A *Daubert* Discipline for Merger Simulation

BY GREGORY J. WERDEN, LUKE M. FROEB, AND DAVID T. SCHEFFMAN

LITTLE ATTENTION WAS PAID TO the unilateral effects of mergers prior to the release of the 1992 Horizontal Merger Guidelines.[1] But "merger simulation"—the formal use of structural, game-theoretic models to make quantitative predictions of unilateral competitive effects—quickly came into vogue after their release. The idea is simple: With suitable models indicating what actions market participants take under particular circumstances, it is straightforward to predict the likely outcome, or "equilibrium," of their interaction, and it is similarly straightforward to compute the likely effects of a merger on the equilibrium, provided that the same, well-specified model of competitor interaction applies before and after the merger. Thus, merger simulation takes a standard model of oligopoly appropriate for the industry, calibrates it to match critical features of the industry (e.g., prices and market shares), and uses it to compute the post-merger equilibrium internalizing competition between the merging firms.[2]

If merger simulation had a well-established and consistent high degree of accuracy in predicting the effects of actual mergers, its reliability would be a settled question. Because that is not the case,[3] the reliability of any particular application of merger simulation should be gauged by examining the modeling process, which is at least as much art as science. To make the myriad choices required, the modeler draws on prior beliefs as well the available data, so any predictions from a model derive from a complex combination of beliefs, qualitative evidence, and data. Particularly because merger simulation may be used in an adversarial setting, it is important to examine the process of combining these inputs. Thus, we propose that every modeling choice in a merger simulation apt to matter significantly be accompanied either by some sort of justification or by a sensitivity analysis indicating its impact.

We first explain how our proposal for assessing the reliability of merger simulation borrows principles from the Federal Rules of Evidence and then detail several modeling choices that matter—showing how some might be supported by evidence, and how others should be subject to sensitivity analysis. This discussion draws on lessons learned from a decade of applying the merger simulation methodology, the main one being that it is a serious mistake to use the methodology to predict the future without first making sure that it explains the past.

Gregory Werden is Senior Economic Counsel, Antitrust Division, U.S. Department of Justice. Luke Froeb is Director, Bureau of Economics, Federal Trade Commission. David Scheffman is a Director of LECG and adjunct professor at the Owen School of Management, Vanderbilt University and formerly was Director of the FTC Bureau of Economics. The views expressed herein are not purported to be those of the U.S. Department of Justice, the Federal Trade Commission, or any of its Commissioners. *John Geweke and Tim Muris provided helpful comments.*

A *Daubert* Discipline for Merger Simulation

Daubert *and Progeny.* In *Daubert* the Supreme Court required trial judges to ensure that only "scientifically valid" testimony is exposed to the jury.[4] In *Kumho Tire* the Court explained the purpose of "*Daubert*'s gatekeeping requirement" "is to make certain that an expert . . . employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field,"[5] and it made clear that the gatekeeping requirement applies to all expert testimony, including economic testimony in merger cases.[6]

In *Daubert*, the Court also held that expert testimony is admissible only if "sufficiently tied to the facts of the case that it will aid the jury in resolving a factual dispute," i.e., only if there is a good "fit" between the testimony and the pertinent inquiry.[7] In *Joiner*, the Court again stressed this "fit" requirement in cautioning that a court should not "admit opinion evidence which is connected to existing data only by the *ipse dixit* of the expert. A court may conclude that there is simply too great an analytical gap between the data and the opinion proffered."[8]

Failure to fit the facts has been the principal basis for excluding economic expert testimony in antitrust cases. The leading example is *Concord Boat*, in which the court held that "a theory that might meet certain *Daubert* factors . . . should not be admitted if it does not apply to the facts of the case."[9] After the "thorough analysis of the expert's economic model" required by *Daubert*, the court found the model wanting in several respects.[10] In several other antitrust cases, testimony premised on empirical economic models was excluded because the courts determined that those models departed from the facts of the case in critical ways.[11]

A* Daubert *Discipline. The *Daubert* line of cases addresses the admissibility of expert testimony at trial. Although very few merger cases ever go to trial, merger analysis in general, and merger simulation in particular, nevertheless should exhibit "intellectual rigor," and "the *ipse dixit* of the expert"

is never acceptable. To impose the sort of discipline that would be imposed at trial, every modeling choice in a merger simulation apt to matter significantly should be accompanied either by some sort of justification or by a sensitivity analysis indicating its impact.

For most modeling choices, the justification should be that they "fit" the industry under review, i.e., that there is consistency between the factual setting of the industry and a structural model that can be employed in a simulation. Evaluating fit draws on the full array of qualitative evidence developed in the case. Evaluating fit also draws on particular quantitative features of the industry, which may be directly measured, as with price-cost margins, or estimated econometrically, as with demand elasticities. If there is a general rule for evaluating fit, it is that a model of the competitive process fits the industry if it explains the past at a fairly high level of generality. For example, it is wholly unnecessary for a model to explain week-to-week price movements, but essential that it explain the average level of prices over a year.

Of course, *Daubert* does not demand a perfect fit between the model and the facts. Structural economic models are abstractions that can never perfectly describe the real world. Moreover, a perfect fit between the model and the facts is not even a goal to which a modeler should aspire. If structural models become too complex, through elaborate attempts to fit every detail of an industry, the models are apt to lose their value in merger analysis; they likely impose unreasonable informational demands and may yield no clear predictions. What is required is that a standard model of oligopoly interaction explain past outcomes of the competitive process reasonably well. Hence, a model may fit an industry quite well enough even if it does not reflect notable features of the industry.[12] Anyone performing a merger simulation ultimately should be convinced, and prepared to persuade others, that the oligopoly model employed explains the past well enough to provide useful predictions of the future.[13]

For a few modeling choices, an ample justification can be found in an axiom of economics, e.g., that firms maximize profits (in some sense). And for a few modeling choices, no justification is likely to be available because neither economic theory nor observation of the industry indicates which choice to make. For example, neither provides a sound basis for choosing a particular functional form for consumer demand. Such choices should be subjected to a sensitivity analysis—analyzing the implications of alternative choices—to make clear the range of uncertainty that surrounds the predictions of the model and whether the particular choice is apt to skew predictions in a particular direction. Price increase predictions may prove insensitive to some choices, but they are quite sensitive to others.[14]

Price-increase predictions always are subject to modeling error, stemming from assumptions that are never exactly right and may be terribly wrong, and from sampling error in the statistical estimation of model parameters.[15] Merger simulation predictions are *at best* reasonable, but rough, estimates of the likely effects of mergers. These two sources of error imply, for example, that price increase predictions close to zero cannot meaningfully be distinguished from zero.[16]

Basic Issues in Simulating Branded Consumer Products Mergers

Merger simulation has most often been applied to mergers involving branded consumer products, using the Bertrand oligopoly model. That model assumes competitors interact just once, each maximizing its short-run profit, with price as the sole dimension of competition.[17] Bertrand equilibrium is reached when all competitors are happy with their prices, given rivals' prices.[18] Whether the Bertrand model is appropriate in any particular case may depend on many considerations, three of which are of general application.

First, the role of non-price competition should be evaluated. Aspects of marketing strategy may interact in important ways with the choice of price or be affected by the merger in ways that would cause the price-increase predictions to be a seriously misleading description of the merger's effects. Second, responses in the recent past to any significant cost changes, new product introductions, or other "shocks" should be evaluated, asking how well the Bertrand model would have predicted them. Finally, the observed price-cost margins for the merging products and close substitutes should be compared to the margins predicted by the Bertrand model.[19]

The first step in a merger simulation is model "calibration"—choosing parameter values to make the model fit certain features of the industry.[20] In simulating a branded consumer products merger using the Bertrand model, calibration involves prices, shares, and elasticities of demand. A set of prices and shares is chosen to represent the equilibrium "but for" the proposed merger, i.e., the prices and shares that are expected to prevail in the near future absent the merger.[21] The best evidence of the "but for" equilibrium normally is the equilibrium prevailing when the merger is proposed, so the usual practice is to take the "but for" equilibrium to be the average prices and shares over a recent period, commonly the most recent one-year period for which data are available. In particular cases, however, it may be appropriate to adjust historic data to reflect reasonably foreseeable changes in prices or shares absent the merger.

Demand elasticities often are estimated econometrically using high frequency scanner data or survey data. Estimation, especially using scanner data, raises a host of potentially difficult econometric issues[22] and ultimately may not bear significant fruit. When reliable estimation is infeasible, the demand elasticities can be approximated from indications of preferences or switching patterns derived from surveys, marketing studies, and other documentary evidence. Alternatively, because the demand elasticities must have a particular relationship to price-cost margins in a Bertrand equilibrium, they can be approximated from observed margins.

The predicted price effects of the merger are the differences between the simulated post-merger prices and the

prices used in the calibration. It would be meaningless to compare the simulated post-merger prices to any set of pre-merger prices other than those used to calibrate the model, because the difference between the two would only partially be attributable to the effects of the merger. In *Concord Boat* the court of appeals rejected a damage estimate the court found to have been based on such a faulty comparison. The damage model in that case attributed to the challenged conduct all sales made by the defendant in excess of half of total market sales. That attribution was inappropriate because the defendant made three-quarters of market sales before undertaking the challenged conduct.[23] A properly calibrated model might have attributed to the challenged conduct only sales by the defendant in excess of three-quarters of total market sales.

Simulating post-merger prices requires values for the marginal costs for all products in the simulation, which generally are inferred from the calibrated model. The pre-merger marginal costs are assumed to be those making the observed prices and shares a Bertrand equilibrium, given the estimated elasticities. In computing the post-merger equilibrium, it generally is necessary to assume that marginal costs are invariant to output, although it is simple to incorporate any likely effects of merger synergies on the marginal costs of the merging products.

It is important to compare the inferred marginal costs with whatever evidence is available on actual marginal costs.[24] If it appears that the inferred marginal cost for any merging product differs substantially from the likely true value, the Bertrand model does not explain pre-merger pricing and therefore cannot reliably predict post-merger prices.[25] Cost data for non-merging products typically are not available, but even without access to cost data, it may be apparent that the inferred marginal costs for one or more non-merging products are implausible. For example, a negative marginal cost clearly is implausible. The inference of a negative marginal cost despite a plausible value for a product's demand elasticity indicates that the Bertrand model does not explain that product's pricing; indeed, such a product is being priced *much more* aggressively in the real world than the Bertrand model predicts. It also can be useful to compare inferred marginal costs across products, checking in particular for implausibly large inter-product differences in marginal costs.

A virtue of formal structural modeling, such as merger simulation, is that it forces assumptions to be made explicit, which facilitates the examination of the differing implications of alternative assumptions. Structural modeling can be particularly useful for identifying what really matters, why it matters, and how much it matters. A decade of merger simulation also has lead to a greater appreciation of the complexity and variety of competitive processes, and clearer understanding that differing modeling assumptions can amplify or attenuate merger price increases, and even make them disappear altogether. Making assumptions explicit also can help keep structural modeling firmly grounded in fact, by facilitating a comparison between features of the model and the real world. Experience with merger simulation has taught that it can usefully complement a fact-intensive analysis of consumers, competitors, and the institutional setting of an industry, but it cannot substitute for such an analysis. An assessment of the facts is required to determine which of many combinations of evidence and assumptions (about demand and competitor interaction) are reasonable.

Three Important Modeling Choices

Simulating a merger involving branded consumer products involves many choices, and the price increase predictions can be highly sensitive to some of them. The remainder of this article explores several important examples.

Demand Elasticities. Demand elasticities are critical determinants of the price increase predictions from the simulation of a merger among sellers of branded consumer products that compete strictly on the basis of price. In the Sprint-WorldCom merger investigation,[26] several economists estimated firm-level demand elasticities for residential long-distance service, in which the merger would have combined the second and third largest carriers.[27] Unfortunately, it can be difficult to get precise estimates of demand elasticities, and demand estimation for residential long-distance service presented major problems.[28] Particularly when there are such problems, it is important to explore the sensitivity of the price increase predictions to the choice of values for the relevant demand elasticities.

To illustrate the sort of sensitivity analysis that might be used, we consider a simple model, based on a restrictive—potentially unrealistic—assumption about the nature of substitution among competing brands. This assumption is that customers lost by one carrier as it increased price would switch to other carriers in proportion to their relative market shares.[29] Hence, a carrier with a share of 20 percent would gain twice as many customers as a carrier with a share of 10 percent. This restrictive assumption makes it possible to calibrate the model with just prices, shares, and two demand elasticities—the aggregate elasticity of demand for residential long-distance service and the elasticity of demand faced by any one individual carrier.[30]

Figure 1 presents a contour plot of the predicted increase in residential long-distance prices averaged over all carriers, assuming Bertrand competition among them.[31] This plot reflects values of residential long-distance demand elasticity between –1.5 and –0.5 and values of WorldCom's demand elasticity between –4 and –1.25. This range of aggregate elasticities brackets estimates in the academic literature, while the range of WorldCom elasticities is consistent with many estimates we have seen for branded consumer products. The contours represent combinations of the two elasticities yielding market-wide average price increases of 0.4, 0.6, 0.8, 1.0, and 1.2 percent. Thus, the highest contour represents an average price increase three times that of the lowest contour.[32]

Presenting merger simulation results this way makes it clear how, and by how much, the choice of values of the rel-

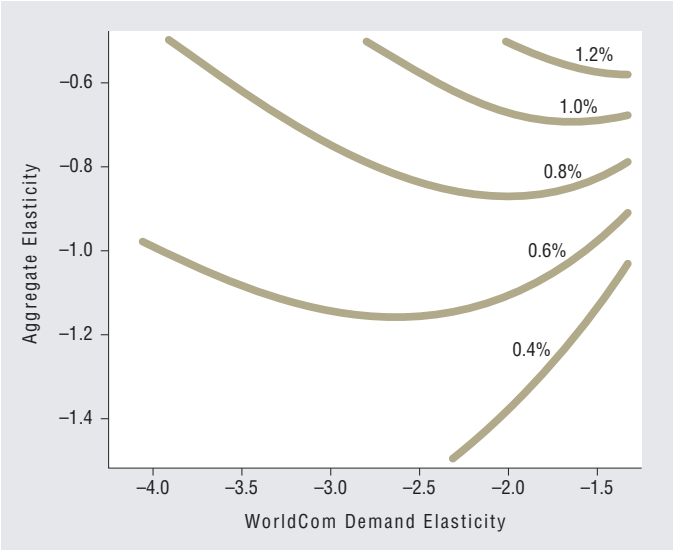

Figure 1. Market-Wide Average Price Increases Predicted from the Sprint-WorldCom Merger

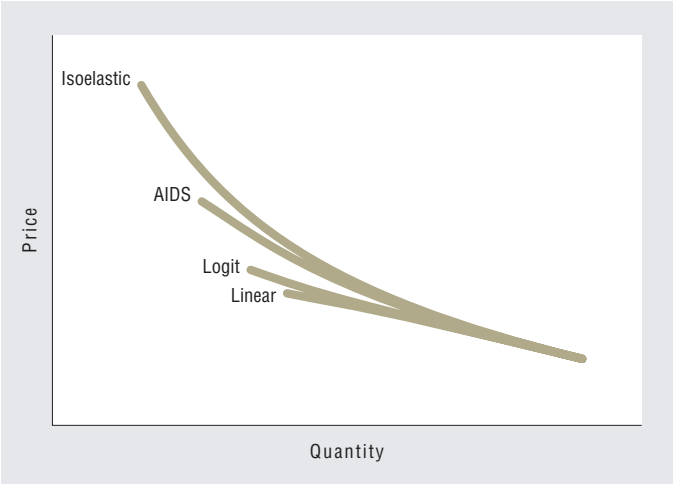

Figure 2. Four Demand Curves Plotted Between the Competitive and Monopoly Prices

evant demand elasticities affects the predicted price effects of a merger. Some sort of sensitivity analysis always should be performed, but the details may depend on the basis for the elasticity values employed (e.g., whether econometrics was used) and the nature of the uncertainty about the elasticities. Without some kind of sensitivity analysis relating to the values for the demand elasticities, it would be very difficult for enforcement agencies or courts to get a clear picture of what the data and modeling really are saying about possible price increases.

Demand Curvature. While demand elasticities commonly are determined in some fashion from the available data, how the elasticities change with changes in prices is not. Rather, that is determined by the *assumed* functional form for demand.[33] Every functional form conventionally used in merger simulation has inherent "curvature" properties relating to the effect of a change in the price of a given product on the own and cross elasticities of demand for the merging products and close substitutes. Four functional forms have been used significantly in merger simulation—AIDS, isoelastic, linear, and logit demand. The former two yield substantially higher price increase predictions than the latter two whenever the predicted price increases are substantial.[34] Indeed, the former two can easily yield predicted price increases several times those of the latter two.

We illustrate the importance of the choice of a functional form for demand in Figure 2, in which the four commonly used demand curves are plotted between the monopoly and competitive prices. All four demand curves share a common competitive price and quantity at the lower right (i.e., the point at which price equals the assumed marginal cost), and all have the same elasticity (specifically, –2) at that point. If only a very narrow range of prices near the competitive level were observed, all four of these demand curves would be consistent with the observed data.

We can imagine that the pre-merger industry was roughly at the competitive equilibrium, and if the proposed merger were significantly anticompetitive, it would necessarily move the equilibrium significantly. In the limiting case of merger to monopoly, the post-merger equilibrium could be one of the four equilibria at the left endpoints of the curves in Figure 2. But these four demand curves have quite different monopoly equilibria. The highest monopoly price is associated with the isoelastic demand curve, which exhibits the same demand elasticity at every point along the curve.[35] The linear, logit, and AIDS demand curves all become more elastic as price increases, and because consumers become more sensitive to price changes as prices increase, the merged firm would raise price less with those demand curves than with isoelastic demand. The linear demand curve yields the lowest monopoly price because the elasticity of demand rises faster with linear demand than with logit or AIDS demand.

There are essentially two ways to respond to the inherent uncertainty about demand curvature. One is to choose a demand form that is conservative. For example, a plaintiff attempting to block a merger could choose linear or logit demands, both of which yield relatively small price increase predictions. In an enforcement agency's deliberations on whether to challenge a merger, the same conservative approach is appropriate. A defendant could choose isoelastic or AIDS demand, which yield relatively large price increase predictions.

The other way to respond to the inherent uncertainty about demand curvature is to undertake an analysis somewhat different than merger simulation, which is not sensitive to demand curvature. Instead of asking by how much a merger would raise price in the absence of synergies affecting marginal costs, one can ask by how much would merger synergies have to reduce marginal costs to prevent any price increases at all. These latter amounts are referred to as compensating marginal cost reductions (CMCRs). CMCRs do not depend on demand curvature for the simple reason that the post-merger, post-synergy equilibrium, with the CMCRs, is precisely the same as the pre-merger, pre-synergy equilibrium. Using the Bertrand model, it is reasonably straightforward to compute the CMCRs for a merger of branded consumer products, given a set of prices, shares, and elasticities used to calibrate a merger simulation.[36]

The Retail Sector. A retail sector typically separates the merging manufacturers from the consumers, and, when that is the case, simulating a merger involving manufacturers of branded consumer products requires a modeling choice about the retail sector. Most published merger simulations have just ignored the retail sector, effectively choosing to model the industry as if manufacturers sold directly to consumers.[37] This choice can be justified only in two scenarios. One is that of a "transparent" retail sector in the sense that the retail and manufacturing sectors are effectively merged together by manufacturers' use of contractual devices to extract all of the retailers' profits.[38] The other is that of retailers following a simple rule of thumb and applying a constant percentage mark-up to the prices they pay to manufacturers. In this latter scenario, the demand elasticities are exactly the same at the retail and wholesale levels, and it is trivial to translate between the two.[39]

In all other scenarios, ignoring the retail sector is apt to render merger simulation predictions significantly misleading. Regrettably, a totally realistic analysis of competing manufacturers selling through competing retailers is extraordinarily complex and well beyond the current state of the economic literature. The analysis of relatively simple models, however, has indicated that the retail sector can amplify, attenuate, eliminate, or simply pass through upstream price increases from merger.[40]

If individual retailers face no competition and charge prices that fully exploit their monopolies at the retail level, a manufacturing merger could have no effect on retail prices. The manufacturers and retailers both would want to make the "profit pie" as big as possible by setting optimal retail prices, which would be unaffected by the merger. Hence, retail prices likely would remain the same after a manufacturing merger. How manufacturers and retailers divide the pie would be determined by their relative bargaining power, which likely would be altered by a merger. The absence of an effect on retail prices may not mean that the merger of two manufacturers escapes condemnation under Section 7,[41] but ignoring the retail sector would be highly problematic. The effect of the merger would be very different because of the retail sector; indeed, the merger could affect only fixed fees, while leaving wholesale prices, as such, unchanged.

Things are quite different if manufacturers and retailers both exercise market power at their respective levels of distribution, and if the terms under which manufacturers sell to retailers involve a single wholesale price and no fixed fees. Manufacturers then price above their marginal costs to a degree determined by the competition among them, and retailers mark up the wholesale prices to a degree determined by competition in retailing, thus presenting the "double markup" or "double marginalization" problem. Both the manufacturer and the retailer raise price significantly above their marginal cost in the attempt to capture a larger slice of the "profit pie," but that shrinks the size of the pie. Equilibrium retail prices are higher than those maximizing joint retailer and manufacturer profit.

No general model has been analyzed in which the manufacturing and retail sectors behave in this manner, but in a model with a single retailer and several manufacturers, it has been shown that the price effects of merger can be attenuated or amplified relative to those with a transparent retail sector that simply passes along upstream price increases. Whether price effects are attenuated or amplified is determined largely by the curvature of demand. The effects have much in common with the price effects of marginal cost changes, and the analysis of the pass through of cost changes demonstrates the central role of demand curvature. Particularly sensitive to assumptions about demand curvature are the price increases by the non-merging firms producing reasonably close substitutes for the merging products.[42]

In a 1995 analysis of a merger of leading bakers of white pan bread, the Justice Department's expert (one of this article's authors) concluded that retailers priced by applying a constant percentage markup to the wholesale price. In the light of this conclusion, it was straightforward to account for the retail sector in simulating the merger.[43] In other cases, it may be possible to gain some insight into the manufacturer-retailer relationship by examining the manufacturers' price-cost margins. For example, those margins are predicted to be zero or negative in two models that have been analyzed, and either prediction may be refuted easily.[44] A close examination of retailer behavior and manufacturer-retailer dealings can be vital for accurate prediction of the effects of a branded consumer products merger.

Conclusion

The basic economic theory underlying unilateral effects from horizontal mergers is deceptively simple: Before the merger, each seller of competing branded consumer products selects the price that maximizes its profits. A merger of two such competitors necessarily alters the profit calculus by changing product ownership. Increasing the quantity sold for one merging product takes sales away from one or more products the merger brings into common ownership. The merging

firms had ignored this effect, but the merged firm fully accounts for it, responding to this change in incentives by raising prices. Non-merging firms respond with price increases of their own.

Behind this simple story is a complex game-theoretic model replete with assumptions about how consumers, retailers, and manufacturers behave, and especially about how competing manufacturers interact with each other and with retailers.[45] By specifying a particular model, it is possible to make quantitative predictions of the price effects of branded products mergers. It is important to assess the reliability of these predictions, yet there is scarce empirical evidence on their accuracy in predicting the actual price effects of mergers. Thus, to assess reliability, we propose standards derived from *Daubert* and the Federal Rules of Evidence.

Any model used to predict the effects of a merger must fit the facts of the industry in the sense that the model explains past market outcomes reasonably well. Many critical modeling choices can be justified or rejected by evidence gathered in the normal course of a merger investigation. The modeling exercise indicates kinds of evidence useful to gather and how to interpret it, while the evidence indicates whether any given model is appropriate. When the evidence cannot justify or reject an important choice, a sensitivity analysis should be done. A range of estimates should be reported that reflect the uncertainty in the model's predictions. ■

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[1] U.S. Dep't of Justice and Federal Trade Commission, Horizontal Merger Guidelines (1992, rev'd 1997), *reprinted in* 4 Trade Reg. Rep. (CCH) ¶ 13,104.

[2] On simulating the unilateral effects of mergers in branded consumer products industries, which is the most common application, see ABA Antitrust Section, Econometrics in Antitrust ch. 11 (John D. Harkrider & Daniel L. Rubinfeld eds, forthcoming 2004) [hereinafter Econometrics]; Gregory J. Werden & Luke M. Froeb, *Simulation as an Alternative to Structural Merger Policy in Differentiated Products Industries*, in The Economics of the Antitrust Process 65 (Malcolm B. Coate & Andrew N. Kleit eds., 1996); Gregory J. Werden, *Simulating Unilateral Competitive Effects from Differentiated Products Mergers*, Antitrust, Spring 1997, at 27; Gregory J. Werden, *Simulating the Effects of Mergers in Differentiated Products Industries: A Practical Alternative to Structural Merger Policy*, 5 Geo. Mason L. Rev. 363 (1997). For illustrative applications to actual mergers, see Jerry A. Hausman & Gregory K. Leonard, *Economic Analysis of Differentiated Products Mergers Using Real World Data*, 5 Geo. Mason L. Rev. 321 (1997); Aviv Nevo, *Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry*, 31 Rand J. Econ. 395, 416 (2000); Gregory J. Werden, *Expert Report in* United States v. Interstate Bakeries Corp. and Continental Baking Co., 7 Int'l J. Econ. Bus. 139 (2000).

[3] Because it is difficult to generate reliable estimates of the actual price and output effects of mergers in most industries, there is scarce evidence on the accuracy of every method for predicting the competitive effects of mergers. As for merger simulation in particular, one study found merger simulation *under-predicted* the actual price effects of airline mergers. Craig Peters, Evaluating the Performance of Merger Simulation: Evidence from the U.S. Airline Industry (U.S. Dep't of Justice, Antitrust Division, Economic Analysis Group Discussion Paper 03-1, Jan. 2003). But we find merger simulation ill-suited to the airline industry because pricing is not well explained by any oligopoly model that can be used in merger simulation. We also have doubts about the estimated "actual" price effects of the mergers in this study. Another study found simulation predicted reasonably well the effects of a merger in the ready-to-eat breakfast cereal industry. Nevo, *supra* note 2. That conclusion, however, was not based on a detailed and reliable study of the actual effects of the merger.

[4] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 593 (1993).

[5] Kumho Tire Co. v. Carmichael, 526 U.S. 137, 141, 152 (1999).

[6] *Id.* at 141 ("[T]he trial judge's general 'gatekeeping' obligation . . . applies not only to testimony based on 'scientific' knowledge, but also to testimony based on 'technical' and 'other specialized' knowledge.").

[7] *Daubert*, 509 U.S. at 591.

[8] General Elec. Co. v. Joiner, 522 U.S. 136, 146 (1997).

[9] Concord Boat Corp. v. Brunswick Corp., 207 F.3d 1039, 1056 (8th Cir. 2000).

[10] *Id.* at 1055–57.

[11] In *American Booksellers Ass'n, Inc. v. Barnes & Noble, Inc.*, 135 F. Supp. 2d 1031, 1041 (N.D. Cal. 2001), a highly respected econometrician's empirical model was excluded for purposes of proving damage causation because the model contained "too many assumptions and simplifications that are not supported by real-world evidence." In *Johnson Electric North America, Inc. v. Mabuchi Motor America Corp.*, 103 F. Supp. 2d 268, 280–87 (S.D.N.Y. 2000), the empirical analysis of another noted econometrician was excluded because it did "not 'fit' the facts of [the] case because it fail[ed] to take into account" key industry facts. In *Blue Dane Simmental Corp. v. American Simmental Ass'n*, 178 F.3d 1035, 1039–41 (8th Cir. 1999), an empirical damage estimate was excluded because it inferred "causation without considering all independent variables that could affect the conclusion." Also of interest is *Group Health Plan, Inc. v. Philip Morris USA, Inc.*, 344 F.3d 753, 760–61 (8th Cir. 2003), in which the plaintiffs' expert testimony, although "thorough, sophisticated, and often well-grounded in the relevant scientific literature," was excluded because of "excessive speculation" and a "disconnect" between the expert's analysis and the plaintiffs' "theory of liability."

[12] Information about the world is never perfect, and different sources of information often are inconsistent. The merging firms and other interested parties have incentives to slant the truth in ways that suit their interests and to avoid disclosing potentially enlightening information. Moreover, uninterested parties may not be forthcoming. Consequently, a merger investigation or trial cannot be expected to determine all facts with complete clarity and precision, and merger simulation should not be held to a higher standard of proof than is applied to other analysis. It simply may not be possible to fit *all* the "apparent facts" together in any sensible way.

[13] Different observers also perceive the facts differently or take different views of which facts are critical. If so, more than one approach may satisfy the demands of *Daubert*, leaving it to the trier of fact or the enforcement agency to determine which, if either, to credit. That determination is most fruitfully made if the competing analyses are accompanied by explicit statements of key assumptions and their justifications.

[14] Sensitivity analysis is not required for any modeling choice that is well justified by its fit with the facts. When the fit with the facts may be in dispute, however, it is useful to undertake a sensitivity analysis in addition to justifying a choice. For some modeling choices—for example, the oligopoly model used—no useful sensitivity analysis may be possible; therefore, such choices require solid justifications.

[15] If model parameters are not derived through econometrics, there may be no sampling error, although sampling error still may be associated with the measurement of prices and shares. Moreover, key economic constructs, such as marginal cost, are necessarily measured with error, so measurement error may replace sampling error when demand elasticities are inferred from the observed relationships between prices and costs rather than estimated econometrically.

[16] In addition, if the predicted price increases absent any synergies are close to zero, modest marginal-cost reductions from merger synergies would cause the merging firms to *decrease* prices, and the merger might have other offsetting consumer benefits, such as speeding the introduction of new products.

[17] The model is named for Joseph Louis François Bertrand, who posited it in *Review of "Théorie Mathématique de la Richesse Sociale*," and "*Recherches sur les Principes Mathématiques de la Théorie des Richesses*," 67 Journal des Savants 499 (1883). A modern translation appears in Cournot Oligopoly 73 (Andrew F. Daughety ed., 1988). For an introductory presentation of the model, *see* Dennis W. Carlton & Jeffrey M. Perloff, Modern Industrial Organization 166–72 (3d ed. 2000). For more technical treatments, see Carl Shapiro, *Theories of Oligopoly Behavior*, *in* 1 Handbook of

INDUSTRIAL ORGANIZATION 329, 343–48 (Richard Schmalensee & Robert D. Willig eds., 1989); XAVIER VIVES, OLIGOPOLY PRICING: OLD IDEAS AND NEW TOOLS ch. 5 (1999).

[18] A Bertrand equilibrium is a Nash non-cooperative equilibrium. The concept was introduced by mathematician John F. Nash, Jr., and it earned him a share of the 1994 Nobel Memorial Prize in Economics.

[19] The price-cost margin is price minus short-run marginal cost, all divided by price. The authors of this article do not agree on exactly what the comparison between actual and predicted margins shows or how important it is, but several aspects of this comparison are detailed below.

[20] Calibrating models to observable data distinguishes the principal policy use of structural models from principal academic use of these models. In addition, much academic research is content with determining the signs of the various effects, while in policy applications, the magnitudes of the effects tend to be critical. In merger enforcement, it is plainly insufficient to determine that a merger will raise price by some—possibly trivial—amount. Typically, modeling assumptions make that a forgone conclusion, and the critical issue is whether the merger likely would raise prices substantially.

[21] By construction, the properly calibrated simulation model normally perfectly "predicts" the set of prices and shares to which the model is calibrated. In some cases, however, a perfect fit may be impossible, and the calibration entails determining the parameters making the model fit the data best.

[22] *See generally* ECONOMETRICS, *supra* note 2, App. V; Daniel Hosken et al., Demand System Estimation and Its Application to Horizontal Merger Analysis (FTC Bureau of Economics, Working Paper 246, Apr. 2002), *available at* http://www.ftc.gov/be/workpapers/wp246.pdf.

[23] Concord Boat Corp. v. Brunswick Corp., 207 F.3d 1039, 1056 (8th Cir. 2000). "The model also failed to account for market events that both sides agreed were not related to any anticompetitive conduct . . . ." *Id.*

[24] Available accounting data on the variable costs associated with the production of branded consumer products commonly make it possible to produce reasonable estimates of the relevant short-run marginal costs. However, there may be significant conceptual issues in some cases that make it difficult to estimate marginal costs. For example, significant opportunity costs may be associated with the use of scarce factors of production that have alternative profitable uses.

[25] For an illustration in which a testifying expert (one of the authors of this article) found the Bertrand model to explain pre-merger pricing very well, *see* Werden, *Expert Report*, *supra* note 2.

[26] United States v. WorldCom, Inc., No. 1:00CV01526 (D.D.C. filed June 27, 2000). The parties announced the termination of their merger agreement on July 13, 2000.

[27] For a discussion of demand estimation in the case, see ECONOMETRICS, *supra* note 2, App. IA.

[28] The available price data masked complexity and variation of the actual terms of the calling plans among which consumers selected. The price data also reflected a mix of current and legacy prices, as well as a variety of current offerings, and the observed average prices obscured characteristics on which consumers based their choices among carriers. In addition, consumers appeared to exhibit considerable inertia in responding to new calling plans, and many likely were ill-informed.

[29] The logit model of demand is built on this assumption. On that model and merger simulation using it, see Gregory J. Werden, Luke M. Froeb & Timothy J. Tardiff, *The Use of the Logit Model in Applied Industrial Organization*, 3 INT'L J. ECON. BUS. 83 (1996); Gregory J. Werden & Luke M. Froeb, *The Effects of Mergers in Differentiated Products Industries: Logit Demand and Merger Policy,* 10 J.L. ECON. & ORG. 407 (1994).

[30] We use the prices and shares reported in ECONOMETRICS, *supra* note 2, App. IA, table 2.

[31] The same sort of analysis could be used as an initial screening device, i.e., a quick method for determining whether a merger plausibly might produce significant anticompetitive effects. Merger simulation of the sort described here is well-suited to such a use because little data is required for model calibration. *See* Gregory Werden & Luke Froeb, *Calibrated Economic Models Add Focus, Accuracy, and Persuasiveness to Merger Analysis*, *in* THE PROS AND CONS OF MERGER CONTROL 63 (Swedish Competition Authority 2002). We believe such screening is a productive use of merger simulation, and because the predictions are not given significant weight, the reliability standards advocated here do not apply.

[32] The price increases for the merged firm are substantially greater than the market-wide average price increase, and the former price increases could be much greater than shown here if consumers perceived WorldCom and Sprint as offering particularly close substitutes.

[33] The available data in any particular case almost certainly contain too much noise and too little price variation for an empirical determination of functional form.

[34] *See* Philip Crooke, Luke Froeb, Steven Tschantz & Gregory J. Werden, *The Effects of Assumed Demand Form on Simulated Postmerger Equilibria*, 15 REV. INDUS. ORG. 205 (1999).

[35] Both axes of the graph have been translated somewhat to make the relevant ranges of the demand curves appear larger. Marginal cost was assumed to be 4, making the competitive price 4 as well. The highest of the monopoly prices, with isoelastic demand, is 8, and the lowest of the monopoly prices, with linear demand, is 5.

[36] *See* Gregory J. Werden, *A Robust Test for Consumer Welfare Enhancing Mergers Among Sellers of Differentiated Products*, 44 J. INDUS. ECON. 409 (1996). Thus, CMCRs can be used as a critical benchmark for assessing the efficiency claims of the merging parties. *See* Luke M. Froeb, Steven Tschantz & Gregory J. Werden, *Pass Through Rates and the Price Effects of Mergers*, INT'L J. INDUS. ORG. (forthcoming 2004). Although no assumption about demand curvature is required to compute CMCRs, such an assumption has to be made if the demand elasticities used to compute the CMCRs are estimated econometrically, and such estimates are sensitive to the assumption made. *See* Halbert White, *Using Least Squares to Approximate Unknown Regression Functions*, 21 INT'L ECON. REV. 149 (1980).

[37] *See, e.g.*, Nevo, *supra* note 2; Hausman & Leonard, *supra* note 2; Atanu Saha & Peter Simon, *Predicting the Price Effects of Mergers with Polynomial Logit Demand*, 7 INT'L J. ECON. BUS. 149 (2000).

[38] *See* Luke Froeb, Steven Tschantz & Gregory J. Werden, Vertical Restraints and the Effects of Upstream Horizontal Mergers (unpublished paper Apr. 2, 2002).

[39] Although the retail and manufacturing level demand elasticities are the same, the prices are different, and that must be accounted for.

[40] *See* Froeb, Tschantz & Werden, *supra* note 38; Daniel P. O'Brien & Greg Shaffer, Bargaining, Bundling, and Clout: The Portfolio Effects of Horizontal Mergers (FTC Bureau of Economics, Working Paper 266, Dec. 2003), *available at* http://www.ftc.gov/be/workpapers/wp266.pdf.

[41] In *FTC v. H.J. Heinz Co.*, 246 F.3d 708, 719 (D.C. Cir. 2001), an "impact at the consumer level" was not required to condemn the merger of two baby food manufacturers. The court held that "the antitrust laws assume that a retailer faced with an increase in the cost of one of its inventory items 'will try so far as competition allows to pass that cost on to its customers.'" *Id.* (quoting *In re* Brand Name Prescription Drugs Antitrust Litig., 123 F.3d 599, 605 (7th Cir. 1997)). It is not entirely clear, however, that Section 7 protects the retailers in this particular scenario from having to share some of their monopoly profits with manufacturers.

[42] *See* Froeb, Tschantz & Werden, *supra* note 38.

[43] *See* Werden, *Expert Report*, *supra* note 2.

[44] *See* Froeb, Tschantz & Werden, *supra* note 38 (the models are described in the two paragraphs following note 40, *supra*). There also have been several empirical analyses of the retailer-manufacturer relationship. *See* K. Sudhir, *Structural Analysis of Manufacturer Pricing in the Presence of a Strategic Retailer*, 20 MARKETING SCI. 244 (2001); Sofia Berto Villas-Boas, Vertical Contracts Between Manufacturers and Retailers: An Empirical Analysis (unpublished paper May 2003), *available at* http://ist-socrates.berkeley.edu/~villas/vertical.pdf.

[45] This article concentrates on branded consumer products, because merger simulation has most often been used with such products. There are, however, other possible applications of merger simulation, and they may raise additional important issues. For an example of a different application involving quite different issues, see Luke Froeb, Steven Tschantz & Philip Crooke, *Bertrand Competition with Capacity Constraints: Mergers Among Parking Lots*, 113 J. ECONOMETRICS 49 (2003). With parking lots, as with airlines and hotels, a large fraction of total cost is incurred in creating capacity, which in the short term is fixed, and its costs are sunk. A competitor's short-term problem is to maximize the revenue, net of variable costs, that can be generated using its fixed capacity. The optimal strategy for parking lots is likely to be to set the highest price that fills up the lots. This likely remains the optimal strategy after a merger, so a merger of directly competing parking lots may have no short-term effect on prices.