American University Washington College of Law


RESEARCH TOPICS IN UNILATERAL EFFECTS ANALYSIS

Jonathan B. Baker
American University Washington College of Law

David Reitman
Charles River Associates

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Jonathan B. Baker
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Abstract

This chapter has been prepared for inclusion in the RESEARCH HANDBOOK ON THE ECONOMICS OF ANTITRUST LAW (Einer Elhauge, ed.). It first explains why unilateral effects may result from horizontal mergers, and then describes several key models that have been developed to gauge the likelihood and/or magnitude of unilateral effects, focusing on mergers in differentiated product Bertrand markets. The remaining sections discuss extensions to these models and measurement issues that arise when implementing unilateral effects analysis in practice, highlighting ongoing and potential future topics for research.

I. Introduction

If a merger harms competition by leading the merged firms to compete less aggressively, holding constant the strategies adopted by non-merging rivals, those harms are said to reflect adverse unilateral effects.\(^1\) Adverse unilateral effects are usually modeled as higher prices, but they may also involve harm to buyers on other dimensions of competition, such as reduced output, lower quality, or slowed new product introduction.

Unilateral effects have been important in merger analysis since the late 1980s, when newly developed empirical methodologies and newly-available computerized point-of-sale scanner data for recording individual retail transactions began to make it possible to identify and measure the loss of direct competition among sellers of differentiated products.\(^2\) The analytical framework the enforcement agencies began to employ was codified in the 1992 Horizontal Merger Guidelines,\(^3\) and remains widely used today.\(^4\)

Our focus in this chapter is on a subset of the possible unilateral effects that may arise from horizontal merger. We emphasize competitive effects that arise when the

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\(^1\) For a similar definition, see Gregory J. Werden & Luke M. Froeb, *Unilateral Competitive Effects of Horizontal Mergers* 43, in Paolo Buccirossi, ed., *HANDBOOK OF ANTITRUST ECONOMICS* (2008); Gregory J. Werden, *Unilateral Competitive Effects of Horizontal Mergers I: Basic Concepts and Models*, in ABA Antitrust Section, *ISSUES IN COMPETITION LAW AND POLICY* 1319 (2008). By contrast, if a merger harms competition by making coordination possible, or by making pre-existing coordination more effective, those harms to competition are said to arise from coordinated effects. Coordinated industry outcomes arise from a repeated interaction among oligopolists, in which firm strategies depend on history, as with oligopoly supergames that arise from infinitely repeated play or finitely repeated play with uncertain termination.


merging firms sell differentiated products without binding capacity constraints, and interact by setting prices in one-shot games with Bertrand-Nash oligopoly conduct.\(^5\) We also discuss extensions of the analysis to other types of oligopoly interaction and dynamic settings, and we refer briefly to bidding models.\(^6\)

II. Basic Intuitions\(^7\)

A merger creates adverse unilateral effects by relaxing a competitive constraint that one or both merging firms previously imposed on the other. In the most common setting for unilateral effects analysis, the loss of direct competition among sellers of differentiated products, that dynamic can be described in two complementary ways: the merger allows one or both firms to recapture previously lost profits from raising price, and the merger removes for one or both firms the competitive response of an important rival.

These conclusions are evident from examining the effect of merger in simple model of a differentiated product industry, in which each firm sells only one product. In the pre-merger setting, firm 1 charges price \(P^1\) and sells \(Q^1\) units. Before the merger, firm 1 recognizes that if it raises its price by a small amount, \(\Delta P^1\), it will lose \(\Delta Q^1\) in sales (where \(\Delta Q^1\) is defined as a positive number). The gains from doing so equal

\(^5\) Unilateral effects also arise in other settings, including the following four. First, in bidding markets and auctions, the merging firms compete by bidding for the business of one or more customers, or participate in an auction to supply services to one or more customers. This includes the case of price discrimination markets, where the suppliers compete to serve one customer or a group of similarly situated customers. Second, in markets with relatively homogeneous goods, firms may compete by choosing quantities, either production levels or capacities. Third, in a market with a dominant firm and competitive fringe, a merger may reduce fringe competition (or, in the limit, create a monopolist). Fourth, unilateral effects may also arise when the merged firm changes its strategy in the first stage of a two stage game, for example if firms choose capacity in the first period and set prices in the second.

\(^6\) For a broader survey, including a discussion of quantity setting models and an expanded treatment of auction models, see Werden & Froeb, *Unilateral Competitive Effects of Horizontal Mergers*, supra n. 1.

while the losses equal \((P^1 - C^1)\Delta Q^1\), where \(C^1\) equals marginal cost and \(P^1 - C^1\) represents the price-cost margin the firm would have earned on the lost sales.

The firm raises price to the point where the gains from a further price increase just equal the losses, that is to where \(\Delta P^1(Q^1) = (P^1 - C^1)\Delta Q^1\). After dividing both sides by \(P^1\) and rearranging terms, this equation can be rewritten as

\[
\frac{P^1 - C^1}{P^1} = \frac{\Delta P^1 Q^1}{\Delta Q^1 P^1}.
\]

This latter equation can be written in the form \(L^i = 1/\eta^i\), where \(L^i = (P^i - C^i)/P^i\) is the firm’s Lerner Index of price-cost margin and \(\eta^i = (\Delta Q^i P^i)/(\Delta P^i Q^i)\) is (the absolute value of) the elasticity of the residual demand facing the firm. This equation is the first order condition for profit maximization by firm 1.

When the first firm raises price in the pre-merger setting, it loses sales as some buyers switch to their second choice product (which could be no product at all, but instead a decision not to purchase from any seller). Some of those buyers may switch to the product sold by a particular second firm.

Now suppose the first firm and the second firm agree to merge. This changes the merged firm’s profit-maximization calculus with respect to the first product (the product formerly sold by the first firm). After the merger the direct gains from raising the price of the first product continue to equal \(\Delta P^1(Q^1)\). But the net losses from raising price are no longer equal to \((P^1 - C^1)\Delta Q^1\). The reason is that some of the \(\Delta Q^1\) lost sales from the

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8 The gains are technically \(\Delta P^1(Q^1 - \Delta Q^1) = \Delta P^1(Q^1) - \Delta P^1 \Delta Q^1\), but the \(\Delta P^1 \Delta Q^1\) term, the product of two small numbers, is second order in magnitude and can be ignored.

9 A firm’s residual demand function describes how its quantity sold responds to changes in its price, after taking into account the competitive responses of rivals. It differs from the more familiar structural demand function, which describes how a firm’s quantity sold responds to changes in its price holding constant the prices charged by rivals. For further discussion, see generally Jonathan B. Baker & Timothy F. Bresnahan, Estimating the Residual Demand Curve Facing a Single Firm, 6 INT’L J. INDUS. ORG. 283 (1988).
first product lead to increased purchases of the second product, allowing the merged firm to recapture some of the lost profits from raising the price of the first product in the form of increased profits on sales of the second product.\textsuperscript{10} The increased profits on the second product can be represented as \((P^2 - C^2)\Delta Q^2\), with \(0 < \Delta Q^2 \leq \Delta Q^1\).\textsuperscript{11} Now the merged firm’s profits from raising the price of the first product to a small amount above the pre-merger price are unambiguously positive, as
\[
\Delta P^1(Q^1) + (P^2 - C^2)\Delta Q^2 > (P^1 - C^1)\Delta Q^1.\textsuperscript{12}
\]
Before the merger, the first firm declined to raise price further because the gains from doing so were not more than the losses. After the merger, the new firm recognizes that it can recapture some of those losses, so now finds it profitable to raise the price of the first product.\textsuperscript{13}

This is not the end of the story for the merged firm, as it may also have an incentive to increase the price of the second product. The higher price for the second product may lead some of the \(\Delta Q^1\) customers who switched from the first product to the second to instead stick with the first product (increasing the profits from raising the price

\textsuperscript{10} Note that firm 2’s product does not have to be the best substitute for firm 1’s product – perhaps more of the lost sales go to some third firm’s product. What matters is that a significant group of firm 1’s customers would respond to a higher price for firm 1’s product by switching to firm 2’s product. For those customers, firm 2’s product is their second choice at pre-merger prices. Accordingly, a merger between sellers of differentiated products may harm competition even when most of the customers switching away from firm 1’s product select the products of non-merging firms or do without the product entirely, and even when some third product is the second choice for more of firm 1’s customers than is the product sold by firm 2.

\textsuperscript{11} That is, the increased profits equal the price-cost margin on the second product, which could be different from the price-cost margin on the first product, times the increase in second product sales (which will be a portion of the lost sales on the first product).

\textsuperscript{12} In this representation, sources of incremental profits from a small price rise are placed on the left hand side of the equation, while sources of incremental losses are placed on the right.

\textsuperscript{13} An alternative intuition arising from the same model arises from observing that after the merger, output expansion by the first firm leads it to cannibalize some of the sales that would otherwise have gone to its merger partner. From this perspective, the merger can be thought of as lowering the marginal revenue obtained from selling the first product or, equivalently, as raising that product’s marginal cost (understood as incorporating an opportunity cost). Accordingly, the acquisition gives the merged firm an incentive to reduce output of the first product. The marginal cost perspective is emphasized in Joseph Farrell & Carl Shapiro, \textit{Antitrust Evaluation of Horizontal Mergers: An Economic Alternative to Market Definition} (Nov. 28, 2008) \textit{available at} http://faculty.haas.berkeley.edu/shapiro/alternative.pdf, as we discuss in the following section.
of the first product) or switch to a third alternative (reducing the profits from raising the price of the first product). The merged firm will choose a profit-maximizing price for both products simultaneously, taking a range of direct effects and feedbacks like these into account.\textsuperscript{14} It will also consider price and “repositioning” responses by third firms.\textsuperscript{15}

But one central idea underlying unilateral effects is captured in the example: a merger allows the firm to recapture some of the profits that would previously have been lost as a result of competition with its merger partner, removing a constraint on pricing and leading to higher prices.

A complementary way to understand unilateral competitive effects is to recognize that before the merger, competition from all firm 1's rivals, including competition from firm 2, contributed to determining $\eta^1$, the elasticity of the residual demand function facing firm 1. The more aggressive was firm 2's competitive response to firm 1 pre-merger – the less willing firm 2 was to match firm 1's price increase or the more that firm 2 would expand output when firm 1's output contracted – the greater firm 1's loss of sales to firm 2 would have been if firm 1 raised price pre-merger, so the more elastic was firm 1's pre-merger residual demand. By merging with firm 2, firm 1 removed the competitive response of product 2 to a price increase on product 1.\textsuperscript{16} In consequence, the residual demand for product 1 will become less elastic, making it profitable for the merged firm to

\textsuperscript{14} The mathematics of the profit-maximization calculus for the merged firm are treated in, for example, Werden & Froeb, \textit{Unilateral Competitive Effects of Horizontal Mergers}, supra n. 1 at 45, including a discussion of various assumptions about the structure of buyer preferences and the interaction among sellers.

\textsuperscript{15} Firms may reposition products by altering their physical or non-physical attributes. As we discuss in more detail below, rival repositioning could counteract or deter the exercise of market power by the merged firm, so must be accounted for in a full analysis of the unilateral competitive effects of merger.

\textsuperscript{16} Following the merger, firm 1 likely has an incentive to raise the price of both products. The merged firm has an incentive to raise the price of the first product because it knows that the acquisition will allow it to recapture some of the lost profits through increased sales of the second product. It similarly has an incentive to raise the price of the second product — making the pricing response of the second product less aggressive than it would have been pre-merger.
increase the first product’s price. This example captures an alternative way of understanding unilateral effects: the merger removes for one or both firms the competitive response of an important rival, removing a constraint on pricing and leading to higher prices.

Even when a merger among rivals threatens adverse unilateral effects, because it relaxes a competitive constraint that one or both merging firm previously imposed on the other, competition is not invariably harmed. Mergers among rivals also routinely benefit competition, as by permitting the firms to reduce costs or to develop new or better products. If merger-related marginal cost reductions are sufficiently large, the net impact on the merged firm’s pricing decisions may result in lower prices in the post-merger market equilibrium. Accordingly, merger analysis must also ask whether the anticompetitive pricing incentive outweigh the procompetitive synergy incentive for the merger.

III. Simple Models Used to Identify Unilateral Effects

The Horizontal Merger Guidelines establish presumptions indicating when a horizontal merger entails a sufficient increase in concentration to raise competitive concerns. These presumptions are related to changes in concentration given the merging firms’ share of the market. Presumptions about which mergers are more likely to be of concern can improve the transparency, consistency, and efficiency of the merger.

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17 This idea is implemented empirically in Jonathan B. Baker & Timothy F. Bresnahan, The Gains from Merger or Collusion in Product Differentiated Industries, 33 J. INDUS. ECON. 427 (1985). This method offers a way of approximating the post-merger incentive to raise price based on the assumption that the merged firm reduces output of both products by the same percentage. However, it does not provide an exact solution to the merged firm’s joint profit maximization problem. This approach does not require knowledge of the oligopoly solution concept or reliable estimates of the level of marginal cost. Information about oligopoly conduct is instead inferred empirically from the past reactions of the non-merging firms.

18 U.S. Dep’t of Justice & FTC, Horizontal Merger Guidelines, supra n. 3 §1.51.
review process. However, in the context of price-setting differentiated product markets, the Merger Guidelines presumptions are not directly linked to unilateral merger effects. Those presumptions are based on market shares, which may bear no relationship to the loss of direct competition between merging firms.\textsuperscript{19}

In contrast, the models discussed in this section are built around the key drivers of unilateral effects in price-setting markets. We classify them as simple models because they do not attempt to incorporate all the interactions and strategic possibilities that can arise in a fully specified model of post-merger competition. The data requirements for these models are, in consequence, less demanding than for a fully specified model. That simplicity makes these models candidates to be an alternative initial screen for whether a particular merger is likely to raise competitive concerns, or else as a basis for a safe harbor to deflect potential concerns.

In some cases these models may be precursors to a more thorough quantitative assessment of unilateral effects claims using the simulation methods discussed in the next section. But in other cases, where data on demand, transactions, or consumer preferences are limited or unavailable, these models may be the only quantitative evidence used in assessing the likelihood of an anticompetitive unilateral price increase. The different models in this section emphasize different elements of the drivers of unilateral price increases, which correspond to the different intuitive bases for unilateral effects discussed above.

\textsuperscript{19} In differentiated product markets, a firm’s market share reflects the fraction of potential customers who select its product as their first choice. But the constraint imposed by any particular rival depends instead on its customers’ second choices – in particular, on the extent to which its merger partner’s product is the second choice for those of its customers who would switch rather than stay loyal were the first firm to raise price. Thus, market shares are informative as to likely unilateral effects only to the extent that customer second choices are distributed similarly to customer first choices. Farrell & Shapiro, \textit{Antitrust Evaluation of Horizontal Mergers}, supra n. 13 at 4 argue that the market definition exercise diverts attention from the analysis of the loss of competition between the merging firms.
A. Upward Pricing Pressure

The upward pricing pressure ("UPP") measure of Farrell and Shapiro starts with the recaptured customer effect resulting from a horizontal merger.\(^\text{20}\) Suppose firm 1 and firm 2 merge. When firm 1 raises the prices of its products, some customers who would have bought from firm 1 buy from firm 2. Of the customers who stop buying firm 1’s product in response to a price increase by firm 1, the fraction that switch to buying firm 2’s product is \(D^{12}\), the diversion ratio from firm 1 to firm 2.\(^\text{21}\) Let \(P^2\) and \(C^2\) be the price and marginal cost, respectively, of firm 2’s product.\(^\text{22}\) Then for each customer who leaves firm 1 in response to a price increase, the expected recaptured profit is 
\(D^{12} (P^2 - C^2)\), which is the probability that the customer switches to firm 2 times the gross profit earned on firm 2 customers. A central insight of the UPP concept is that this expected recaptured profit has the same impact on firm 1’s pricing post merger as an increase in marginal cost: both will induce the firm to charge a higher price. In order for there to be no net incentive to raise prices post merger, the marginal cost savings due to merger induced synergies must be at least as large the recaptured profit component. For the purposes of implementing a screen for upward pricing pressure, Farrell and Shapiro propose using a “standard deduction” of some percentage, \(E\), of pre-merger costs, rather than trying to measure actual synergies. Thus a merger creates upward pricing pressure if


\(^{21}\) The diversion ratio can be written as a function of the own and cross price elasticities of demand: if \(\varepsilon^{11}\) is the own price elasticity of demand for product 1 and \(\varepsilon^{21}\) is the cross-price elasticity of demand for product 2 with respect to the price of product 1, and if \(Q^1\) and \(Q^2\) are the outputs of products 1 and 2, respectively, then 
\[D^{12} = \frac{-(\varepsilon^{21})}{(\varepsilon^{11})} \left( Q^1 / Q^2 \right).\]

\(^{22}\) This discussion presents the simplest version of the UPP test; the authors discuss extensions of the test that incorporate multiproduct firms and that internalize the feedback from price increases on one product to other products. Farrell & Shapiro, Antitrust Evaluation of Horizontal Mergers, supra n. 13 at 13, 26.
The UPP test captures the central role element of eliminating direct competition between the merged firms, while limiting the data requirements to an estimate of diversion ratios between the merging firms and prices and margins for those firms.²³

B. Critical Loss

Critical loss is fundamentally a tool for market definition. It starts with the hypothetical monopolist test for a proposed market definition, and asks what fraction of customers would the hypothetical monopolist have to lose in order to make a significant and non-transitory increase in price (SSNIP) unprofitable.²⁴ That minimal level of lost sales is the critical loss.²⁵ Critical loss has also been used as a tool for unilateral effects analysis because of the similarity between a substantial unilateral post-merger price increase by a merged firm and a SSNIP for a hypothetical monopolist: if the merged firm would be able to raise prices substantially, that suggests that the products of the merged firm themselves constitute a relevant antitrust market.²⁶ Conversely, if the merged firm’s products are not by themselves an antitrust market, then the merged firm will generally not be able to raise prices by more than a SSNIP post merger, though it may still be able to raise prices enough to be of antitrust concern.²⁷ Critical loss (or critical elasticity)

²³ There can nevertheless be substantial issues in measuring both of those components, as discussed in section VI below.
²⁴ Critical loss was introduced in Barry Harris & Joseph Simons, Focusing Market Definition: How Much Substitution is Necessary? 12 RES L. & ECON. 207 (1989). The hypothetical monopolist test is described in the Merger Guidelines; U.S. Dep’t of Justice & FTC, Horizontal Merger Guidelines, supra n. 3 §1.11.
²⁵ A variant of critical loss, critical elasticity, is defined similarly: What is the minimal market elasticity for the proposed market that would make a SSNIP unprofitable for the hypothetical monopolist.
²⁶ The similarity between market definition and unilateral effects analysis arises because the same economic force, buyer substitution, is central to each. They are not identical, however; in particular, they make different assumptions about whether non-merging firms raise prices in response to a price increase by the merging firms.
²⁷ The connection between post-merger unilateral price increases and market definition plays a prominent role in the court’s decision in the Oracle-PeopleSoft merger (United States v. Oracle Corp. (2004). 331 F.
implements the intuition that a merger will reduce the elasticity of the residual demand function faced by the merged firm, which in turn induces the merged firm to raise prices somewhat (in the absence of cost reductions). The question is whether the elasticity of demand for the merged products is reduced enough to make a SSNIP profitable. For a given level of SSNIP, the critical loss depends only on the margins earned by the merged firms: the higher the margins, the lower the critical loss needed to make a SSNIP unprofitable. It is thus among the simplest quantitative tests to implement for unilateral effects analysis, and has been used both to argue that a merger is unlikely to lead to unilateral effects because the firms compete in a broader market in cases such as SunGard\textsuperscript{29} and Whole Foods\textsuperscript{30}, as well as to argue that a merger would be anti-competitive, as in XM-Sirius.\textsuperscript{31}

C. Compensating Cost Reduction

In contrast to the proposed standard deduction for synergies used in UPP, Gregory J. Werden derives the precise marginal cost reductions necessary for a merger to have no

\textsuperscript{28} A criticism of critical loss analysis, as commonly applied, is that it does not require consistency between estimates of margins and estimates of demand elasticities. The critics point out that margins also inform the actual losses a firm would sustain from a SSNIP, with higher pre-merger margins indicating low demand elasticity and relatively little substitution away from the merged firm following a price increase. See Daniel O’Brien & Abraham Wickelgren, A Critical Analysis of Critical Loss Analysis, 71 ANTITRUST L. J. 161 (2003); Michael Katz & Carl Shapiro, Critical Loss: Let’s Tell the Whole Story, ANTITRUST 49 (Spring 2003).


impact on prices.\textsuperscript{32} Werden observes that the compensating cost reduction can be determined without knowledge of the demand function beyond the elasticity at the pre-merger equilibrium, simply by solving the post-merger first order conditions for the level of costs at which the optimal prices remain at the pre-merger level.\textsuperscript{33} As such, this test implements the intuition that unilateral effects reflect an imbalance between the anti-competitive incentive to exploit a reduction in competitive constraints with the pro-competitive benefits of synergies. Comparing actual (anticipated) cost reductions with the benchmark produced by the test shows whether the balance tilts toward a unilateral price increase or price reductions post-merger. As with UPP, an advantage of this test is that the conclusion does not depend on assumptions about the shape of the demand curve.\textsuperscript{34}

D. PCAIDS and ALM

The PCAIDS model of Epstein and Rubinfeld is designed to compute merger price effects using a simplified model with relatively light data requirements.\textsuperscript{35} The earlier Antitrust Logit Model (ALM) of Werden and Froeb similarly implements a merger simulation with minimal data requirements.\textsuperscript{36} The key element of both models is that they infer buyer substitution patterns among brands in the market from market shares. Thus, the models could provide a basis for interpreting the market share based screens of the Merger Guidelines.

\textsuperscript{33} The resulting cost reduction is shown in the next section, \textit{infra} at n. 56.
\textsuperscript{34} An additional similarity is that both tests can predict an ambiguous overall merger effect, with price predicted to increase for one or more merging products and decrease for others.
The relationship between shares and substitution patterns is most clearly seen with the logit model of demand. In that model, customers rank alternatives based on a index for each product, which in a simple version is \( v_i = \alpha_i + \beta P_i + \varepsilon_i \), where \( \varepsilon_i \) is a random term with an extreme value distribution.\(^{37}\) This functional form coupled with the particular error term distribution implies that the probability that a customer will choose brand \( i \) is \( e^{v_i} / \sum_j e^{v_j} \). This in turn means that, if \( s_i \) is the market share for firm \( i \), the diversion ratio from product \( i \) to product \( j \) is \( D_{ij} = s_i / (1 - s_i) \).\(^{38}\) In other words, the diversion to another product is proportional to the share of that product,\(^{39}\) as would be the case if buyer second choices are distributed similarly to buyer first choices.\(^{40}\) Thus the models can be calibrated using market shares and an overall measure of market elasticity and/or the propensity to choose the “outside good”.\(^{41}\) Unlike the other simple models discussed above, these models provide a measure of the unilateral price impact, rather than just whether there is likely to be a price increase resulting from the merger. But PCAIDS and ALM can be regarded as preliminary screens because they measure the extent of a unilateral price effect under the proportional diversion assumption, before asking whether

\(^{37}\) See Werden & Froeb Unilateral Competitive Effects of Horizontal Mergers, supra n. 1 at 53 and Margaret E. Slade, Merger Simulations of Unilateral Effects: What Can We Learn from the UK Brewing Industry?, in Bruce Lyons, ed., CASES IN EUROPEAN ECONOMIC POLICY: THE ECONOMIC ANALYSIS (2009) at 316 for more details on the logit model, including the derivation of own and cross price elasticities implied by the model.

\(^{38}\) The PCAIDS (proportionally calibrated AIDS) model, similarly assumes that diversion is proportional to market revenue shares within an AIDS demand model.

\(^{39}\) More complex substitution patterns are possible when using a nested logit, which allows products that are presumed to be close substitutes to be grouped together in nests. The resulting substitution patterns between products depends on the choice of which products are in which nests as well as parameters governing choice between nests. Additional flexibility can be obtained using the distance-metric demand model. See Slade, Merger Simulations of Unilateral Effects, supra n. 37 at 317.

\(^{40}\) For example, if (hypothetically) 30% of soft drink buyers select Coke as their first choice at current prices and 10% pick 7Up, then this functional form presumes that (30% / (100%-10%)) = 33% of those buyers who select 7Up as their first choice would pick Coke as their second choice.

\(^{41}\) Slade shows that estimated elasticities are sensitive to the choice of the outside good, so that this choice plays a role similar to market definition when the analysis of competitive effects is based on market concentration. Slade, Merger Simulations of Unilateral Effects, supra n. 37 at 316, 339.
the merged products are relatively close or distant substitutes, which would increase or
decrease the predicted unilateral effect.

E. Discussion

The advantage of using these simple models to analyze unilateral effects is that they
can provide a preliminary read on the likely impact of the merger quickly and with
relatively light data requirements.\(^{42}\) In part this is because the models rely upon
parameters describing selected aspects of the market, whether diversion between the
merging parties, aggregate elasticity, margins, synergies, or market shares, without
requiring a full simulation model that incorporates all of these elements and more.

That selectivity comes with at least two potential costs. One is that conclusions based
on only some aspects of the market will at times differ from those drawn from analysis of
the overall impact of the merger based on all available data.\(^{43}\) The other is the possibility
that having multiple preliminary models using different categories of information will
resemble the proverbial blind men and the elephant, reaching different conclusions based
on the components of the market being used in the analysis. In markets for products with
high margins, the UPP model will tend to conclude that mergers will be anti-competitive,
since the profit gained from recaptured sales is large and the standard deduction for
efficiencies will have a relatively small impact on prices. In contrast, critical loss
analysis would typically show that the critical loss for the merged firm is relatively low in
such markets, suggesting that the market is broader and the merger is less likely to

\(^{42}\) While to varying extents these models are envisioned as preliminary screens, they may frequently end up
being the primary quantitative model used, either because data for a more detailed study are not available,
or because the simplicity of these models make them an appealing vehicle for presenting evidence about
the likelihood of unilateral effects.

\(^{43}\) After comparing predicted merger effects from a series of increasingly detailed models, Slade concludes
that, “the predictions about markups and merger effects that can be obtained from simple models are often
misleading.” Slade, Merger Simulations of Unilateral Effects, supra n. 37 at 338.
present a competitive issue. In addition, these models to varying degrees simplify aspects of competition that would be incorporated in a more complete simulation of competition in the market. Examples include allowing multiproduct firms to have different post-merger price increases for different products and incorporating the competitive response of non-merging firms. This suggests exploring how likely the models are to reach different conclusions, both from each other and from a fully-specified merger model. Particularly if these models are to be used as preliminary screens for potentially problematic mergers, it is important to gauge how reliable they are both as a predictor for the results of a more thorough study as well as for predicting actual anticompetitive effects.

IV. Merger Simulation

Merger simulations combine a model of industry conduct with information or assumptions about the parameters to predict the effect of the merger on industry outcomes, usually prices. Simulation modeling usually begins by estimating demand functions for the differentiated products at issue, and incorporates parameters from those estimates into a model that also accounts for costs and oligopoly behavior. Then the structure of the model is modified to account for the merger by allowing the merged firm to optimally select all the decision variables previously chosen independently by the merger partners, and the model solved for the post-merger equilibrium conditions (using the parameters estimated on pre-merger data).

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44 This is not the only way that merger effects may be simulated, but it is the most common. For an example of a different approach to merger simulation, using a reduced form model that relates price to market structure, see Orley Ashenfelter, David Ashmore, Jonathan B. Baker, Suzanne Gleason & Daniel S. Hosken, Empirical Methods in Merger Analysis: Econometric Analysis of Pricing in FTC v. Staples, 13 INT’L J. ECON. BUS. 265 (2006).
This approach is made clear in a benchmark calculation – essentially a simple simulation model – presented by Carl Shapiro.\textsuperscript{45} For this calculation, Shapiro assumes (1) each merging firm has one product, (2) demand functions are linear, (3) the merging products are symmetric in demand prior to the merger, in the sense that the two diversion ratios (from each to the other) are identical (and denoted $\alpha$), (4) marginal costs are constant, (5) the merging products have the identical price-cost margins $L = (P - C)/P$ prior to the merger, and (6) the interaction between firms is characterized by Bertrand-Nash behavior. Under the above assumptions, Shapiro finds that 

$$\Delta P/P = \alpha L/[2(1 - \alpha)],$$

where $\Delta P/P$ represents the percentage price increase from merger for each product. If assumption (2) is altered so that demand functions are constant elasticity, then 

$$\Delta P/P = \alpha L/ (1 - \alpha - L).$$

Shapiro’s benchmark formulae can be used to illustrate some of the benefits of simulation modeling. First, simulation modeling can synthesize a great deal of empirical information – here information about diversion ratios and margins – in a logically consistent way. Second, and relatedly, simulation modeling provides a metric for understanding the strength of the incentive to raise price implied by key parameters, particularly those associated with demand (elasticities or diversion ratios).\textsuperscript{46} In the Shapiro example, if $\Delta P/P$ is an economically significant amount, that result would suggest a concern about adverse unilateral effects of merger.\textsuperscript{47} Third, simulation

\textsuperscript{45} Carl Shapiro, \textit{Mergers with Differentiated Products}, 10 ANTI TRUST 23, 26-27 (Spring 1996). Derivations are set forth in Carl Shapiro, \textit{Unilateral Effects Calculations} (Sept. 2007), available at
http://faculty.haas.berkeley.edu/shapiro/unilateral.pdf.

\textsuperscript{46} Because the simulation procedure necessarily combines estimates and assumptions about which there may be significant uncertainty, the output of the procedure – a set of projected price changes – is better viewed as an indicator of the strength of incentives to raise price post-merger, rather than as a forecast.

\textsuperscript{47} There is no consensus among antitrust economists about how large the price increase must be, or how long it must last, to be considered economically significant. In practice, a 3% price increase is often treated
modeling can help identify the critical uncertainties in model specification or parameter estimates on which the strength of that incentive depends.\textsuperscript{48} In the example, if $\Delta P/P$ is economically significant when demand is taken to follow a constant-elasticity form, but not economically significant if demand is assumed linear, that difference would suggest the importance of gathering information about the functional form for demand.\textsuperscript{49}

Simulation modeling has other potential benefits, not illustrated by the Shapiro formulae. It can in principle be used to quantify the degree of uncertainty in the price increase forecasts resulting from sampling error in the statistical estimation of model parameters (and the equivalent uncertainty when parameters are determined based on qualitative information).\textsuperscript{50} It can also offer a way to net the unilateral incentive to raise price resulting from merger against the incentive to lower price that arises from merger-related synergies.

The mechanics of simulation will be described using a more general setup than Shapiro employed.\textsuperscript{51} The first step is to specify a model and work out the pre-merger and post-merger equilibria. The model in this example assumes, as Shapiro did, that each

\textsuperscript{48} One aspect of identifying critical uncertainties involves testing for consistency in simulation models with over-identified model restrictions. For example, margins implied by demand elasticities and pre-merger profit maximizing conditions can be compared to actual margins derived from accounting data; see Steven Tenn, Luke Froeb, & Steven Tschantz, \textit{Mergers when Firms Compete by Choosing both Price and Promotion} (2009) at 2, available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=980941

\textsuperscript{49} The price increase in Shapiro’s model is greater when demand elasticities are assumed constant because linear demand functions grow more elastic as price increases. This difference can be substantial; for example, with 40% margins and a 20% diversion ratio between the merging firms, the predicted price increase in the linear model is 5%, while under the constant elasticity model the predicted price increase is 20%.


\textsuperscript{51} This model is taken from Werden & Froeb, \textit{Unilateral Competitive Effects of Horizontal Mergers}, supra n.1 at 51.
merging firm has one product and that the interaction between firms is characterized by
Bertrand-Nash behavior. But each product \( i \)'s demand has a more general functional
form \( Q^i(P^i, P^j) \), where \( P^j \) is a vector of prices for the \( n-1 \) products sold by rivals.\(^{52}\)
This general functional form allows for demand elasticities to differ across products, and
permits asymmetric demand cross-elasticities (or diversion ratios). Marginal cost
\( C^i(Q^i(P^i, P^j)) \) is also more general than in Shapiro’s simple framework: it now varies
with firm output and may differ across products. With Bertrand-Nash conduct, the pre-
merger equilibrium is characterized by \( n \) first order conditions \( L^i = -1/e^{ii} \), where
\( L^i = (P^i - C^i)/P^i \) is the Lerner index for product \( i \) and \( e^{ii} \) is the own elasticity of
demand for product \( i \).

If brands \( i \) and \( j \) merge, the post-merger first order condition for product \( i \)
becomes \( L^i = -1/e^{ii} - L^i \left( e^{ji}/e^{ii} \right) (Q^j/P^j/Q^i/P^i) \), where \( e^{ji} \) is the cross-elasticity of
demand of product \( j \) with respect to the price of product \( i \).\(^{53}\) The post-merger first
order condition for product \( j \) is analogous and the first order conditions for the other \( n-2 \)
products do not change.

To simulate a merger in this framework, it is necessary to estimate the parameters
of the demand system (to recover own and cross-elasticities of demand, as functions of
price) and to estimate the parameters of the cost functions for each merging firm (to infer
the marginal cost functions).\(^{54}\) Some of the parameters of these functions are chosen by

\(^{52}\) With no loss of generality, and with empirical estimation in mind, the demand function can also
incorporate a vector of exogenous variables affecting demand.

\(^{53}\) Werden and Froeb specify the first order conditions in an equivalent form that uses diversion ratios rather
than cross-elasticities. Werden & Froeb, Unilateral Competitive Effects of Horizontal Mergers, supra n. 1
at 51.

\(^{54}\) In this model, if marginal cost is assumed to be constant, its level can be inferred by solving the first
order conditions for firm profit-maximization, allowing the merger to be simulated without data on
calibrating to match pre-merger prices, outputs, and costs. Once the parameters are determined by estimation or calibration, they are used to specify the system of $n$ pre-merger first order conditions (which may be non-linear). These first order conditions are solved simultaneously to make inferences about other terms in the model; this is a form of calibration. The next step is to specify the first order conditions that pertain to the post-merger market after accounting for joint ownership of the merged firm. Then the system of $n$ post-merger first order conditions are solved for the post-merger price and output vectors.\textsuperscript{55} If the cost functions are expected to change as a result of merger-related efficiencies, those new functions can be employed in deriving the post-merger equilibrium.\textsuperscript{56}

Full-fledged simulation modeling incorporates substantial technical complexity in specifying and solving the model and estimating its parameters. It is as yet unclear whether the payoff in more accurate enforcement determinations is worth the effort.\textsuperscript{57} Absent such modeling, unilateral effects can be (and are) demonstrated with less technically demanding evidence that show that the merging firms’ products are close substitutes in demand.\textsuperscript{58}

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\textsuperscript{55} The simultaneous solution of a system of non-linear equations can raise computational issues not treated here.

\textsuperscript{56} Alternatively, Werden shows that the post-merger first order conditions can be solved to find the cost reduction necessary to preserve pre-merger prices. In the case of symmetric merging products, the necessary post-merger marginal cost is $\hat{C} = \frac{C}{1-L} \left( 1 + \frac{1}{\epsilon^m + \epsilon^w} \right)$. Werden, \textit{A Robust Test for Consumer Welfare Enhancing Mergers among Sellers of Differentiated Products}, supra n. 32.

\textsuperscript{57} For a discussion of the application and impact of merger simulations in six cases reviewed or challenged by competition authorities in the US and Europe, see Budzinski & Ruhmer, \textit{Merger Simulation in Competition Policy}, supra n. 50 at 20.

\textsuperscript{58} The types of evidence used to demonstrate demand substitution may include buyer surveys, demand elasticity studies, information about buyer switching costs, inference from company documents and monitoring of competitors, and views of third party experts on the market. \textit{See} Jonathan B. Baker, \textit{Market
In addition to the benefits of simulation methods just discussed (synthesizing information, providing a metric for the degree of anticompetitive concern, and identifying critical parameters) merger simulation appear to have three primary advantages relative to informal methods of proving unilateral effects. First, they may be able to identify unilateral effects when the merging firms’ products are substitutes but not the closest substitutes, so the magnitude of the post-merger incentive to raise price is not initially obvious. This advantage is potentially important in markets where sellers are densely distributed (either product markets with brand proliferation, such as breakfast cereals, or geographic markets, such as gas stations or hospitals). The advantage of simulation methods here comes from incorporating the full set of own and cross-price elasticities in a demand system. But a large demand system may be difficult to estimate with precision, and agencies and courts may be reluctant to base merger enforcement decisions on the implications of econometric estimates of the parameters of a large demand system unless those conclusions are confirmed by other, more qualitative evidence that the merging firms’ products are substitutes in demand.

Second, simulation methods promise to account for supply-side limitations on unilateral price increases, and in particular rival reactions. However, existing methods commonly treat rival reactions as a matter of assumption (as by imposing Bertrand-Nash behavior) rather than viewing oligopoly conduct as something to estimate.59 One might

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59 See Budzinski & Ruhmer, Merger Simulation in Competition Policy, supra n. 50 at 4 (“there is a widespread consensus that Bertrand competition is the first choice for heterogeneous oligopolies”) and Slade, Merger Simulations of Unilateral Effects, supra n. 37 at 321 (“Bertrand competition is an obvious focal point for the estimation of unilateral effects in markets where products are differentiated.”) Simulation methods relying on residual demand estimates are an exception because rival reactions are incorporated into residual demand functions. See Jonathan B. Baker & Timothy F. Bresnahan, The Gains from Merger or Collusion in Product Differentiated Industries, 33 J. INDUS. ECON. 427 (1985).
expect that the choice of solution concept would make a difference to the inferred equilibrium prices, because it alters the first order conditions defining the pre- and post-merger equilibria.  

Consistent with this expectation, Peters’ merger retrospective involving the airline industry found that the predicted price changes from merger implied by several common simulation methods could be improved by incorporating more information about rival reactions. On the other hand, the airline industry may be relatively undifferentiated, so supply-side factors may matter particularly in simulating unilateral effects in such markets. In any case, Peters found that all the simulation methods he studied properly identified the substantial price increases arising from loss of competition in the five markets studied. Accordingly, Peters’s study is not inconsistent with Baker and Bresnahan’s judgment that in product differentiated industries, “an enquiry that looks only at demand substitution to address market definition and identify market power, ignoring supply-side factors like costs and strategic conduct, is in general likely to be largely right.”

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60 The pre-merger first order condition for each differentiated product seller of a single product can be written independent of solution concept as \( L = -\frac{1}{\eta} \), where \( \eta \) is the elasticity of the firm’s residual demand. (This is because a differentiated product seller can be thought of as a monopolist of its residual demand.) The residual demand elasticity equals the own elasticity of demand if the solution concept is Bertrand Nash (as in the Werden and Froeb example in the text) but under other solution concepts it will also include terms reflecting cross-elasticities of demand and best response functions.

61 Craig Peters, Evaluating the Performance of Merger Simulation: Evidence from the U.S. Airline Industry, 49 J. L. & ECON. 627 (2006). Cf. David Genesove & Wallace P. Mullin, Testing Static Oligopoly Models: Conduct and Cost in the Sugar Industry, 1890-1914, 29 RAND J. ECON. 355 (1998) (finding that empirical models using changes in demand elasticities and cost components in order to infer oligopoly market power and unobserved components of marginal cost provide the best fit to data directly measuring cost when conduct is estimated as a free parameter). For a review of additional tests comparing structural models and merger effects, see Tenn, Froeb & Tschantz, Mergers when Firms Compete by Choosing both Price and Promotion, supra n. 48 at 2, and Budzinski & Ruhmer, Merger Simulation in Competition Policy, supra n. 50 at 36.

62 Peters, Evaluating the Performance of Merger Simulation, supra n. 61 at 641 & 644 (tables 3 & 4).

Baker and Bresnahan also note that “[c]areful attention to the supply-side along with demand becomes important only when the question shifts from whether the firm or firms exercise market power – the issue in market definition or unilateral effects of merger among sellers of differentiated products – to whether changes in supply, as from the efficiencies that may result from firm conduct or the increased competition that could result from firm remedies, would counteract the exercise of market power in such markets.”64 This observation suggests the third primary advantage of simulation methods over informal methods of proving unilateral competitive effects: the promise that they can be used to trade off merger-related efficiencies against the anticompetitive incentive to raise price. Whether this promise can be fulfilled in practice, however, depends on the ability to measure the two incentives – to raise price and lower price – with sufficient precision to make a comparison reliable.65 It is unclear whether the available methods and data allow for such comparisons outside of cases in which one incentive is powerful and the other weak – the setting where sophisticated simulation methods provide the least advantage over simpler methods of unilateral effects analysis.66

V. Extensions


64 Baker & Bresnahan, Economic Evidence in Antitrust, supra n. 63 at n. 92.

65 In this regard, we note that current practice does not generally attempt to quantify the uncertainty around the point estimate of simulation forecasts. That is a difficult task because it combines sampling uncertainty in the econometric measurement of demand with model specification uncertainty. The latter uncertainty can be addressed with sensitivity analyses but is hard to summarize succinctly. Models that attempt to estimate the confidence intervals around merger simulation predictions were discussed earlier at supra n. 50.

66 We note two additional benefits of simulation modeling that may pertain in some applications. Simulation models can be adapted to account for atypical elements of a market setting such as partial cross ownership, regulations, or capacity constraints that may be difficult to incorporate in an informal analysis. In addition, they can be useful in evaluating the extent to which alternative divestiture proposals mitigate concerns about a post-merger price increase.
While the models discussed thus far differ with respect to such things as symmetry assumptions and demand specifications, they make many of the same simplifying assumptions in abstracting from real world settings to tractable models. One assumption is that the products available post merger are unchanged, both in terms of product characteristics and the number of brands or brand extensions offered for sale. Another assumption underlying these models is that firms choose prices according to a static Nash equilibrium, rather than engaging in more complex dynamic equilibrium behavior or taking into account longer term drivers of strategic choices. A third assumption is that prices are picked by sellers rather than being determined through bidding in an auction setting. Fourth, firms’ abilities to expand output post-merger is not constrained by increasing marginal costs or capacity limitations. And finally, the models typically do not explicitly consider the extent to which cost savings will be passed on to customers. Rather, pass-through rates are determined by adoption of a specific demand model. This section discusses relaxing each of these assumptions.

A. Product Repositioning

Just as both merging and non-merging firms in a price-setting, differentiated product market will generally have an incentive to revise their prices in the post-merger market, they will also generally have an incentive to change their product positioning. Prior to the merger, the merging firms positioned their brands to compete against all other firms in the market, including each other. Post-merger, the two merging firms “have each

67 This assumes that repositioning a product is not sufficiently costly that the incentives to change product position are outweighed by the adjustment cost. The same assumption is routinely made with respect to prices: in some cases there may be adjustment costs to reconfiguring prices, at least in the short term, which may mitigate the ability of firms to take advantage of the post-merger incentive to raise prices. Adjustment costs with respect to prices are rarely discussed in the context of unilateral effects analysis; adjustment costs with respect to product positioning are presumably more common, and may often be sunk, so there is a correspondingly greater need to incorporate them into unilateral effect models of product repositioning.
other’s back” and no longer need to consider competing against each other. As a result, there is an incentive to reposition their products to compete more directly against other firms. This in turn will induce non-merging firms to adjust their product positions until equilibrium conditions for both price and position are satisfied. In addition, as the head-to-head competition between merging firms is eliminated, there may be an incentive for non-merging firms to fill that competitive vacuum by repositioning existing products or introducing new product varieties that replace some of the pre-merger competitive interactions.

The incentive facing non-merging firms is discussed in the Merger Guidelines.68 The description suggests that consideration of post-merger repositioning will make unilateral effects less of a concern than would be the case in a less flexible model with fixed product characteristics. This is not the only possibility: repositioning by the merged firm can also potentially lead to higher average prices across the market as a whole. The merged firm may reconfigure its products so that they serve a broader cross-section of the market rather than competing head-to-head for the same customers.69 Thus an extended unilateral effects model that incorporates product repositioning could lead to either higher or lower average price increases than a model in which all product offerings are fixed.

Introducing product repositioning into unilateral effects models raises several issues. One is simply the additional complexity of the model, particularly if product

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68 “A merger is not likely to lead to unilateral elevation of prices of differentiated products if, in response to such an effect, rival sellers likely would replace any localized competition lost through the merger by repositioning their product lines.” U.S. Dep’t of Justice & FTC, *Horizontal Merger Guidelines, supra* n. 3 § 2.212. The Guidelines’ analytical framework for evaluating repositioning is the same as for entry. U.S. Dep’t of Justice & FTC, *Horizontal Merger Guidelines, supra* n. 3 at n. 23.

69 After the Princess-Carnival cruise line merger, the merging firm repositioned its brands to target niche customers (premium customers, in the case of the Cunard Line and British customers in the case of P&O Cruises) that the merging firms had not served as effectively prior to the merger. Amit Gandhi, Luke M. Froeb, Steven Tschantz, & Gregory J. Werden, *Post-Merger Product Repositioning*, 56 J. IND. ECON. 49 (2008).
characteristics are treated as a multidimensional space that allows a full range of
differentiation between products.\textsuperscript{70} In addition, adding product location as a choice
variable can make the best response functions discontinuous, and thus substantially
harder to solve for an equilibrium. A third issue is the prevalence of multiple equilibria
in games where firms choose both locations and prices, since often various configurations
of the different firms can be Nash equilibria given the locations chosen by other firms.\textsuperscript{71}

One alternative approach to finding a tractable model may be to replace the
assumption that firms choose their brand positions simultaneously with one in which the
merged firm is a Stackelberg leader in choosing locations. The merged firm is naturally
positioned as a leader since non-merging firms have no incentive to change their location
until the merged firm changes its location or prices. Anticipating how the merged firm
might reposition is complicated if there are multiple equilibria that could emerge post-
merger. That suggests that other firms may let the merged firm adjust brand locations
first, and then react optimally. Such a structure could simplify finding the equilibrium, as
the merged firm would solve for its optimal location given the best responses of non-
merging firms, though the solution may still be challenging to the extent that response
functions are discontinuous. In addition, while costless repositioning is a natural
modeling assumption to make when exploring how repositioning can affect unilateral

\textsuperscript{70} As an example of how limited dimensionality limits differentiation possibilities, suppose that location is
modeled using a single dimension (products are ordered along a line). If products A and B are equally
differentiated from C, then either A and B are identical products, or they are twice as far apart as each is
from C. With multiple dimensions, all intermediate degrees of differentiation between A and B are also
possible. Demand models based on product characteristics, which are discussed in the next section,
provide a promising avenue for incorporating strategic decisions over a more complex and realistic
description of product locations.

\textsuperscript{71} Gandhi, Froeb, Tschantz & Gregory J. Werden, \textit{Post-Merger Product Repositioning}, supra n. 69 explore
the range of outcomes that come into play when costless product repositioning is allowed by limiting the
product space to a single dimension (brands are arrayed along a line). They use a selection criterion to deal
with multiple equilibria that picks out the equilibrium with the most separation between brands.
effect outcomes, repositioning may not be costless in many markets, so repositioning models that neglect adjustment costs likely overstate repositioning incentives. In some markets, costly repositioning may resolve the problem of multiple equilibria: if the cost of repositioning is increasing in the amount of change in product characteristics, reducing the cost of repositioning could play the role of a selection criterion in determining what equilibrium will result post merger.

In addition to changing the attributes of brands, firms can change their competitive posture by introducing addition brands or line extensions into the market. Post-merger price increases or repositioning by other firms can make more profitable a new product introduction that was unprofitable pre-merger given the cost of start-up. While the merged firm may have new profitable opportunities to introduce products post-merger, the more compelling possibility is that an existing non-merging firm will introduce a new product to replace some of the competitive interactions that are lost if two of the merging firm brands are close substitutes. Not only could a product introduction introduce additional competition into the post-merger market, but in some cases anticipation of such an introduction (particularly if offering a brand extension can be done relatively cheaply and quickly) could constrain a post-merger price increase by the merged firm as it attempts to limit competitive opportunities for rivals.

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72 If those costs are sunk or repositioning takes time, moreover, additional strategic considerations reducing the likelihood of repositioning may come into play.  
73 Such post-merger changes differ from the analysis of entry or non-committed market participants because they involve firms already competing in the market pre-merger, who expand their product offerings post-merger. Incumbent firms may have advantages over de novo entrants through shared costs and the incentive to internalize customer substitution between existing brands and brand extensions. This suggests that, at least in contexts where additional product varieties can be introduced relatively cheaply, there is value for incorporating brand extensions in unilateral effect models directly rather than treating it as entry.  
74 Draganska, Mazzeo & Seim offer one such model, in which the locations of possible brand offerings for each firm are fixed, but firms choose which of the menu of available products they will put on the market
B. Dynamic Models

The various unilateral effects models discussed thus far share one common element: they are all based on the Nash equilibrium of a static game, in which firms choose their optimal strategies as if there is a one-time interaction between the firms post-merger. In reality, of course, firms compete in ongoing interactions that make possible a much richer menu of strategic options than are possible in a one-shot game. These richer strategies fall in at least two categories. First, repeated interaction expands the range of price-quantity outcomes that emerge as equilibria of the market when firms engage in history- or state-dependent strategies. Rather than the single Nash equilibrium which generally characterizes the static equilibrium used in unilateral effects models, the set of sustainable equilibrium profits in the dynamic game (as characterized by the folk theorem) ranges from the static equilibrium outcome of the one-shot game to something close to full collusive profits. In addition, firms may engage in a variety of complex intertemporal pricing strategies such as intertemporal price discrimination, durable goods pricing that takes into account competition against the installed base, or penetration pricing where current sales increase future demand through word-of-mouth advertising or network effects.

If the modeling goal was solely to predict the equilibrium of a game in which firms can use dynamic pricing strategies rather than static strategies, then the multiplicity of possible equilibria in a dynamic model would often only expand the range of plausible

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outcomes. But in the context of unilateral effects analysis, particularly in a setting where there is abundant data available, a dynamic model can help to resolve evidence that may otherwise be incompatible. Suppose, for example, that sufficient data is available to estimate individual firm demand functions, and that the cross elasticity matrix is used to calibrate the pre-merger equilibrium, which results in marginal cost estimates for each product. However, these imputed marginal costs diverge substantially from the margins inferred using cost data. Rather than assuming that one or the other estimates is unreliable, an alternative explanation is that the pre-merger outcomes reflect an equilibrium in which firms are using dynamic pricing strategies. If calibrated margins are larger than actual margins, firms might be using penetration pricing, deliberately setting lower prices than what would maximize prices in the short run in order to expand the market in future periods. If calibrated margins are smaller than actual margins, it may be because firms are able to sustain higher prices than in the static equilibrium by using dynamic pricing strategies. In both cases, a unilateral effects model that incorporates the dynamic strategies implied by the pre-merger data may more accurately predict the post-merger outcome than a model based on a static equilibrium that does not incorporate all the information in the pre-merger data.

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An inconsistency between demand and marginal cost estimates could also be due to mismeasurement of demand or costs, as discussed in the next section.

In the XM-Sirius merger, the parties argued that they deliberately set low prices to increase current demand, since word-of-mouth advertising means that additional customers now produce more customers in the future. Short run profits would increase by raising prices now, but long run profits would suffer. Not only would dynamic pricing reconcile the observed margins and elasticities, but it provides an pro-competitive benefit of the merger: the merged firm would internalize the demand expanding effect of word-of-mouth advertising on the rival firm, resulting in a greater incentive to engage in penetration pricing post-merger. See Steven C. Salop, Steven R. Brenner, Lorenzo Coppi & Serge X. Moresi, *Economic Analysis of the Competitive Effects of the Sirius-XM Merger*, paper filed at the Federal Communications Commission, In the Matter of XM Satellite Radio Holdings Inc., Transferor, and Sirius Satellite Radio Inc., Transferee, Consolidated Application for Authority to Transfer Control of XM Radio Inc. and Sirius Satellite Radio Inc., MB Docket No. 07-57 (July 24, 2007).
Adapting the unilateral effects model to incorporate equilibria other than that of the one-shot game does not necessarily require a full dynamic model. If conjectural variations parameters are constants, the pre-merger equilibrium can be calibrated using them in the first order condition for profit maximization. For example, suppose firm $i$ expects that when it raises its price by one dollar, in equilibrium other firms will raise their price by $\mu_i$ (that is, the firm conjectures, correctly, that $\frac{\partial P_i}{\partial P_j} = \mu_i$, $\forall j \neq i$.) Then, in the simple one product per firm case, the first order conditions in the pre-merger equilibrium are given by

$$Q^i + (P^i - C^i)\left[\frac{\partial Q^i}{\partial P^i} + \mu_i \sum_{j \neq i} \frac{\partial Q^i}{\partial P^j}\right] = 0, \quad \forall i$$

Given estimated demand parameters and margins, the first order conditions can be solved for the conjectural variation parameters that characterize the pre-merger equilibrium.\(^\text{79}\)

Once the conjectural variations parameters or other parameters of the pre-merger equilibrium are calibrated, the natural assumption is to assume that those same parameters carry over to the post-merger equilibrium. That assumption is subject to criticism: it may be that a different equilibrium of the post-merger merger dynamic game as reflected by the conjectural variation parameters will be selected, or that the incentives to engage in time dependent pricing strategies with respect to consumers will change with fewer firms in the market.\(^\text{80}\) However, the same assumption about unchanging pre- and post-merger parameters is implicit in static models, with the parameters stuck at the default value inherent in the static model. Incorporating such parameters explicitly at

\(^\text{79}\) This discussion assumes that demand and cost (hence margins) are observable but oligopoly conduct is not.

\(^\text{80}\) Note that the first of these criticisms blurs the line between unilateral and coordinated merger effects, and may be handled better through an explicit coordinated effects model.
least provides an opportunity to consider how *ad hoc* assumptions about post-merger changes in those parameters would affect the unilateral effects results. It remains to be seen how closely a unilateral effects model using conjectural variations parameters to capture long run steady state equilibria resembles the results of an explicitly dynamic model.

C. Auction Models

In some markets, price determination more closely resembles an auction than either the posted price mechanism in differentiated Bertrand models or the quantity choice and market clearing prices in Cournot models. In order to better capture predicted price effects in such markets, unilateral effects analysis can be undertaken using an auction model rather than the price and quantity setting models we have discussed thus far.\(^{81}\) The underlying intuition for unilateral effects is analogous in an auction setting. When suppliers offer bids at which they are willing to sell their product, they take into account the expected bids of other suppliers. The optimal bid is chosen to beat the second best offer made to a customer. In the pre-merger market, that second best bid is sometimes offered by the merger partner. However, after the merger, when bidding for customers for whom the merger partner would have been the second best alternative, the optimal bid need only beat the third best alternative. Thus firms bid less aggressively post-merger, by an amount that depends on the frequency of sales opportunities in which the merging firms’ products would have been the customer’s first and second choices. Unilateral

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effects arise because the merger removes the competitive constraint imposed by the merger partner when the latter firm is the second best alternative for some customers.

Merger simulation using auctions follows much the same algorithm as with price setting models.\textsuperscript{82} A particular auction model is picked, with an eye toward capturing important facts of the market in question. The parameters of the model are chosen so that the equilibrium of the model is calibrated to prices and shares in the pre-merger market. Then the auction is simulated in the post-merger market, allowing for coordinated bidding of the merged firm’s products. The resulting prices are then compared to the pre-merger prices to compute the predicted unilateral effect from the merger. Such a model was used by the plaintiff’s expert in the Oracle\textsuperscript{83} case to simulate the increase in prices for enterprise software that would result from a merger of Oracle and PeopleSoft.\textsuperscript{84}

The court did not directly evaluate the simulation but found the results to be unreliable because the market shares used to calibrate the model had already been determined to be unreliable. Nevertheless, that simulation highlights a way in which many auction models used to evaluate unilateral effects ignore relevant information that could be used to improve their predictions. The model does not directly capture whether two products are close or distant substitutes, but instead infers the frequency with which the products are the first and second choices for customers from market shares. When additional empirical information about demand is available, such as information (for example, from win-loss reports) on which products are most often first and second choices, it can be employed to calibrate patterns of head to head competition more

\textsuperscript{82} See, for example, Keith Waehrer & Martin K. Perry, \textit{The Effects of Mergers in Open-Auction Markets}, 34 RAND J. ECON. 287 (2003);
\textsuperscript{83} United States v. Oracle Corp. (2004). 331 F. Supp. 2d 1098 (N.D. Cal.).
\textsuperscript{84} Werden & Froeb, \textit{Unilateral Competitive Effects of Horizontal Mergers}, supra n. 1 at 70 describe the Oracle case as “the only U.S. merger case in which a merger simulation was introduced at trial.”
accurately before predicting unilateral effects. An additional question is the extent to which differentiated product models like UPP can be adapted to an auction context to provide an initial screen for identifying which mergers are likely to lead to unilateral effects without requiring a full auction simulation.

D. Other extensions

We briefly discuss two other possible extensions of unilateral effects models. One concerns whether pass-through can be modeled explicitly in a unilateral effects simulation. Pass-through describes the relationship between cost changes experienced by firms and price changes received by customers. It can be a contentious issue in merger cases, as in Staples. Typically pass through is determined by assumption, as a by-product of the functional forms used in a merger simulation model (a linear demand model produces a pass through rate of 50%, for example.) But in some cases it may make sense to model pass through directly, setting parameters by using the available evidence as to oligopoly conduct and the curvature of demand. For example, in a merger of products sold in supermarkets, the pass through rate would be determined not only by wholesale competition and the consumer demand function but also by the retail pricing equilibrium among supermarkets. Rather than developing a full two stage model of competition (only one stage of which is directly affected by the merger) it may be sufficient to capture the effect of the retail stage using a pass-through parameter.


86 The importance of curvature of demand (the elasticity of the elasticity) to pass-through is emphasized in Jeremy I. Bulow & Paul Pfleiderer, A Note on the Effect of Cost Changes on Prices, 91 J. POL. ECON. 182 (1983).
One final area for extending unilateral effects models is the impact of non-linear cost functions or capacity constraints. Intuitively, if non-merging firms are less willing to expand output following a merger because costs rise as output expands or because they run into capacity constraints, those firms will provide less of a constraint on post-merger pricing, which would tend to increase adverse unilateral effects. On the other hand, if the merging firms’ output was constrained by rising marginal costs or capacity constraints pre-merger, they will have less incentive to cut output post-merger, which will tend to reduce unilateral effects. In one set of simulations that allowed simultaneously for both possibilities, the second effect tended to dominate.  

VI. Measurement Issues

A number of measurement issues arise in analyzing unilateral effects, regardless of whether informal methods or merger simulation is employed to measure incentives to raise price post-merger. This section considers several such topics.

A. Demand

Most simulation modeling begins by estimating a demand system for the products at issue.  Doing so raises familiar econometric issues, including the choice of functional form, simultaneity and identification, and the possibility of omitted variable bias. Our
brief discussion highlights a number of issues that frequently arise when demand system parameters are employed for merger simulation. The same issues necessarily arise when informal methods are used to infer demand elasticities, but they are generally not exposed (and may not be recognized when present) in such settings.

First, in differentiated product settings, there is commonly no reason to expect symmetry in demand elasticities or diversion ratios across products. Such asymmetries can have a large effect on the outcome of a merger simulation, so demand estimation should allow for that possibility. Second, some limits will invariably be placed on the scope of products included in the demand study. The decision whether to include or exclude a relatively distant substitute for the products of the merging firms generally has little practical effect on the simulated price increases, however.

Third, if the merger simulation model accounts for the possibility that cost savings will be passed through to price, it must incorporate parameters related to the curvature of demand. To infer such parameters statistically, it will be necessary to estimate demand using flexible functional forms that allow demand elasticities to vary freely with price.

The latter issue points to a more general tradeoff in merger simulation between tractability (which pushes toward reducing the number of parameters that must be estimated or inferred) and flexibility (which pushes toward increasing the number of parameters). Limiting the number of parameters can be particularly important for

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90 Even if (hypothetically) most Dr Pepper drinkers view Coca-Cola as their second choice soft drink at current prices, Coke drinkers might nevertheless largely see Pepsi as their second choice, for example. See generally, Jonathan B. Baker, Contemporary Empirical Merger Analysis, 5 GEO. MASON L. REV. 347, 357 (1997) (“there is no basis, theoretical or empirical, for presuming absent evidence from the market at issue that the cross elasticities are symmetric”).

91 We discuss pass-through of cost savings in section V above.
tractability when estimating demand in differentiated-product industries where each firm sells a wide range of product variants.\textsuperscript{92}

On one extreme, some merger simulation methods, such as the PCAIDS and ALM models discussed earlier, rely on a limited number of demand parameters. These parameters are sometimes assessed informally using qualitative evidence, without quantitative estimation of a demand system, or inferred from market shares. Other methods, with more complex computational requirements, infer demand parameters from market shares and product characteristics.\textsuperscript{93} Still another way of restricting the number of demand parameters in estimation characterizes demand as resulting from multi-stage budgeting, and assumes separability of demand between the products in various sub-aggregates.\textsuperscript{94}

A fourth issue in estimating demand arises in settings where dynamic behavior is important.\textsuperscript{95} In many retail markets, the combination of short-term seller promotions and household inventor- ing create short run buyer responses to price changes that differ from how buyers behave over a longer run more relevant to antitrust analysis.\textsuperscript{96} Demand estimates that use high frequency (daily or weekly) data and do not explicitly model these

\textsuperscript{92} Relatedly, Budzinski & Ruhmer emphasize the expense and time required for sophisticated merger simulation. Budzinski & Ruhmer, \textit{Merger Simulation in Competition Policy}, supra n. 50 at 34; see also Slade, \textit{Merger Simulations of Unilateral Effects}, supra n. 37 at 338 (discussing the tradeoffs between simplicity and accuracy in differentiated product merger simulation models.)


\textsuperscript{95} We are grateful to Aviv Nevo for discussion of these issues.

\textsuperscript{96} See generally Baker, \textit{Contemporary Empirical Merger Analysis}, supra n. 90 at 352-55.
dynamics may estimate inconsistent coefficients and, even if they do not, may measure short run effects that differ from the elasticities of interest for simulating unilateral effects.

A final issue relates to out-of-sample predictions. If price variation is limited in the data used to identify demand, it may be possible to identify empirically local demand elasticities with precision without precisely identifying the curvature of demand. Yet mergers can substantially alter market structure, leading to discrete, not localized, movements in prices and output. The curvature of demand can be very influential in determining the price changes that result from loss of direct competition in this context, and it is central to determining the rate at which the merged firm would pass through marginal cost savings to price. If price variation is limited in the data, it may still be possible to exploit other types of informal experiments, particularly the entry and exit of products or locations, to gauge the curvature of demand.

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97 See Igal Hendel & Aviv Nevo, A Simple Model of Demand Anticipation (Sep. 11, 2009) and Tenn, Froeb & Tschantz, Mergers when Firms Compete by Choosing both Price and Promotion, supra n. 48. Another common problem arises when demand systems are estimated on weekly store data: cross-price effects not infrequently have the “wrong” sign (likely substitutes appearing to be complements). This may reflect a failure to account properly for promotional activity and household inventory. In a personal communication with one of us, Aviv Nevo suggested instead that this may arise from a lack of independent exogenous variation in prices (that is, variation in the part of price explained by the instrumental variables). The problem is less common in estimating logit models of demand, mainly by assumption. The discrete choice framework tends to require that products be substitutes by virtue of the assumption that if buyers do not purchase one product they select another.


99 For example, if a supermarket or other multi-location retailer opens at a new location, it in effect lowers the price for its products at that location from what was the delivered price (the price at the nearest
B. Marginal Cost

Another set of measurement issues involves marginal cost. The profit recapture perspective on unilateral effects emphasizes that any effort to calibrate demand elasticities or diversion ratios – to determine whether those demand parameters imply a large or small incentive to raise price – values the lost sales from a unilateral price rise (an amount determined by the shape of demand) by weighting them by the contribution margin on those sales. The contribution margin in turn depends on measurement of marginal cost – most importantly its level, and secondarily how it varies with output.100 Putting aside the analysis of efficiencies, the unilateral effects model in differentiated products industries thus uses marginal cost mainly to determine the lost contribution to profit from a reduction in output by the merging firms.

It is typically possible even for industry outsiders to observe changes in prices of some key inputs into production or distribution of differentiated products.101 But detailed accounting information about the components and level of average variable cost, a common proxy for marginal cost, is generally only available to industry insiders, who can make it available for antitrust analysis.102 Some simulation methods treat marginal cost

100 Understatement of marginal cost (markup overestimate) limited to one firm may lead to an overstatement of the unilateral incentive to raise price arising from merger. Marginal cost underestimation across the board (for all firms) will likely lead to a misstatement of the unilateral incentive to raise price, but the bias could go either way. Baker, Contemporary Empirical Merger Analysis, supra n. 90 at 358 n. 43.

101 This type of information can often be used to identify demand econometrically.

102 It is often necessary to interview executives to understand the technology of production and distribution and clarify the interpretation of accounting data from the merging firms. For an example of the kind of analysis required to develop a convincing measure of average variable cost even when detailed accounting data is available, see Genesove & Mullin, Testing Static Oligopoly Models, supra n. 61 at 359-61.
as unobservable, and infer cost and price-cost margins from demand using the first order conditions for firm profit-maximization. This approach allows mergers to be simulated without data on marginal cost. The resulting inferences as to marginal cost and the effect of the merger on price and output can be sensitive, however, to various assumptions, particularly as to the functional form of demand\textsuperscript{103} and to the oligopoly solution concept (\textit{e.g.} that it is Bertrand-Nash).\textsuperscript{104}

Other difficulties with measuring marginal cost derive from the possibility that the merging firm’s marginal decision relevant to merger analysis is not the same as the decision implicit in the accounting data from which its average variable cost is computed.\textsuperscript{105} For example, if the merged firm reduces output of the products sold by either (or both) merger partner in order to raise price, it might on the one hand lose out on volume discounts previously available or the ability to access low-cost channels of distribution, raising per unit costs above what is recorded in the accounting data. On the other hand, the merged firm might free itself from paying the higher costs associated with approaching a capacity constraint, or from rising marginal costs in marketing a differentiated product,\textsuperscript{106} thus lowering per unit costs below what is recorded in the accounting data.

\textsuperscript{103} See Slade, \textit{Merger Simulations of Unilateral Effects}, supra n. 37 at 334.
\textsuperscript{104} See generally, Genesove & Mullin, \textit{Testing Static Oligopoly Models}, supra n. 61. Even if firms experience their conduct as setting price rather than output, their behavior is not necessarily consistent with Bertrand-Nash competition, a common assumption in that context. \textit{E.g.} David M. Kreps & José A. Scheinkman, \textit{Quantity Precommitment and Bertrand Competition Yield Cournot Outcomes}, 14 BELL J. ECON. 326 (1983).
\textsuperscript{105} That, the accounting data may implicitly assume that the merged firm reduces output (loses sales) over a different time period or different scale than contemplated by the unilateral effects model.
\textsuperscript{106} The marginal cost of distributing a differentiated product will slope upward if the firm sells first to buyers who can be informed or persuaded least expensively. That is, firms selling differentiated products may experience decreasing returns to scale in promotion and distribution even if they experience constant returns to scale in production.
Similarly, an accounting measure of average variable cost that excludes all expenditures on advertising and promotion may underestimate marginal cost. The marginal cost relevant to pricing includes those advertising and promotional expenditures that would change were the firm to adopt a different pricing strategy over a full promotion and inventory cycle – a time period more relevant to merger analysis than the short run period over which average variable cost is often computed.\textsuperscript{107}

Other problems in measuring marginal cost may arise when firms sell multiple products; we highlight issues arising when either or both merging firms sell demand complements for the products of concern.\textsuperscript{108} Suppose, for example, the unilateral effects concern from a proposed (and entirely hypothetical) merger involves the merging firms’ sale of shampoo, and that one or both firms also sells conditioner under the same brand name (where adverse competitive effects are not threatened). No firm in this hypothetical example sells shampoo combined with conditioner, many but not all consumers of shampoo also use conditioner, and consumers of a particular shampoo brand tend to use the same brand of conditioner. Under such circumstances, if a merging firm reduces the output of shampoo (to profit from anticompetitive unilateral effects), it will lose sales and profits in conditioner as well. Accordingly, the lost contribution to profit in conditioner

\textsuperscript{107} This idea might justify using average operating cost or average total cost rather than average variable cost as a proxy for marginal cost in some cases. If the merged firm reduces output in order to raise price, marginal cost might also be reduced to the extent the output reduction leads the firm to cut back on planned investments such as capacity expansion. The marginal cost reduction could go beyond the direct savings to include any “real option” benefit arising when investment decisions are deferred.

\textsuperscript{108} There are three other cases. First, if a merging firm also sells products that are complements in supply (joint products, like beef and hides), an anticompetitive reduction in output by the merged firm will reduce the contribution to profit from the supply complement. This lost profit should be seen as part of the marginal cost of producing the product of concern. Second, if a merging firm sells products that are substitutes in demand, its profit-maximizing output decision with respect to that good is presumably accounted for directly in the analysis of unilateral effects. Third, if it sells products that are substitutes in supply, any contribution to profit obtained from shifting the marginal unit of production or distribution capacity to that supply substitute would reduce the marginal cost of the product of concern for the purpose of unilateral effects analysis.
resulting from a marginal increase in the shampoo price should be included in assessing the marginal cost of shampoo. An analysis of unilateral effects that does not account for this dynamic will understate the cost of raising the price of shampoo to the merging firm, and, in consequence, likely overstate the unilateral incentive to raise price.  

Moreover, if current sales of a product make future sales more likely, as would arise, for example, if buyers learn about product attributes from trial or from network effects, then future sales can be viewed as a demand complement for current sales and a similar analysis would apply.

C. Non-Price Dimensions of Competition

Much competition takes place on non-price dimensions, including improvements in product quality, modification of product features or geographic locations, and new product introductions. Unilateral effects analyses that focus on output and price likely incorporate some of these dimensions by measuring price and output in quality-adjusted units. But it is an open question whether that analysis fully proxies for unilateral reductions in these other dimensions of competition, which might take the form of slowed innovation.

VII. Testing of Unilateral Effects Analyses

Merger retrospectives are difficult to conduct and rare, but a recent study by Orley Ashenfelter and Daniel Hosken offers the most reliable test of unilateral effects analyses

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109 Note, however, that if all firms in the market sell complementary products, and if as a result the cost of raising price is understated for all firms, then the bias in the unilateral effects analysis could go either way; see Baker, Contemporary Empirical Merger Analysis, supra n. 90 at 358 n. 43.


111 For a recent effort to make product characteristics endogenous, see Draganska, Mazzeo & Seim, Beyond Plain Vanilla: Modeling Joint Pricing and Product Assortment Choices, supra n. 74.
to date.112 Their study examines the price effects of merger following five recent branded consumer products acquisitions using scanner data. The mergers were selected for analysis based on data availability and on indications that the merger, though not challenged, might have presented a close call for the U.S. antitrust enforcement agencies.113 The mergers were in industries where the likely competitive effects theory was the loss of direct competition among sellers of differentiated products – historically the primary concern of unilateral effects analysis.

The study employs a difference-in-difference empirical strategy to control for factors that might affect prices other than the merger. It compares the change in prices for the merged firm’s products from before the merger to after the merger (using various definitions of price and various definitions of before and after) to the change in prices of products in two control groups: private label products in the same industry, and branded consumer products sold by rivals. In four of the five cases, the study finds that the merger led to price increases (typically between 3% and 7%) relative to prices in the control groups, while leading to no price increase in the fifth case.

These results suggest that the marginal unilateral effects merger – one that would be a close call to antitrust enforcers – raised price, at least in the short run, before all efficiencies kicked in. This conclusion implies that the antitrust agencies, in employing unilateral effects analysis, are successfully targeting transactions that would have an anticompetitive effect on prices.


113 Those indications include apparent high market concentration and, in some cases, evidence of an active enforcement agency review before the merger was allowed to proceed.
In future retrospective analyses of unilateral cases, it would be useful to extend this result, in analyzing these or other transactions. Many other questions could be studied. Did rival repositioning undermine or counteract the harm in these or other mergers? Did efficiencies from merger make these transactions pro-competitive in the long run? Do the agencies do as well when the unilateral effects theory involves a bidding model?