 near here]

**Conclusion**

The argument of how vertical foreclosure can exist as a long-run equilibrium is subtle, and it can be difficult for students to grasp. This subtlety implies that there are sizable benefits from relatively straightforward quantitative examples. In this paper I have made slight compromises with the existing literature in order to make such a quantitative example comparatively accessible. This example is intended to offer a credible story that withstands the traditional Chicago criticism. If complemented with other models behind anticompetitive vertical tactics, it has the potential to give students an even-handed perspective when considering real-world antitrust issues regarding vertical mergers.
Acknowledgments: I think Becca Jorgensen and Mark Tremblay for their valuable feedback. Isabella Mancini provided excellent research assistance.

Declaration of Interest Statement
The Author declares that there is no conflict of interest.
References


Table 1: Comparative Vertically Integrated (V.I.) Equilibrium Results

<table>
<thead>
<tr>
<th></th>
<th>V.I. Cartel</th>
<th>V.I. Duopoly</th>
<th>No V.I. Duopoly</th>
<th>Myopic Partial V.I.</th>
<th>Strategic Partial V.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail price</td>
<td>$0.5A + 0.5c$</td>
<td>$0.3A + 0.6c$</td>
<td>$0.5A + 0.4c$</td>
<td>$0.416A + 0.583c$</td>
<td>$0.578A + 0.422c$</td>
</tr>
<tr>
<td>Market quantity</td>
<td>$0.5\left(\frac{A - c}{b}\right)$</td>
<td>$0.6\left(\frac{A - c}{b}\right)$</td>
<td>$0.4\left(\frac{A - c}{b}\right)$</td>
<td>$0.583\left(\frac{A - c}{b}\right)$</td>
<td>$0.422\left(\frac{A - c}{b}\right)$</td>
</tr>
<tr>
<td>Intermediate price</td>
<td>N/A</td>
<td>N/A</td>
<td>$0.3A + 0.6c$</td>
<td>$0.25A + 0.75c$</td>
<td>$0.385A + 0.615c$</td>
</tr>
<tr>
<td>Market profit</td>
<td>$0.25\frac{(A - c)^2}{b}$</td>
<td>$0.2\frac{(A - c)^2}{b}$</td>
<td>$0.247\frac{(A - c)^2}{b}$</td>
<td>$0.243\frac{(A - c)^2}{b}$</td>
<td>$0.244\frac{(A - c)^2}{b}$</td>
</tr>
<tr>
<td>Firm 1 quantity</td>
<td>$0.25\left(\frac{A - c}{b}\right)$</td>
<td>$0.3\left(\frac{A - c}{b}\right)$</td>
<td>$0.2\left(\frac{A - c}{b}\right)$</td>
<td>$0.416\left(\frac{A - c}{b}\right)$</td>
<td>$0.230\left(\frac{A - c}{b}\right)$</td>
</tr>
<tr>
<td>Firm 2 quantity</td>
<td>$0.25\left(\frac{A - c}{b}\right)$</td>
<td>$0.3\left(\frac{A - c}{b}\right)$</td>
<td>$0.2\left(\frac{A - c}{b}\right)$</td>
<td>$0.16\left(\frac{A - c}{b}\right)$</td>
<td>$0.192\left(\frac{A - c}{b}\right)$</td>
</tr>
<tr>
<td>Retailer 1 profit</td>
<td>$0.125\frac{(A - c)^2}{b}$</td>
<td>$0.1\frac{(A - c)^2}{b}$</td>
<td>$0.049\frac{(A - c)^2}{b}$</td>
<td>$0.174\frac{(A - c)^2}{b}$</td>
<td>$0.133\frac{(A - c)^2}{b}$</td>
</tr>
<tr>
<td>Retailer 2 profit</td>
<td>$0.125\frac{(A - c)^2}{b}$</td>
<td>$0.1\frac{(A - c)^2}{b}$</td>
<td>$0.049\frac{(A - c)^2}{b}$</td>
<td>$0.028\frac{(A - c)^2}{b}$</td>
<td>$0.037\frac{(A - c)^2}{b}$</td>
</tr>
<tr>
<td>Manufacturer 1 profit</td>
<td>N/A</td>
<td>N/A</td>
<td>$0.074\frac{(A - c)^2}{b}$</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Manufacturer 2 profit</td>
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<td>N/A</td>
<td>$0.074\frac{(A - c)^2}{b}$</td>
<td>$0.042\frac{(A - c)^2}{b}$</td>
<td>$0.074\frac{(A - c)^2}{b}$</td>
</tr>
</tbody>
</table>

Notes: In cases of asymmetric vertical integration, Firm 1 is assumed to be the vertically integrated firm. When a firm is vertically integrated, firm-specific outcomes appear in Retailer rows.