Asymmetries, Simulation and the Assessment of Input Foreclosure in Vertical Mergers

Jeffrey Church*

Department of Economics, University of Calgary

Adrian Majumdar

Centre for Competition Policy, University of East Anglia and RBB Economics LLP

Markus Baldauf

Department of Economics, Stanford University

June 9, 2011

Version 8

Abstract

This paper considers the competitive effects of vertical mergers in theory and in practice, with a focus on input foreclosure. Our aims are two fold. First, we extend the extant literature to consider substantial asymmetries in parameter specifications and find that vertical mergers are typically beneficial. Of particular interest is that vertical mergers with "large" downstream shares are unlikely to harm consumers. We note that harmful mergers are more likely where

*Contact Author. Professor of Economics, Department of Economics, University of Calgary, 2500 University Drive, N.W., Calgary, Alberta T2N 1N4, Canada; Email: jrchurch@ucalgary.ca. Telephone: 403-220-6106.

large asymmetries are found between downstream firms. Second, we set out a simulation approach that can be utilized well within the usual time frame of a Phase I assessment and does not require econometric estimation of parameters. We propose a technique that considers literally millions of possible pre- and post-merger outcomes but filters out only those results that are consistent with realistic pre-merger outcomes. We then consider what share of such plausible pre-merger outcomes predict harmful post-merger effects. When used to complement other empirical evidence on the effects of a vertical merger, we consider that this technique could prove valuable in shedding light on the risks of clearing a vertical merger.

Keywords: Vertical Merger, Merger Simulation, Foreclosure

JEL Classification: L12, L41

We thank seminar participants at UEA, the Office of Fair Trading, Bates White Seventh Annual Antitrust Conference, the 2011 Meetings of the Canadian Economic Association, as well as Steve Davies, Tim Hazeldine, Bruce Lyons, and Ralph Winter for comments.

1 Introduction

This paper considers the competitive effects of partial input foreclosure from a vertical merger in light of the recently published European Commission *Non-Horizontal Merger Guidelines* (NHMGs).[1] We consider a stylized scenario where pre-merger there are two upstream firms that produce a homogenous input which is sold to two differentiated downstream firms. All firms are non-integrated prior to the merger, which brings together an upstream and a downstream firm. Our focus is on the scope for harm to consumers that may arise from partial input foreclosure. Partial input foreclosure arises when the integrated firm continues to participate in the input market. Even though it continues to participate in the input market (unlike in the case of complete foreclosure), its incentives to participate are changed by the vertical merger. It will recognize an additional benefit of reducing supply is an increase in profits downstream from raising the costs of its rivals.

A prominent competition policy concern with vertical mergers is the potential that the incentives to compete of the upstream division of a vertically integrated firm will be less than when it was an independent firm. The upstream division will have an incentive to compete less vigorously since doing so raises upstream prices and hence the costs of its downstream rivals. Input foreclosure results if the denial or reduction of supply by the integrated firm leads to higher prices in the upstream market.[2]

We note that the term "foreclosure" often has harmful connotations. However, we emphasize that "foreclosure" need not be harmful, at least as defined in this paper. We follow the distinction made by the Commission in its NHMGs between "foreclosure" (which may benefit consumers) and "anticompetitive foreclosure" (where consumers are harmed).[3] This perspective means that

[1] See *Guidelines on the Assessment of Non-Horizontal Mergers under the Council Regulation on the Control of Concentrations between Undertakings*. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52008XC1018(03):EN:NOT

[2] See Salinger (1988).

[3] See NHMGs at paragraphs 16, 18, and 29 which distinguish between impacts in the upstream market (not sufficient to harm consumers) and harm in the downstream market as a requirement for anticompetitive foreclosure. Paragraphs 18 and 29 emphasize that foreclosure is anticompetitive only if it results in an increase in prices to con-

the competitive impact of a vertical merger depends only on its effect on consumers in downstream markets, not just the effect on the price in upstream markets. This is a critical point—the upstream price may rise for the non-integrated firm but this will not necessarily imply harmful effects as consumers may gain overall. For example, consumers may gain as the price of the integrating firm downstream may fall (as it now acquires the input at marginal cost) and if its unintegrated rivals respond by lowering their prices in spite of their higher costs.

We begin with a review of the relevant theoretical literature in order to develop the intuition for why and when a vertical merger might give rise to anticompetitive foreclosure. A limitation on the results found in the literature is that, for understandable reasons of tractability, the analysis typically considers a setting where demand and costs are symmetric. Since that is not the case with regard to most real world transactions, a model of partial foreclosure when demand and costs are asymmetric is developed in Section 3.

The intuition developed in Section 2 is confirmed by the numerical analysis in Section 4. Section 4 considers millions of possible parameter combinations for the model developed in Section 3. We find that harmful outcomes for consumers are both rare and associated with large asymmetries in the margins and relative prices of downstream firms. In addition, we find that vertical mergers that give rise to anticompetitive foreclosure are much more likely if the integrating firm has a small pre-merger market share downstream.

Finally, we explain how our approach is easily adapted for utilization within the usual time frame of a Phase I assessment.[4] We argue that the range of pre-merger outcomes can be narrowed down sensibly to focus on a plausible range of outcomes for the following variables:

- the market share and margins for the downstream integrating firm and its rival;

sumers. Paragraph 16 defines consumers to be the customers in the downstream market to whom the downstream operation of the integrated firm sells.

[4]In Canada, the European Union, and the U.S., transactions that meet certain thresholds must be prenotified to the relevant antitrust enforcement agency (the "Agency"). The Agency then conducts a preliminary or Phase I investigation. The Phase I investigation must be completed relatively quickly.

- the share of the input in total downstream costs for both firms; and
- relative prices of the downstream firms.

The preceding variables should be observable pre-merger for an Agency with information gathering powers and may be known with reasonable accuracy by merging firms and their rivals. We find that filtering pre-merger outcomes based on these criteria allows for an extremely rich but manageable sensitivity analysis. Millions of possible parameter combinations can be tested yet only a relatively small subset will give rise to pre-merger outcomes that pass all of the relevant selection criteria. The filtered set give rise to a set of post-merger predictions based on realistic pre-merger outcomes. The set of post-merger outcomes from the filtered set can then be used to identify the potential for the transaction to harm consumers. First, some prospect for the transaction to harm consumers can be inferred from the number of outcomes that indicate harm. Second, the harmful outcomes can be parsed to consider the extent of harm and the consistency of the circumstances required with facts of the industry.

Of course, the approach is subject to the critique that the chosen theoretical model could be wrong. We acknowledge this and so would expect that the simulation technique would be useful as a complement to other empirical evidence and should not be decisive in its own right. Nonetheless, we note the following:

- The approach is flexible to the use of other theoretical models. In principle, the sensitivity analysis could vary not only parameters of an existing model but competing theoretical models.
- The NHMGs point to many factors that need to be taken into account when understanding the effect of input foreclosure, these include market power and market share up and downstream, the share of input in total costs, margins up and downstream, the extent of diversion of demand downstream from unintegrated rivals to the integrated firm, and the effect of transaction specific efficiencies, in particular the internalization of double marginalization.

Competition authorities would usually require assumptions on these variables to be internally consistent and this is likely to require the use of a theoretical model of the vertical structure and a comparison of pre and post transaction equilibria. This implies that assuming functional forms will be unavoidable. An equilibrium model is required to integrate and consider all of the effects of a vertical transaction and this requires assuming functional forms.[5]

Section 4 includes an example of how our approach might be utilized. Unlike unilateral effects analysis involving merger simulation for a horizontal merger—which often involves estimate first and simulate second—our approach is instead to simulate first and filtrate second.

2 What Do We Know About Input Foreclosure?

The literature on the potential for a vertical merger to result in input foreclosure that raises the costs of rivals and harms consumers distinguishes between partial and complete foreclosure. The difference between complete and partial foreclosure is that in the case of complete foreclosure the integrated firm does not participate in the upstream market, whereas in the case of partial foreclosure it continues to supply its downstream rivals, but does so at a higher price. The relevant literature is the relatively recent contributions that consider the effects of a vertical merger when there is imperfect competition upstream and downstream pre-transaction.[6]

When there is imperfect competition upstream pre-merger that results in prices being set above marginal cost, the effect of a vertical merger is to introduce a cost asymmetry between the inte-

[5] In some cases, it will be clear that there is no ability or incentive to engage in input foreclosure. However, where the answer is not so clear, theoretical modeling will likely be an important to guide the analyst.

[6] For a recent review of both this literature and the older literature associated with the Chicago school that assumed monopoly upstream, see Church (2008), which we follow in this discussion. Note that an important consideration in our discussion and analysis is double marginalization pre-transaction. This means that we consider situations where market power is exercised pre-transaction. This distinguishes our approach from those such as Ordover, Saloner, and Salop (1990) where Bertrand pricing by suppliers of a homogeneous input implies marginal cost pricing in the absence of a vertical merger.

grated firm downstream and its unintegrated downstream rivals. The downstream marginal cost of the integrated firm will be reduced because of the elimination of double marginalization: the firm now has access to the upstream input at marginal cost. How much of a cost advantage the integrated firm has relative to its unintegrated rivals depends on (a) the change in the upstream price (which may rise or fall) and (b) the importance of the input in question (i.e., whether it constitutes a large or small share of variable costs). The change in the upstream price depends on whether the integrated firm no longer participates in the upstream market, that is, whether the integrated firm no longer supplies what are now competing downstream firms.

2.1 Complete Foreclosure

If the integrated firm withdraws from the upstream market, the interplay of three effects determines whether the price of the input rises for the unintegrated firms in the downstream market. First, the withdrawal of the integrated firm's upstream division reduces competition upstream, raising the market power of the remaining input suppliers. This "supply effect" puts upward pressure on the input price. Second, the withdrawal of the integrated firm's downstream division reduces demand for the input. Third, there is an induced fall in demand for the upstream input as well. The cost advantage of the integrated firm provides it with a competitive advantage downstream that translates into an increase in its quantity sold and a decrease in the quantity sold by its unintegrated rivals in the downstream market. These two demand effects put downward pressure on the upstream price. Whether the price of the input paid by unintegrated downstream firms rises or falls depends on whether the supply or demand effects dominate. The supply effect depends on the elasticity of derived demand for the input, the competitiveness of the upstream market, and the ability of unintegrated suppliers to increase their output. The less elastic derived demand, the less competitive upstream supply, and the greater the constraints on the extent to which unintegrated suppliers can increase output, the bigger the supply effect. The demand effects depend on the market share of the integrating downstream firm and changes in the downstream equilibrium from the internaliza-

tion of double marginalization. The greater the extent of double marginalization and the greater the sensitivity of the unintegrated downstream rivals' market share to reductions in cost by the integrated firm the greater the induced fall in demand by rivals.

Even if the upstream price increases, the downstream price might still fall if the output expansion of the integrated firm exceeds—sufficiently—the reduction in output of its unintegrated rivals downstream. Identifying when foreclosure is profitable and anticompetitive is difficult. It depends on the extent to which competition in the downstream market can be harmed. It is more likely that the downstream price will rise if the vertical merger involves the last independent supplier upstream and the exclusion of the unintegrated downstream firms from foreclosure creates a significant increase in market power for the remaining integrated firms. This is more likely the larger the number of downstream firms supplied by the previously unintegrated supplier.

2.1.1 Formal Results in the Literature

Salinger (1988) assumes Cournot competition upstream and Cournot competition downstream. The setting is symmetric: the downstream good is assumed to be homogenous and all firms have the same cost function. Church (2006) is similar to Salinger in that the downstream product is homogenous, but he assumes only two firms upstream, with one high cost and one low cost. Häckner (2003) also adopts a similar framework to Salinger, except that competition downstream is over price and the downstream products are differentiated. Again the setting is symmetric: all firms have the same cost function and the size of the market and own price elasticities are assumed to be the same across the downstream brands. Reiffen and Vita (1995) is similar to Häckner (2003) but with just two firms up and downstream.

Salinger demonstrates that for the downstream price to rise, the number of downstream firms must be sufficiently larger than the number of upstream firms and more than half of the upstream firms must already be integrated. The larger the number of unintegrated downstream firms, the greater the effectiveness of raising their costs in creating market power downstream. Church demonstrates that the downstream price falls, regardless of whether the vertical merger involves

the high cost or low cost upstream firm.

Häckner considers the effects of the creation by vertical merger of a single vertically integrated firm that can commit not to participate in the upstream market. He shows that a vertical merger harms consumers only if the number of downstream firms exceeds the number of upstream firms (as with Salinger) and the products downstream are sufficiently differentiated. The extent of the critical value of differentiation is increasing in the number of downstream firms and decreasing in the number of upstream firms.

Reiffen and Vita show that the effect of a vertical merger on the upstream price depends on how substitutable the downstream products are. If they are close substitutes, then the demand effect will dominate, and the upstream price will fall. The price of the unintegrated product downstream might rise or fall—it will fall if the price of the upstream input decreases and it might fall even if the price of the upstream input rises. However, Reiffen and Vita demonstrate that the sum of the downstream prices must fall, indicating that consumers will be better off with a vertical merger since they will be able to replicate their premerger consumption with less expenditure.

2.2 Partial Foreclosure

A key issue in assessing the welfare effects of a vertical merger is the credibility of non-participation by any and all of the integrated firms in the upstream market. An integrated firm will find it profitable to sell to downstream firms, rather than relinquish those sales to its unintegrated upstream competitors. Given that sales to unintegrated downstream firms are going to occur, the integrated firm would like to make them.

However that is not the same as saying that the incentives to participate in the upstream market by the integrated firm are unchanged post-merger. Instead the integrated firm will recognize that there is a link between the upstream price and the costs of its unintegrated rivals downstream. It will therefore internalize the effect that reducing supply in the upstream market will raise the price of the input, raising the costs of its downstream unintegrated rivals, thereby reducing the output (or

raising the price) and weakening the competitive constraint of its rivals in the downstream market. The raising rivals' cost effect may be sufficiently profitable that the integrated firm may engage in strategic purchasing. It engages in strategic purchasing when it becomes a net buyer in the upstream market, buying units of the input at a wholesale price above its cost of production.

Relative to the case of complete foreclosure, participation by integrated firms in the upstream market is almost certain to result in an increase in upstream output—either because they are buyers of the input or because they find it profitable to supply it. In either case, total production of the input rises and, hence so too does downstream output. Hence relative to the case of complete foreclosure it is less likely that partial foreclosure will be anticompetitive.

The intuition is the same as in the complete foreclosure case, only the supply effect is less. The analysis of the partial foreclosure case highlights the importance of distinguishing between the effects of the vertical merger on the incentives of the integrated firm and the equilibrium outcome. A "first-order approach" would infer an increase in the upstream price by simply looking at how the incentives of the integrated firm change as a result of the merger. However, while necessary, this is not enough to infer either an increase in the input price or the price downstream.

Consideration of the effect of the vertical merger on these two prices requires an assessment of the new equilibrium post merger. This involves determining how the vertical merger changes the incentives and behavior of the integrated firm in the downstream market and how other firms will respond to its change in behavior. In particular, the integrated firm has an incentive to increase its output in the downstream market, an incentive that arises from the internalization of double marginalization. In response, its downstream rivals may well reduce their downstream output, further reducing demand for the input with the net impact that the input price falls because the demand effects exceed the supply effects. Or alternatively even though the price of the input rises, the downstream rivals respond to lower prices by the integrated firm by lowering their prices. In other words, despite the indications of a first-order approach, the result of a vertical merger could be lower prices both up and downstream.

2.2.1 Formal Results in the Literature

The formal work found in the literature assumes symmetry in costs and either an homogenous product downstream or symmetric differentiated products downstream. Competition upstream is typically Cournot, corresponding to upstream market power pre-merger. Competition downstream is over price if the downstream products are differentiated and Cournot if the downstream good is homogenous. Gaudet and Long (1996) and Higgins (1999) consider a situation identical to Salinger, but do not assume complete foreclosure. Gilbert and Hastings (2001) consider a situation similar to Reiffen and Vita (1995), except that foreclosure is not complete. The results from the work involving an homogenous product and Cournot competition downstream show that the effects of a vertical merger are beneficial to consumers. Gilbert and Hastings also demonstrate that vertical integration reduces the upstream price, and hence the price of both goods downstream falls, enhancing the welfare of consumers.

2.3 Implications for Understanding the Effects of Vertical Mergers with Asymmetries

In the case of partial foreclosure the literature finds that a vertical merger always enhances the welfare of consumers. However, the literature considers only symmetric cases. In symmetric cases, the literature suggests that the output expansion effects from the internalization of double marginalization exceed any raising rivals' cost effect (to the extent that rivals' costs are raised at all).

On the basis of that literature, however, it is possible to develop some guidance regarding the effects of a vertical merger in asymmetric cases. The two effects of relevance will continue to be the extent to which the costs of the integrating firm are reduced from internalizing double marginalization and the potential and magnitude for raising rivals' costs. The potential for raising rivals' costs will depend on whether the input price rises (which will depend on the relative magnitude of the supply and demand effects) and the significance of that price increase on costs in the down-

stream market. The interaction of these two effects determines the effect on downstream prices. The outcome of the interaction will depend on the extent to which the cost changes (potentially up for unintegrated firms, down for the integrating firm) are passed through and the equilibrium response of all firms.

Figure 1 shows how the two effects play out in a downstream duopoly with differentiated products and Bertrand competition. The figure shows the pre-merger best response functions for the two firms $p_i = R_i(p_j)$ and the pre-merger equilibrium at *E*. Assume firm 1 integrates. Then the post merger best response functions are $p_i = \hat{R}_i(p_j)$. The best-response of firm 1 shifts left, reflecting that its costs have been reduced by the elimination of the mark up on the input. If this was the only effect the new equilibrium would be at *B*, with lower prices for both downstream firms, with the extent of the lower prices determined by the size of the shift in firm 1's best response function (from the reduction in its costs) and the slope of firm 2's best response function. However, if there is a raising rivals' cost effect, the cost of firm 2 increases and its best response function shifts up. This puts upward pressure on both prices (relative to *B*). The post transaction equilibrium could be at $\hat{E}_1$, $\hat{E}_2$, or $\hat{E}_3$ depending on the shift in R_2 and the slope of $\hat{R}_1$. Ceteris paribus, a small increase in costs might still mean lower downstream prices ($\hat{E}_1$), a larger shift an increase only in the price of the unintegrated rival ($\hat{E}_2$), or a much larger shift that results in higher prices for both products ($\hat{E}_3$).

The cost reduction from internalizing double marginalization depends on the size of the markup pre-merger, which depends on competitiveness of the upstream market pre-merger. The extent to which costs are raised depends on whether the input price increases and the cost share of the input in total costs. The effect on the input price depends on the relative magnitude of the supply and demand effects. The supply effect depends on the degree of competition upstream that remains post-merger and the elasticity of derived demand for the input. The latter depends on the degree to which unintegrated downstream firms can profitably pass on higher costs. This will typically be increasing in the unintegrated downstream firm's relative advantages over the product of the integrated downstream good: the greater the market size of the unintegrated firm, the lower its

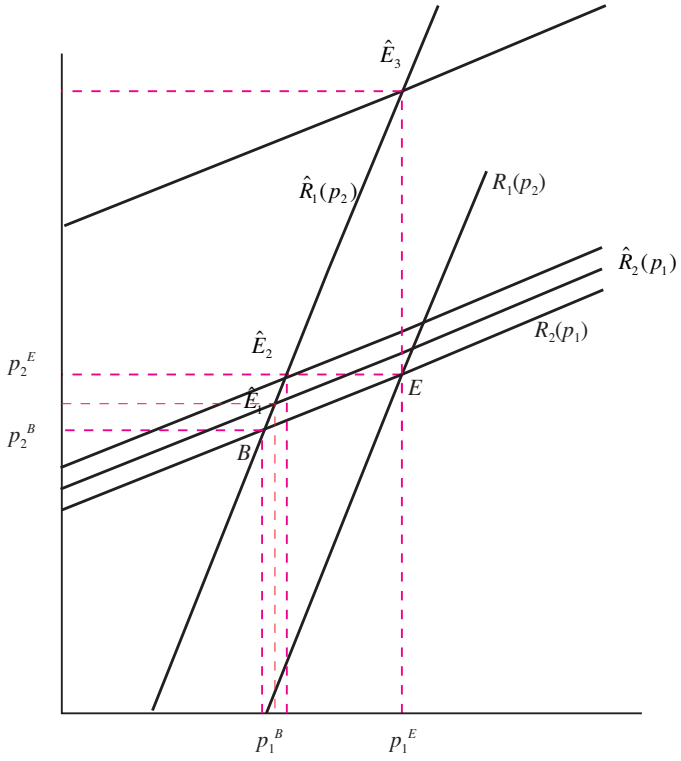

Figure 1: Downstream Impact of RRC and Internalizing Double Marginalization

downstream marginal cost, and the more inelastic its demand. The latter factors would also tend to give the unintegrated downstream firm a larger market share and higher margins.

Recall that there are two demand effects. The reduction in demand in the upstream market by the integrating firm will depend on its market share downstream. The pre-merger market share of the integrated firm will typically be increasing in its relative advantage vis-a-vis its rival: lower marginal cost, larger market size, and the smaller its elasticity of demand. The potential for input demand to fall because of the competitive response by unintegrated downstream firms depends on the slope of their best response functions downstream. These are determined by the interaction of the responsiveness of demand to own and rival prices. The more sensitive the market share of the unintegrated rival to the fall in price by the integrated rival, the greater the induced demand effect. The induced demand effect is reduced if the downstream products are relatively differentiated and demand inelastic.

In the symmetric case the internalization of double marginalization is sufficiently strong that even if the supply effect exceeds the demand effects and the upstream price rises, the downstream price falls. If there are asymmetries, however, it is possible that the raising rivals' cost impact, when it occurs, may dominate the effect of internalizing double marginalization.

Our model below confirms the strong presumption in the literature that when pre-merger outcomes are largely symmetric, harmful mergers rarely arise. Moreover, our model (consistent with the preceding intuition from the existing literature) indicates that large asymmetries are necessary—but by no means sufficient—for a vertical merger to result in anticompetitive foreclosure. The nature of the asymmetry for a vertical merger to result in anticompetitive foreclosure, however, is surprising. Our model indicates that to the limited extent that harmful mergers could arise, anticompetitive effects are far more likely to be associated with integration by a *small* downstream player rather than the market leader, pre-merger margins in the upstream market are low, and the margins of the unintegrated downstream firm relatively high.

The intuition is as follows. Where the merging firm has a relatively small market share, the own (from its withdrawal from the upstream market) and induced demand effects will be small,

and the raising rivals' costs affects a larger share of the market. When the upstream market is relatively competitive pre-merger, the upstream price-cost margins will be relatively low and the scope for cost reduction form the internalization of double marginalization constrained. Moreover, the raising rivals' cost effect will be enhanced the more inelastic derived demand. When production downstream is fixed proportions, the elasticity of derived demand is determined by the share of the input in costs and the elasticity of downstream demand.[7] If the margin pre-merger of the unintegrated rival is relatively large, its demand must be relatively inelastic and so too is its derived demand for the input. In these circumstances not only will the supply effect be more significant, but the unintegrated rival will be able to more easily pass through cost increases to final consumers.

In the next section we develop a model that allows for a very wide range of asymmetries in downstream market size, marginal costs, and own- and cross- price elasticities. To add yet more flexibility, rather than model competition upstream as Cournot, we model competition upstream using conjectural variations. This allows us to vary the extent of rivalry upstream to reflect that margins upstream might be smaller than would be expected if competition was Cournot. Simulations with this model confirm the intuition in the previous paragraphs and support the proposition that integration between the market leader downstream and a supplier upstream will not result in anticompetitive foreclosure.

3 A Model of Partial Foreclosure

3.1 Assumptions

We assume a representative consumer with quadratic *indirect* utility function:

$$V(m, p_i, p_j) = m - \alpha_1 p_1 - \alpha_2 p_2 + (1/2)(\beta_1 p_1^2 + \beta_2 p_2^2) - \gamma p_1 p_2 \tag{3.1}$$

[7] Assuming, as we will, that the elasticity of supply of other inputs is perfectly elastic, consistent with a constant unit cost per unit of downstream output for all other inputs required for production downstream.

defined over income (*m*) and the prices of the two differentiated goods (p_1 and p_2). The market downstream is assumed to be a differentiated duopoly. Using Roy's identity the demand for each brand *i* is linear and given by

$$q_i(p) = \alpha_i - \beta_i p_i + \gamma p_j.^{8} \tag{3.2}$$

The parameter α_i measures the market size of product *i*: the bigger α_i the bigger the market for *i*. The parameter β_i reflects own price responsiveness: the bigger it is the more elastic demand for *i*. Finally, the larger γ the greater the extent to which the two brands are substitutes.

Production downstream is assumed to be fixed proportions, with cost function

$$\lambda_i = w + c_i. \tag{3.3}$$

where *w* is the price of the input and c_i the costs to firm *i* of other components used to produce the downstream good.

Upstream there is a duopoly in the production of the input.[9] The marginal cost of each firm is normalized to zero and the intensity of competition between the two is measured by the symmetric conjectural variation parameter denoted by ϕ . The conjectural variation parameter is the response of firm *j* expected by firm *i* when *i* increases its output. It varies between -1 and 1. If it is -1, then the model nests Bertrand competition and the pre-merger price equals marginal cost. If it is 1, the two firms act like a monopolist and maximize industry profits. A value of 0 corresponds to

[8]The assumption of differentiated products seems natural in many industries but would have to be verified against the case in hand. For analytical tractability, the integrating firm's rivals are treated as a single competitor. This means that it is assumed that the integrating firm can raise the costs for *all* rivals. In practice, however, some rivals may be protected from increases in the input price (e.g., through long-term supply contracts). In this case, partial foreclosure is less likely to raise rivals' costs and so our simplifying assumption might over-state the case for partial foreclosure. We find it easier to work with the dual of the quadratic utility function. Of course the representation is identical with an appropriate change in variables.

[9]In principle we could include more competing suppliers. Modeling increased upstream competition would make partial foreclosure less likely to harm consumers since it would constrain the scope for *w* to rise: the supply effect of the vertical merger would be less.

Cournot behavior. Hence ϕ can be used as a measure of rivalry in the upstream market, with the intensity of competition decreasing as ϕ increases from -1 to 1.

The use of conjectural variations to model oligopoly interaction has come under harsh criticism.[10] A focus of the critique is that it is an attempt to shoehorn dynamic considerations into a static modeling framework. Our use here is similar to its use in the New Empirical Industrial Organization: it is used as a means to summarize the "competitiveness" of the outcome of a dynamic game without having to model the supergame played by the two suppliers. The application of the model to screen for relevant outcomes involves matching observables pre-merger (market share, margins, relative prices) to primitives. The use of conjectural variations allows the model to generate positive margins without imposing Cournot competition on the upstream market. More or less competitive interaction than Cournot may be required to generate realistic outcomes that match pre-merger observables.

3.2 Downstream Equilibrium

The profits of downstream firm *i* are

$$\pi_i = (p_i - c_i - w)q_i(p). \tag{3.4}$$

The best response function for firm *i* is

$$p_i(p_j) = \frac{\alpha_i + \gamma p_j + \beta_i(c_i + w)}{2\beta_i}. \tag{3.5}$$

The slope of the best-response function is $\gamma/(2\beta_i)$. The more substitutable the two products (as measured by γ) and the more inelastic demand (smaller β_i) the greater the price increase of firm *i* from an increase in the price of firm *j*. The "first-order" pass-through from a change in marginal costs to the profit-maximizing price is constant and equal to $1/2$.[11]

[10] See Shapiro (1989) or Church and Ware (2000).

[11] The equilibrium pass-through depends on the response by its rival.

The downstream Bertrand-Nash equilibrium prices are:

$$p_i = \frac{2\beta_j\alpha_i + \gamma\alpha_j + \gamma(w + c_j)\beta_j + 2\beta_i\beta_j(w + c_i)}{4\beta_i\beta_j - \gamma^2} \tag{3.6}$$

where stability requires $4\beta_i\beta_j - \gamma^2 > 0$ and is implied by the second order conditions for utility maximization. Substituting the equilibrium prices into the demand functions (3.2) gives equilibrium output downstream as a function of the upstream input price *w*. Since they are algebraically extensive we denote them in implicit form as $q_1(w)$ and $q_2(w)$.

3.3 Equilibrium Pass-Through

The downstream Nash equilibrium in prices is defined by the two equations given by (3.5). Totally differentiating this system of equations we can find the effect in equilibrium of changes in the cost of either firm on prices. The effect on p_i of changes in upstream costs is

$$dp_i = \frac{2\beta_i\beta_j d(c_i + w) + \beta_j\gamma d(c_j + w)}{4\beta_i\beta_j - \gamma^2}. \tag{3.7}$$

The effect of a vertical merger involving firm *i* on costs is to reduce $c_i + w$ to c_i so that $d(c_i + w) = -w$ and to raise the costs of firm *j* by dw. As a result the equilibrium effect on p_i of the vertical merger is

$$dp_i = \frac{-2\beta_i\beta_j w + \beta_j\gamma dw}{4\beta_i\beta_j - \gamma^2}. \tag{3.8}$$

For the vertical merger to result in an increase in p_2 (in equilibrium) requires, from (3.8),

$$\frac{dw}{w} > \frac{\gamma}{2\beta_2} \tag{3.9}$$

and for p_1,

$$\frac{\gamma}{2\beta_1} > \frac{w}{dw}. \tag{3.10}$$

Examination of (3.9) and (3.10) suggests the following:[12]

[12]These are only suggestive since they assume that w and dw are independent of the downstream demand parameters.

- The smaller the pre-merger upstream price (w), the more likely the vertical merger results in higher prices downstream since the reduction in the integrated firm's costs from internalizing double marginalization will be smaller.

- The larger the increase in the price for firm 2 (dw), the more likely the vertical merger results in higher prices downstream.

- The smaller β_1 and the larger γ the more likely p_1 rises when there is a vertical merger involving firm 1 (response of p_1 to a change in p_2 is greater).

- The greater β_2 and the smaller γ the more likely p_2 rises when there is a vertical merger involving firm 1 (the response of p_2 to the decrease in p_1 is smaller).

Of some interest is that the direction of the cross-price elasticity and own price elasticity are different. The more elastic demand for good two and the lower the cross price elasticity the more likely the price for good two will increase. The less elastic good one and the greater the cross price elasticity the more likely the price for good one will increase.

3.4 Vertical Separation

3.4.1 Downstream Equilibrium

Because production downstream is fixed proportions, demand for the input (X) equals total demand for the downstream good. In the vertical separation case this means

$$X(w) = q_1(w) + q_2(w). \tag{3.11}$$

We invert (3.11) to find the inverse demand function for the upstream input:

$$w(X) = A - sX \tag{3.12}$$

where $X = \sum_{i=1}^{2} x_i$ is the total supply of the input by the two competitors upstream (x_i is the supply of upstream firm *i*). Inverse demand is linear, with the parameters A and s complicated functions of the five demand parameters and two marginal cost parameters.

3.4.2 Upstream Equilibrium

The profits of upstream input supplier *i* are

$$\pi_i = w(X)x_i. \tag{3.13}$$

The perceived marginal revenue of firm *i* is

$$MR_i(x_i) = w + \frac{\partial w}{\partial X}[1+\phi]x_i. \tag{3.14}$$

In a conjectural variation equilibrium, firm *i* sets its perceived marginal revenue equal to its marginal cost:

$$w + \frac{\partial w}{\partial X}[1+\phi]x_i = 0. \tag{3.15}$$

In the conjectural variations equilibrium, (3.15) must hold for both firms. The equilibrium output for each firm is

$$x = \frac{A}{s[3+\phi]} \tag{3.16}$$

and total output is

$$X = \frac{2A}{s[3+\phi]} \tag{3.17}$$

Substituting (3.17) back into (3.12) gives the equilibrium upstream price,

$$w = \frac{(1+\phi)A}{[3+\phi]} \tag{3.18}$$

from which the downstream prices and quantities can be determined. The equilibrium price upstream depends on the intensity of competition (ϕ) and, via A, the exogenous demand parameters and downstream costs.

3.5 Vertical Integration

Assume downstream firm 1 and upstream firm 1 merge.[13]

[13] We assume the other firm to be unintegrated. If we moved beyond the 2x2 framework, we expect that the presence of a second vertically integrated firm in the market would reduce the incentive for the integrating firm to reduce its

3.5.1 Downstream Equilibrium

The functional dependence of the downstream equilibrium prices and quantities on *w* is unaffected by integration and so the equilibrium expressions for prices as a function of *w* continue to be given by (3.6) with the important difference that the marginal cost for firm 1 is now c_1 (instead of $c_1 + w$). Demand downstream for the input equals the derived demand of firm 2 plus any purchases of the input by firm 1 (x_1^b):

$$\hat{X}(w) = x_1^b + \hat{q}_2(w). \tag{3.19}$$

Because firm 1's costs have been reduced by w, demand for the input by the unintegrated rival is less. In (3.19)

$$\hat{q}_2(w) = q_2(w) - w\beta_1\beta_2\gamma(4\beta_1\beta_2 - \gamma^2)^{-1}. \tag{3.20}$$

In (3.20), the second term on the right hand side reflects the reduction in q_2, and hence demand for the input from the unintegrated rival, when the cost of the integrated firm downstream is reduced by w.

Supply of the input in the upstream market is

$$X = \sum_{i=1}^{2} x_i^s$$

where x_i^s is the supply of upstream firm *i*. In equilibrium

$$\hat{q}_2(w) + x_1^b = x_1^s + x_2^s \tag{3.21}$$

or

$$\hat{q}_2(w) = x_1 + x_2 = X \tag{3.22}$$

supply upstream. First, as the extent of competition increases upstream, the ability to raise rivals' costs decreases. Second, as the number of integrated firms increase, holding the number of downstream firms constant, the number of unintegrated rivals subject to double marginalization and any raising rivals' cost activities of the integrated firms declines.

where x_i equals the net supply of firm *i* ($x_i^s - x_i^b$). Note that this allows for the possibility that the integrated firm might purchase from the non-integrated upstream firm (i.e., x_1 can be negative).

The total net supply of inputs by the two competitors upstream is $X = x_1 + x_2$. We can invert (3.22) to find the inverse demand function for the upstream input:

$$\hat{w}(X) = \hat{A} - \hat{s}X. \tag{3.23}$$

Inverse demand is linear, with the parameters $\hat{A}$ and $\hat{s}$ complicated functions of the five demand parameters and two marginal cost parameters. Derived demand when there is vertical integration is not the same as under vertical separation: $\hat{A} \neq A$ and $\hat{s} \neq s$ because of the change in the integrated firm's incentive to participate and the induced fall in firm 2's demand.

3.5.2 Upstream Equilibrium

The profits of the unintegrated upstream firm are

$$\pi_2 = \hat{w}(X)x_2. \tag{3.24}$$

The perceived marginal revenue of firm 2 is

$$MR_2(x_2) = \hat{w} + \frac{\partial \hat{w}}{\partial X}[1 + \phi]x_2. \tag{3.25}$$

As in the pre-merger scenario, in a conjectural variation equilibrium, firm 2 sets its perceived marginal revenue equal to its marginal cost

$$\hat{w} + \frac{\partial \hat{w}}{\partial X}[1 + \phi]x_2 = 0. \tag{3.26}$$

We have assumed that the nature of the competition interaction between the two upstream firms is unchanged by the vertical merger. That is, ϕ is not changed by the vertical merger. However, we recognize that the incentives to participate in the upstream market by the integrated firm will have changed.

The profits of the integrated firm are

$$\prod\nolimits_1 = \hat{w}(X)x_1 + \pi_1(\hat{w}). \tag{3.27}$$

When determining its optimal upstream output, the integrated firm will take into account the dependence of *w* on aggregate upstream output X through (3.23) and how changes in *w* will affect its profits downstream. The first term on the right of (3.27) is the profit of the integrated firm upstream, the second term on the right of (3.27) its profits downstream.

Firm 1's optimal output is found by maximizing (3.27) under the assumption that firm 1's conjecture regarding the response by firm 2 to a change in output by firm 1 is given by ϕ. The condition is

$$[\frac{\partial \pi_1}{\partial \hat{w}} + x_1]\frac{\partial \hat{w}}{\partial X}[1+\phi] + \hat{w} = 0. \tag{3.28}$$

The incentives of the integrated firm differ from its unintegrated rival. Comparing (3.26) to (3.28), (3.28) has the following extra term:

$$\frac{\partial \pi_1}{\partial \hat{w}}\frac{\partial \hat{w}}{\partial X}[1+\phi]. \tag{3.29}$$

This term reflects that changes in x_1 change $\hat{w}$ and the integrated firm's downstream profit. The effect on downstream profit (using the envelope theorem) is

$$\frac{\partial \pi_1}{\partial \hat{w}} = (p_1 - c_1)\frac{\partial q_1}{\partial p_2}\frac{\partial p_2}{\partial \hat{w}} > 0. \tag{3.30}$$

This reflects the profits of extra sales firm 1 makes if the price of brand 2 rises. The larger the increase in p_2, the greater the diversion of sales to brand 1, and the greater firm 1's margin, the greater the incentive to reduce upstream supply for firm 1.

The upstream equilibrium is solved numerically. It is found by solving (3.26) and (3.28) simultaneously for x_1 and x_2 , recognizing that $\hat{w}$ is given by (3.23) and $\pi_1(\hat{w}) = p_1(\hat{w})q_1(\hat{w})$.[14]

4 Simulation Results

In this section we report the predicted results of a vertical merger in our 2x2 market structure. Our approach is as follows. First we simulate until we identify 100,000 cases for which the vertical

[14]It is actually possible to solve for reduced form solutions for x_1 and x_2. The expressions, however, are very complicated functions of the five demand parameters, the conjectural variation parameter, and the two marginal cost parameters.

merger is profitable. This means that the sum of the profits of the upstream supplier and the downstream firm prior to the merger are less than the profits of the integrated firm post-transaction.[15] For these 100,000 cases we identify sets of parameters for which the vertical merger harms consumers and develop some intuition for the circumstances under which a vertical merger raises concerns. Second we "filter" these negative cases by identifying pre-merger outcomes that match or are reasonable for a hypothetical transaction. That is, we identify simulations whose pre-merger outcomes match a subset of industry observables. From this filtered set we can then test whether the cases where welfare is harmed by the transaction match other pre-transaction observables. In particular, we can focus on relative observables. Relative observables of interest include: market shares, margins, and the input price as a share of average variable cost. Because such relative measures are unit free, they are robust to certain changes in the parameters as we now explain.

4.1 Calibration

We can place bounds on the parameter space over which we simulate because of the following two results.

Proposition 4.1. *(i) If the parameters α_1, α_2, β_1, β_2, and γ are all multiplied by a scalar, $\mu > 0$, then independent of vertical structure $q_i(\mu\Gamma) = \mu q_i(\Gamma)$, $X(\mu\Gamma) = \mu X(\Gamma)$, $p_i(\mu\Gamma) = p_i(\Gamma)$, and $w(\mu\Gamma) = w(\Gamma)$ where $\Gamma = \{\alpha_1, \alpha_2, \beta_1, \beta_2, \gamma)$.*

(ii) If the parameters c_1, c_2, α_1, and α_2 are all multiplied by a scalar, $\lambda > 0$, then independent of vertical structure $q_i(\lambda\Gamma) = \lambda q_i(\Gamma)$, $X(\lambda\Gamma) = \lambda X(\Gamma)$, $p_i(\lambda\Gamma) = \lambda p_i(\Gamma)$, and $w(\lambda\Gamma) = \lambda(\Gamma)$ where $\Gamma = \{c_1, c_2, \alpha_1, \alpha_2)$.

Proposition 4.1 means that for a given value of ϕ (recall that $-1 < \phi \leq 1$), we can consider only values for the parameters c_1, c_2, α_1, α_2, β_1, β_2, and γ in the range $[0, 1]$ without loss of generality. For example, consider an arbitrary combination of parameters, where each has a positive value and

[15] An obvious extension is to consider the profitability of counter-strategies and their implications for the profitability of the initial transaction.

$\max(c_1, c_2, \alpha_1, \alpha_2, \beta_1, \beta_2, \gamma) = k > 1$. By 4.1(i), we can divide α_1, α_2, β_1, β_2, and γ by k without affecting the ratios of interest. If by chance, both $c_1 \leq 1$ and $c_2 \leq 1$ then the parameter values all lie in the range $[0, 1]$. If either $c_1 > 1$ or $c_2 > 1$, then by 4.1(ii) we can divide c_1, c_2, α_1, and α_2 by $\max(c_1, c_2)$. By the proposition the ratios of interest—relative prices and quantities— are unaffected and all the parameter values lie in the range $[0, 1]$.

Our simulation proceeds as follows. First, we draw a value for ϕ from the uniform distribution $U(-0.99, 1)$. Then we draw a value each of c_1, c_2, α_1, α_2, β_1,and β_2, from $U[0, 1]$ (all draws are independent). Finally, γ is drawn from $U[0, x]$ where x is the (positive) value of $2\sqrt{\beta_1\beta_2}$. The latter condition ensures the stability condition is passed.

We simulate until we obtain 100,000 results that pass the following conditions:

- The pre-merger market share of the downstream firms are both positive.
- The pre-merger margins of the two downstream firms lie in the range 0%-100%.
- Pre-merger values for prices (both downstream and upstream) are positive.
- Integration is profitable (the integrated firm's profits exceed the sum of the profits earned by its component parts prior to integration).
- Post-merger quantities and prices up and downstream are positive.
- Second order conditions for profit maximization are satisfied.
- Derived demand slopes down.

For any simulation that meets the conditions set out above, we also record whether consumers gain or lose as a result of the merger. That is, the transaction benefits (harm) consumers if (3.1) rises (falls) from the transaction.

4.2 Results

Our results are set out in Table 1. We partition the results by the pre-merger downstream market share of the integrating firm and the intensity of competition upstream. A partition is a market share quintile and one of the following ranges for ϕ: -0.99 to -0.5, -0.5 to -0.1, -0.1 to 0.1, 0.10 to 0.5, and 0.5 to 1. The middle partition approximates Cournot conduct upstream pre-merger. Table 1 shows the number of cases defined by firm 1's (the integrating firm) pre-merger market share and ϕ for which the merger was profitable and the number of those cases for which consumer welfare rose or fell. It shows the median parameter values and pre-merger equilibrium values for each partition. Relative α, β, exogenous cost, and price are the ratio of the value for firm 1 to firm 2, i.e., relative price is the ratio of the pre-merger prices (p_1/p_2). The share and margin differences equal firm 1's margin or share minus firm 2's margin ($m_1 - m_2$) or share ($s_1 - s_2$) respectively.

The following points stand out from the results in Table 1:

- The percentage of profitable vertical mergers which benefit consumers exceeds 82%.
- While vertical mergers are typically good for consumers, they need not always be. Just over 17% of the 100,000 profitable vertical mergers reduce consumer welfare.
- Harmful vertical mergers arise more often when the downstream pre-merger market share of the integrating firm is smaller. In almost 88% of the harmful mergers the pre-merger market share of the integrating firm is less than 60%; for two-thirds the pre-merger market share is less than 40%; and for slightly more than 36%, the pre-merger market share is less than 20%.
- Comparing the median parameter values in all categories between the instances when consumer welfare rises and falls, the median values for γ and the ratio of β_1 to β_2 are markedly different. The median value when consumer welfare falls for γ is much less than the value for when consumer welfare rises. Similarly the ratio of β_1 to β_2 is much greater for the cases when consumer welfare falls than when it rises. These differences are reflected in much

more unfavourable margin differences and lower relative prices for firm 1 in cases where consumer welfare is harmed compared to when it rises and relatively differentiated products downstream.

- The more competitive the upstream market, the more likely consumer welfare is to be harmed by the transaction. The gains from internalizing double marginalization are reduced.

Table 1 also suggests two comparative static results. Raising the pre-merger market share of the integrating firm or decreasing the extent of competition upstream increase the benefits of internalizing double marginalization: the decrease in cost is larger and applied to more downstream output. For the vertical merger to then result in a decrease in consumer welfare, this benefit must be offset by factors that magnify the raising rivals cost effect. Thus in Table 1 moving down a column or across a row shows that as market share of the integrating firm increases or the extent of competition upstream is reduced, then for consumers to be harmed by the transaction, the extent of differentiation must increase (γ falls), demand for the non-merging firm downstream becomes relatively more inelastic (β_1/β_2 rises), and the share of the input in total costs rises ($w/(w + c_i)$ rises).[16] The result is (typically) a widening of pre-merger margins in favour of firm 2 and lower relative prices.

A set of parameters for each quintile for which consumer welfare falls is shown in Table 2. They all assume Cournot behaviour upstream pre-merger. Either firm 1's market share and/or its margin are relatively small. As its market share grows, its pre-merger margin becomes relatively smaller. The pre-merger market share is increased for firm 1 by increasing its market size (increasing α_1). For welfare to fall as the benefits of double marginalization increase, the margins and share in cost of the input for firm 2 must rise. This occurs by making both demand downstream and derived demand for the input more inelastic (both γ and β_2 fall), resulting in increasing margins, cost share, and relative prices for firm 2 pre-merger. For large market shares of the integrating firm pre-merger, brand 2 must be a very inelastic niche product.

[16]For the Cournot case Table 1 does not break out the median values for the cost share.

Finally, the median parameter values for the negative welfare cases by market share quintile are shown in Table 3. The results in Table 3 highlight the importance of inelastic demand for brand 2, increasing competition upstream, and increasing downstream product differentiation as the market share of firm 1 rises for a vertical merger to harm welfare.

4.3 A Hypothetical Merger

In this section we demonstrate how our "simulate and filtrate" approach might be useful in assessing the potential for a vertical merger to harm consumers. The approach involves filtering the set of negative results from the 100,000 simulations to match industry characteristics consistent with the hypothetical transaction. The filter is intended to select negative outcomes that might be relevant to the proposed transaction.

For instance, suppose that the following facts had been established:

- The market share of the integrating firm downstream is between 30 and 50%.
- The margin of the integrating firm downstream is between 30 and 50%.
- The margin of the integrating firm's downstream rivals is between 30 and 50%.
- The share of costs of the input is less than 10%.

Of the 100,000 profitable vertical mergers, only 70 survive the application of these four filters. Of these 70, only 6, or less than 9% involve anticompetitive foreclosure. The parameter values, as well as pre and post transaction market outcomes are shown in Table 4. Four things stand out regarding these negative cases. First, the price of brand 2 is between 2 and almost 5 times higher than the price of brand 1. Second, the extent of upstream competition is very strong, in all cases approaching price taking behaviour. Third, firm 2 has a significant cost disadvantage, again in all cases. Fourth, there are significant margin or market share asymmetries and often both. Either firm 1's market share and/or its margin are relatively small. These results reinforce the observation that large asymmetries are necessary for negative welfare effects. These four results can also be

tested against evidence on relative prices, the competitiveness of the upstream market, market shares, margins, and relative costs downstream. Consideration of the actual values against the requirements for the vertical merger to be harmful casts some light on whether the vertical merger in this case is likely to result in harm to consumers.

Finally, in the negative consumer welfare cases the following are true:

- Total output of the upstream input *rises* in all cases, albeit marginally, from 0.3% to 1.6%.
- The price of brand 1 downstream falls in all cases, from between 0.5% and 2.35%.
- The price of brand 2 downstream rises, but marginally. The largest price increase is 0.85%.

These considerations suggest the net effect on consumer welfare is relatively small and that it would not require substantial non-price efficiencies for total welfare to increase.

5 Conclusion

Both the empirical and theoretical literatures suggest a presumption that vertical mergers are beneficial for consumers.[17] The key policy issue is the identification and prevention of the few vertical mergers that are anticompetitive without casting a chill over beneficial transactions. In this paper we have suggested a method—simulate and filtrate—to quickly identify vertical transactions that warrant further investigation. Our simulation results also indicate that the presumption that vertical mergers benefit consumers is true when the concern is partial foreclosure with asymmetric costs and demand. In the rare cases where we find adverse effects on consumers, our results suggest that vertical mergers are more likely to be harmful when the market share of the integrating firm downstream is small, while margins upstream are also small. Intuitively, low upstream margins imply less scope for efficiency gains in terms of removing double marginalization and a low share for the integrating firm downstream means that efficiencies benefit relatively few consumers.

[17] See Church (2008) for discussion of both.

Harmful effects are also more likely where there are large asymmetries downstream in terms of margins, relative prices and costs. When the relative price, margins and shares of the unintegrated rival downstream are relatively large the raising rivals' cost effect is more likely to dominate the internalization of double marginalization. In this case, any raising rivals' cost effect is strengthened by inelastic demand downstream (which increases pass through) and a wider impact on the downstream market (due to the higher share of the non-integrated firm).

References

[1] Church, J. 2006. *The Impact of Vertical and Conglomerate Mergers on Competition.* Luxembourg: Office for Official Publications of the European Communities.

[2] Church, J. 2008. "Vertical Mergers." *Issues in Competition Law and Policy* Volume 2 ed. W. D. Collins. Chicago: ABA. 1455-1502.

[3] Church, J., and R. Ware. 2000. *Industrial Organization: A Strategic Approach.* San Francisco: McGraw-Hill.

[4] Gaudet, G., and N. V. Long. 1996. "Vertical Integration, Foreclosure, and Profits in the Presence of Double Marginalization." *Journal of Economics and Management Strategy* 5: 409-32.

[5] Gilbert, R., and J. Hastings. 2001. *Vertical Integration in Gasoline Supply: An Empirical Test of Raising Rivals' Costs.* University of California, Berkeley. Mimeo.

[6] Häckner, J. 2003. "Vertical Integration and Competition Policy." *Journal of Regulatory Economics* 24: 213-222.

[7] Higgins, R. S. 1999. "Competitive Vertical Foreclosure." *Managerial and Decision Economics* 20: 229-37.

[8] Ordover, J. A., G. Saloner, and S. C. Salop. 1990. "Equilibrium Vertical Foreclosure." *American Economic Review* 80: 127-142.

[9] Reiffen, D., and M. Vita. 1995. "Comment: Is there New Thinking on Vertical Mergers?" *Antitrust Law Journal* 63: 917-941.

[10] Salinger, M. A. 1988. "Vertical Mergers and Market Foreclosure." *Quarterly Journal of Economics* 103: 345-56.

[11] Shapiro, C. 1989. "Theories of Oligopoly Behaviour." *Handbook of Industrial Organization.* ed. R. Schmalensee and R. D. Willig. Amsterdam: North-Holland. 329-414.

[12] Singh, V., and X. Vives. 1984. "Price and Quantity Competition in a Differentiated Duopoly." *RAND Journal of Economics* 15: 546-554.

Pre-Merger	ϕ	-.99 to -0.50		-0.50 to -0.01		-0.01 to 0.01		0.01 to 0.50		0.5. to 1.00	
Market Share D1	Variable	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises
0 up to 20	# Cases	1,736	872	1,712	1,540	61	95	1,594	2,342	1,393	2,753
	ϕ	-0.745	-0.716	-0.255	-0.226	0.000	0.001	0.256	0.265	0.737	0.753
	γ	0.077	0.228	0.076	0.255	0.109	0.216	0.081	0.233	0.075	0.218
	$s_1 - s_2$	-0.787	-0.724	-0.793	-0.729	-0.799	-0.736	-0.811	-0.747	-0.814	-0.773
	α_1/α_2	0.430	0.220	0.521	0.314	0.584	0.379	0.649	0.488	0.791	0.612
	β_1/β_2	1.790	0.781	2.687	1.122	5.028	1.238	4.238	1.505	6.351	1.640
	$m_1 - m_2$	-0.561	-0.379	-0.574	-0.384	-0.613	-0.374	-0.594	-0.366	-0.634	-0.327
	p_1/p_2	0.475	0.816	0.416	0.719	0.347	0.702	0.365	0.666	0.321	0.686
	c_1/c_2	1.393	1.857	1.295	1.641	1.123	1.547	1.147	1.360	1.011	1.297
	$w/(w+c_1)$	0.168	0.182	0.407	0.464	-	-	0.573	0.620	0.702	0.685
	$w/(w+c_2)$	0.229	0.314	0.492	0.622	-	-	0.614	0.730	0.697	0.762

Table 1: Partition by ϕ, Market Share of D1, and Welfare Effect, Median Parameter Values, Profitable Mergers

Pre-Merger	ϕ	-.99 to -0.50		-0.50 to -0.01		-0.01 to 0.01		0.01 to 0.50		0.5. to 1.00	
Market Share D1	Variable	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises
20 up to 40	# Cases	1,730	3,903	1,421	4,719	49	198	1,259	4,650	930	4,285
	ϕ	-0.747	-0.730	-0.265	-0.252	-0.002	-0.000	0.231	0.248	0.711	0.736
	γ	0.077	0.194	0.076	0.197	0.064	0.183	0.077	0.192	0.072	0.180
	$s_1 - s_2$	-0.403	-0.342	-0.400	-0.359	-0.384	-0.362	-0.414	-0.379	-0.436	-0.390
	α_1/α_2	0.635	0.532	0.768	0.640	0.981	0.803	0.947	0.798	1.136	0.876
	β_1/β_2	4.019	1.066	6.362	1.397	7.475	1.542	10.746	1.516	14.893	1.486
	$m_1 - m_2$	-0.498	-0.243	-0.570	-0.249	-0.615	-0.246	-0.645	-0.221	-0.683	-0.185
	p_1/p_2	0.322	0.804	0.292	0.736	0.276	0.744	0.258	0.745	0.236	0.778
	c_1/c_2	1.091	1.478	1.019	1.253	1.018	1.271	1.015	1.116	0.896	1.059
	$w/(w+c_1)$	0.243	0.256	0.582	0.554	-	-	0.727	0.663	0.820	0.707
	$w/(w+c_2)$	0.264	0.365	0.570	0.639	-	-	0.723	0.707	0.790	0.725

Table 1: Partition by ϕ, Market Share of D1, and Welfare Effect, Median Parameter Values, Profitable Mergers (continued)

Pre-Merger	ϕ	-.99 to -0.50		-0.50 to -0.01		-0.01 to 0.01		0.01 to 0.50		0.5. to 1.00	
Market Share D1	Variable	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises
40 up to 60	# Cases	1,461	8,510	1,149	7,011	32	249	692	5,410	424	4,534
	ϕ	-0.758	-0.750	-0.278	-0.269	-0.000	-0.000	0.227	0.240	0.722	0.739
	γ	0.072	0.171	0.077	0.168	0.069	0.177	0.068	0.170	0.055	0.169
	$s_1 - s_2$	-0.020	0.006	-0.032	-0.001	-0.091	-0.017	-0.041	0.005	-0.042	-0.007
	α_1/α_2	0.923	0.994	1.057	1.059	1.066	1.122	1.319	1.061	1.421	1.067
	β_1/β_2	9.906	1.276	16.926	1.226	23.104	1.156	29.801	1.115	49.356	1.100
	$m_1 - m_2$	-0.447	-0.056	-0.589	-0.042	-0.636	-0.053	-0.681	-0.022	-0.744	-0.016
	p_1/p_2	0.211	0.853	0.197	0.906	0.174	0.946	0.164	0.952	0.128	0.960
	c_1/c_2	0.996	0.981	0.886	0.956	0.680	0.947	0.893	0.951	0.861	0.965
	$w/(w + c_1)$	0.379	0.356	0.729	0.616	-	-	0.818	0.675	0.854	0.704
	$w/(w + c_2)$	0.363	0.361	0.704	0.604	-	-	0.795	0.657	0.833	0.696

Table 1: Partition by ϕ, Market Share of D1, and Welfare Effect, Median Parameter Values, Profitable Mergers (continued)

Pre-Merger	ϕ	-.99 to -0.50		-0.50 to -0.01		-0.01 to 0.01		0.01 to 0.50		0.5. to 1.00	
Market Share D1	Variable	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises
60 up to 80	# Cases	810	5,629	508	5,065	11	210	285	4,543	167	4,054
	ϕ	-0.770	-0.756	-0.266	-0.259	-0.001	-0.001	0.219	0.248	0.722	0.744
	γ	0.068	0.148	0.053	0.143	0.031	0.150	0.046	0.152	0.033	0.153
	$s_1 - s_2$	0.360	0.367	0.356	0.377	0.385	0.375	0.356	0.387	0.329	0.393
	α_1/α_2	1.201	1.847	1.386	1.625	2.527	1.446	1.783	1.389	1.560	1.254
	β_1/β_2	34.314	1.107	65.471	0.880	72.461	0.886	100.861	0.832	156.759	0.836
	$m_1 - m_2$	-0.411	0.198	-0.599	0.215	-0.604	0.198	-0.690	0.188	-0.744	0.159
	p_1/p_2	0.124	1.096	0.104	1.244	0.107	1.150	0.086	1.222	0.062	1.175
	c_1/c_2	0.953	0.696	0.838	0.763	0.848	0.673	0.828	0.804	0.916	0.827
	$w/(w + c_1)$	0.550	0.335	0.837	0.579	-	-	0.870	0.659	0.902	0.701
	$w/(w + c_2)$	0.519	0.249	0.801	0.493	-	-	0.831	0.598	0.881	0.656

Table 1: Partition by ϕ, Market Share of D1, and Welfare Effect, Median Parameter Values, Profitable Mergers (continued)

Pre-Merger	ϕ	-.99 to -0.50		-0.50 to -0.01		-0.01 to 0.01		0.01 to 0.50		0.5. to 1.00	
Market Share D1	Variable	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises	CS Falls	CS Rises
80 up to 100	# Cases	204	2,527	113	2,776	2	114	50	3,033	37	3,148
	ϕ	-0.798	-0.736	-0.307	-0.248	0.006	0.000	0.288	0.260	0.772	0.756
	γ	0.036	0.113	0.023	0.129	0.011	0.134	0.020	0.131	0.013	0.143
	$s_1 - s_2$	0.694	0.757	0.695	0.764	0.856	0.767	0.695	0.778	0.688	0.776
	α_1/α_2	1.210	3.465	1.802	2.435	0.675	2.795	1.116	1.973	1.154	1.634
	β_1/β_2	209.172	0.949	393.317	0.783	2292.150	0.801	593.382	0.702	947.189	0.688
	$m_1 - m_2$	-0.359	0.454	-0.563	0.422	-0.691	0.388	-0.665	0.367	-0.720	0.318
	p_1/p_2	0.046	1.440	0.035	1.457	0.019	1.455	0.030	1.484	0.026	1.404
	c_1/c_2	0.984	0.597	1.071	0.616	11.258	0.726	0.807	0.720	0.744	0.726
	$w/(w+c_1)$	0.658	0.255	0.882	0.515	-	-	0.947	0.613	0.957	0.687
	$w/(w+c_2)$	0.686	0.162	0.890	0.378	-	-	0.928	0.512	0.942	0.593

Table 1: Partition by ϕ, Market Share of D1, and Welfare Effect, Median Parameter Values, Profitable Mergers (continued)

Table 2	Representative Parameter Values and Outcomes for Negative Welfare Cases									
Market Share Quintile	**0-20%**		**20-40%**		**40-60%**		**60-80%**		**80-100%**	
	Pre- Merger	Post-Merger	Pre- Merger	Post-Merger	Pre- Merger	Post-Merger	Pre- Merger	Post-Merger	Pre- Merger	Post-Merger
Market Share Firm 1	10.14%	46.74%	22.40%	54.31%	43.13%	67.65%	64.33%	81.61%	83.72%	92.34%
Market Share Firm 2	89.86%	53.26%	77.60%	45.69%	56.87%	32.35%	35.67%	18.39%	16.28%	7.66%
Price Firm 1	1.1604	0.7399	1.4247	0.9537	2.2181	1.5509	4.3510	3.1018	11.1667	8.2097
Price Firm 2	2.8770	3.0996	3.4371	3.7865	6.0443	7.0374	21.4167	26.8192	104.1792	134.7489
Margin Firm 1	8.85%	79.73%	18.44%	84.27%	30.84%	90.33%	38.88%	95.16%	45.15%	98.17%
Margin Firm 2	63.23%	43.37%	66.19%	44.64%	74.62%	47.61%	87.58%	49.61%	94.12%	49.64%
Output US Firm 1	0.2531	0.1449	0.2932	0.1484	0.3965	0.1587	0.6574	0.1656	1.5056	0.1652
Output US Firm 2	0.2531	0.1912	0.2932	0.1896	0.3965	0.1763	0.6574	0.1670	1.5056	0.1692
Upstream Price	0.9077	1.6053	1.0119	1.9463	1.3840	3.5371	2.5093	13.3642	5.9750	67.7059
Output DS Firm 1	0.0513	0.2950	0.1314	0.4018	0.3421	0.7005	0.8459	1.4759	2.5208	4.0299
Output DS Firm 2	0.4548	0.3361	0.4550	0.3381	0.4510	0.3350	0.4689	0.3326	0.4903	0.3345
Cost Share Firm 2	85.82%		87.09%		90.22%		94.36%		97.55%	
	Parameter Values									
alpha 1	0.200		0.500		1.300		3.000		8.000	
alpha 2	1.000		1.000		1.000		1.000		1.000	
beta 1	0.500		0.500		0.500		0.500		0.500	
beta 2	0.250		0.200		0.100		0.025		0.005	
gamma	0.150		0.100		0.025		0.001		0.001	
cost 1	0.150		0.150		0.150		0.150		0.150	
cost 2	0.150		0.150		0.150		0.150		0.150	
phi	0.000		0.000		0.000		0.000		0.000	

Market Share Integrating Firm	α_1	α_2	β_1	β_2	γ	ϕ
$0 < s_1 < 20$	.381	.703	.662	.183	.077	-.066
$20 \leq s_1 < 40$	.515	.654	.676	.082	.076	-.178
$40 \leq s_1 < 60$	.591	.561	.668	.034	.069	-.348
$60 \leq s_1 < 80$	.607	.444	.681	.011	.055	-.442
$80 \leq s_1 < 100$	.556	.395	.676	.002	.027	-.510

Table 3: Medians Across All Welfare Decreasing Parameters

Table 4								
Anticompetitive Foreclosure	**1**		**2**		**3**		**4**	
	Pre-Merger	Post Merger	Pre-Merger	Post Merger	Pre-Merger	Post Merger	Pre-Merger	Post Merger
Market Share Firm 1	37.12%	38.43%	32.79%	34.62%	35.40%	36.00%	36.63%	39.09%
Market Share Firm 2	62.88%	61.57%	67.21%	65.38%	64.60%	64.00%	63.37%	60.91%
Price Firm 1	0.2798	0.2737	0.1893	0.1850	0.1028	0.1019	0.3446	0.3365
Price Firm 2	1.2840	1.2881	0.8621	0.8661	0.5082	0.5092	1.6660	1.6803
Margin Firm 1	49.46%	52.86%	36.41%	39.79%	44.27%	45.59%	34.97%	38.84%
Margin Firm 2	32.37%	31.91%	35.34%	34.61%	40.16%	39.85%	49.48%	47.93%
Output US Firm 1	0.1614	0.0991	0.1042	0.0671	0.0434	0.0276	0.0799	0.0471
Output US Firm 2	0.1614	0.1017	0.1042	0.0708	0.0434	0.0282	0.0799	0.0519
Upstream Price	0.0124	0.0211	0.0090	0.0179	0.0019	0.0041	0.0183	0.0515
Output DS Firm 1	0.1199	0.1253	0.0683	0.0730	0.0307	0.0314	0.0585	0.0635
Output DS Firm 2	0.2030	0.2008	0.1401	0.1378	0.0561	0.0558	0.1013	0.0989
alpha 1	0.3159		0.1702		0.0883		0.1064	
alpha 2	0.8202		0.5177		0.1934		0.2812	
beta 1	0.8662		0.9913		0.6754		0.4857	
beta 2	0.4885		0.4599		0.2749		0.1228	
gamma	0.0361		0.0995		0.0235		0.0717	
cost 1	0.1290		0.1114		0.0555		0.2058	
cost 2	0.8560		0.5485		0.3022		0.8234	
phi	-0.9493		-0.9421		-0.9802		-0.9403	

Table 4				
Anticompetitive Foreclosure	**5**		**6**	
	Pre-Merger	Post Merger	Pre-Merger	Post Merger
Market Share Firm 1	35.78%	36.18%	48.87%	49.56%
Market Share Firm 2	64.22%	63.82%	51.13%	50.44%
Price Firm 1	0.4765	0.4740	0.6835	0.6794
Price Firm 2	1.0686	1.0704	1.7140	1.7184
Margin Firm 1	37.58%	38.32%	31.59%	32.44%
Margin Firm 2	49.87%	49.63%	44.27%	43.84%
Output US Firm 1	0.2230	0.1421	0.1880	0.0916
Output US Firm 2	0.2230	0.1434	0.1880	0.0993
Upstream Price	0.0051	0.0086	0.0086	0.0185
Output DS Firm 1	0.1596	0.1619	0.1838	0.1876
Output DS Firm 2	0.2864	0.2855	0.1923	0.1909
alpha 1	0.5685		0.6452	
alpha 2	0.8537		0.5787	
beta 1	0.8911		0.8510	
beta 2	0.5374		0.2534	
gamma	0.0147		0.0701	
cost 1	0.2923		0.4590	
cost 2	0.5306		0.9467	
phi	-0.9838		-0.9766	