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A *Daubert* Discipline for Merger Simulation

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Abstract

For more than a decade, structural game-theory models have been used to predict the price effects of mergers, using what is termed "merger simulation." We propose a discipline for merger simulation based on the *Daubert* reliability screen applied to all expert testimony. Specifically, 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.

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I. INTRODUCTION

The basic economics underlying unilateral effects from horizontal mergers has been understood for over a century, but relatively little attention was paid to such effects prior to the release of the 1992 Horizontal Merger Guidelines.[1] After their release, "merger simulation"—the formal use of structural, game-theoretic models to make quantitative predictions of unilateral competitive effects—quickly came into vogue. 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.

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.

Ultimately, what really matters is the accuracy of merger simulation in predicting the effects of actual mergers, but there is scarce evidence on that.[2] A major reason for

[1] U.S. Department of Justice and Federal Trade Commission, Horizontal Merger Guidelines (1992, rev'd 1997), *reprinted in* 4 Trade Reg. Rep. (CCH) ¶ 13,104.

[2] 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. Department 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

this paucity of evidence is that there are surprisingly few studies of the competitive effects of mergers.[3] For a variety of reasons, it is difficult to generate reliable estimates of the actual price and output effects of mergers in most industries.[4] Consequently, there is also scarce evidence on the prediction accuracy of *every* method for predicting the competitive effects of mergers. In particular, that is also the case for "reduced-form" empirical modeling, which attempts to infer the likely effects of mergers from "natural experiments," without any reliance on structural models of competitor interaction.[5] A notable example is the FTC's estimation of likely price effects from the Staples–Office Depot merger, which related prices across cities to the number of competitors.[6] The application of both structural and reduced-form modeling to specific

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study found simulation predicted reasonably well the effects of a merger in the ready-to-eat breakfast cereal industry. That conclusion, however, was not based on a detailed and reliable study of the actual effects of the merger. Aviv Nevo, *Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry*, 31 RAND J. ECON. 395, 416 (2000).

[3] Published studies nearly all focus on airline and hospital mergers, of which there have been many, and on which there is much public data. *See, e.g.*, E. Han Kim & Vijay Singal, *Mergers and Market Power: Evidence from the Airline Industry*, 83 AM. ECON. REV. 549 (1993); Michael G. Vita & Seth Sacher, *The Competitive Effects of Not-for-Profit Hospital Mergers: A Case Study*, 49 J. INDUS. ECON. 63 (2001); Gregory J. Werden, Andrew S. Joskow & Richard L. Johnson, *The Effects of Mergers on Price and Output: Two Case Studies from the Airline Industry*, 12 MANAGERIAL & DECISION ECON. 341 (1991). The airline and hospital industries are sufficiently peculiar that these studies may not have significant implications for other industries.

[4] Assessing the effects of consummated mergers tends to be quite difficult because suitable data generally are unavailable, and because confounding events, such as changes in demand and cost, are difficult to sort out. Moreover, the only mergers available for study are those proposed despite active merger enforcement by the Department of Justice and Federal Trade Commission, and that either were not challenged by the agencies or were consummated after the agencies' challenge was rebuffed. That leaves few mergers thought at the time to have been significantly anticompetitive.

[5] A natural experiment for purposes of evaluating a proposed merger can consist of any significant variation in market structure over time, as from exit and entry, or any significant variation in market structure across space, as from differing numbers of competitors in various geographic markets. Interpreting a natural experiment can be difficult, however, because the natural experiments available for study are only rarely prior mergers and are never mergers just like the one under review. A structural model may be required to extrapolate from the experiments nature has performed to a particular merger.

[6] *See* Jonathan B. Baker, *Econometric Analysis in* FTC v. Staples, 18 J. PUB. POL'Y & MARKETING 11 (1999); Serdar Dalkir & Frederick R. Warren-Boulton, *Prices, Market Definition, and the Effects of Mergers: Staples–Office Depot, in* THE ANTITRUST REVOLUTION 52 (John E. Kwoka, Jr. & Lawrence J. White eds., 4th ed. 2004).

cases can be controversial, and analysts sometimes disagree sharply.[7]

Merger simulation cannot be deemed reliable on the basis of a well-established and consistent high degree of prediction accuracy, so 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.[8] 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.*

For most modeling choices, the justification should be "fit" with the industry under review, i.e., consistency between the factual setting of the industry and the structural models that can be employed in a simulation. Several aspects of evaluating fit are elaborated below. If there is a general rule, 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.

Evaluating fit draws on the full array of qualitative evidence developed in the case, but it is essential appreciate that there can never be a perfect fit between any useful economic model and the real world. A model may be fit an industry quite well enough even if it does not reflect notable features of the industry. Evaluating fit also draws on

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[7] For contrasting views on the structural analysis of a merger, see Marc Ivaldi & Frank Verboven, *Quantifying the Effects from Horizontal Mergers in European Competition Policy*, INT'L J. INDUS. ORG. (likely forthcoming 2004); Jerry A. Hausman, Evaluating the Proposed Volvo-Scania Merger: A Critique of the Ivaldi and Verboven Analysis (unpublished paper Feb. 2, 2000). For contrasting views on the reduced-form analysis of a merger, see Baker, *supra* note 6; Dalkir & Warren-Boulton, *supra* note 6; Jerry A. Hausman & Gregory K. Leonard, Documents versus Econometrics in *Staples* (unpublished paper 1997); Craig M. Newmark, The Positive Correlation of Price and Concentration in Staples: Market Power or Indivisibility? (Independent Insititute Working Paper No. 31, Apr. 2001), *available at* http://www.independent.org/tii/WorkingPapers/Newmark.pdf; Luke M. Froeb, Steven Tschantz & Gregory J. Werden, *Pass Through Rates and the Price Effects of Mergers*, INT'L J. INDUS. ORG. (likely forthcoming 2004).

[8] The same has been argued of econometric estimates. *See* Edward E. Leamer, *Let's Take the Con Out of Econometrics*, 73 AM. ECON. REV. 31 (1983).

particular quantitative features of the industry, which may be directly measured, as with price-cost margins, or estimated econometrically, as with demand elasticities.

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.[9]

A merger investigation or trial cannot 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. But neither should the inherent sources of potential error in merger simulation be ignored. Price-increase predictions 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.[10] 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.[11]

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[9] Sensitivity analysis is not required for any modeling choice that is well justified by fit with the facts. When 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.

[10] 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.

[11] 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.

This article first explains how our proposal for assessing the reliability of merger simulation is grounded in principles in the Federal Rules of Evidence. It then explores 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.

II. A *DAUBERT* DISCIPLINE FOR MERGER SIMULATION

In *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, the Supreme Court required trial judges to serve in a "gatekeeping role": They must make a "preliminary assessment" of whether expert testimony is "scientifically valid," focusing "solely on principles and methodology."[12] The Court also held that expert testimony is admissible only if it is "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.[13] A few year later, the Court again stressed this "fit" requirement in cautioning that a court should not "admit opinion evidence that 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."[14]

In its 1999 decision in *Kumho Tire Co. v. Carmichael*, the Supreme Court made clear that the "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," which necessarily includes economic testimony in merger cases. That decision usefully explained the purpose of "*Daubert*'s gatekeeping requirement":[15]

> The objective of that requirement is to ensure the reliability and relevancy of expert testimony. It is to make certain that an expert, whether basing testimony upon professional studies or personal experience, employs in the courtroom the

[12] 509 U.S. 579, 592–93, 595 (1993).

[13] *Id.* at 591.

[14] *General Electric Co. v. Joiner*, 522 U.S. 136, 146 (1997).

[15] 526 U.S. 137, 141 (1999).

> same level of intellectual rigor that characterizes the practice of an expert in the relevant field.[16]

Revised in the wake of *Daubert*, Rule 702 of the Federal Rules of Evidence allows "a witness qualified as an expert by knowledge, skill, experience, training, or education" to testify "if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case."[17] Although this is a rule for admissibility of evidence at trial, we believe that the analysis in the investigation stage of a merger case should be held to the same high standards.

Whenever significant weight is placed on the predictions of a merger simulation, the discipline of *Daubert* makes three demands: (1) The simulation must be conducted by someone with expertise in structural modeling of real-world industries and the underlying economic theory. (2) The economic models employed in the simulation, and any estimation methods used to calibrate those models, must be considered sound within the relevant fields of economics. (3) The simulation model must reasonably fit the facts of the case.

The first two requirements present no particular difficulties. Merger simulation applies the standard tools of economics, which are considered sound as a matter of economic or econometric theory. The way merger simulation can go badly wrong is by employing sound methods that are nevertheless ill suited to a particular task because they do not fit the facts. And the nature of the expertise required was wonderfully captured by physicist Werner Heisenberg who (as translated from the original German) usefully defined an expert as "someone who knows some of the worst mistakes that can be made in his subject and who manages to avoid them."[18] Many serious mistakes can be made in merger simulation, and anyone performing a merger simulation should know enough to avoid them.

While merger simulation has not been the subject of *Daubert* scrutiny in the

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[16] *Id.* at 152.

[17] FED. R. EVID. 702.

[18] Quoted in THE OXFORD DICTIONARY OF QUOTATIONS 331 (Angela Partington ed., 4th ed. 1992).

courtroom, failure to fit the facts has been the principal basis for excluding economic expert testimony in antitrust cases. The leading example is *Concord Boat v. Brunswick Corp.*, 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."[19] In that case, a substantial damage award was vacated because the structural model used by the plaintiffs' expert economist was "not grounded in the economic reality of the" industry.[20]

The court explained that *Daubert* required "a thorough analysis of the expert's economic model" and undertook that analysis.[21] The model was found wanting in several respects. Most interesting for present purposes, the court noted that the model predicted that the defendant would have had a fifty percent market share in the absence of the challenged practices, even though the defendant had achieved a market share of seventy-five percent before it engaged in any of the challenged conduct.[22] In many 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.[23]

Of course, *Daubert* does not demand a perfect fit between the model and the facts.

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[19] 207 F.3d 1039, 1056 (8th Cir. 2000).

[20] *Id.*

[21] *Id.* at 1055.

[22] *Id.* at 1056. "The model also failed to account for market events that both sides agreed were not related to any anticompetitive conduct . . . ." *Id.*

[23] 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." Similar is *In re Aluminum Phosphide Antitrust Litigation*, 893 F. Supp. 1497, 1504 (D. Kan. 1995). Also of interest is *Group Health Plan, Inc. v. Philip Morris USA, Inc.*, 344 F.3d 753, 760–61 (8th Cir. 2003), in which 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."

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.[24] What is required is that a standard model of oligopoly interaction explain past outcomes of the competitive process reasonably well. Anyone performing a merger simulation 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.

Finally, different observers may perceive the facts differently or take different views of which facts are critical. Hence, more than one approach may satisfy the demands of *Daubert*, leaving it to the trier of fact 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.

III. BASIC ISSUES IN SIMULATING BRANDED CONSUMER PRODUCTS MERGERS

Merger simulation has most often been applied to mergers involving branded consumer products,[25] using the Bertrand oligopoly model. That model assumes

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[24] It also should be noted that information about the world is never perfect: 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. As a consequence, it may not be possible to fit *all* the "apparent facts" together in any sensible way.

[25] On simulating the unilateral effects of mergers in branded consumer products industries, see ABA ANTITRUST SECTION, ECONOMETRICS IN ANTITRUST ch. 11 (forthcoming 2004); 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); Nevo, *supra* note 2; Gregory J. Werden, *Expert Report in* United States v. Interstate Bakeries Corp. and Continental Baking Co., 7 INT'L J. ECON. BUS. 139 (2000).

competitors interact just once, each maximizing its short-run profit, with price as the sole dimension of competition.[26] Bertrand equilibrium is reached when all competitors are happy with their prices, given rivals' prices.[27] Many useful theoretical insights into the potential unilateral competitive effects of mergers involving branded consumer products have been derived from analyses based on the Bertrand model[28]:

- The merging firms' shares are at best very crude proxies for the impact of their merger on prices.[29]
- The price effects of mergers are determined to a substantial degree by the curvature of the assumed functional form for demand.[30]
- The effects of manufacturing-level mergers depend critically on the contractual or other relationships between manufacturers and retailers.[31]

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[26] The model is named for Joseph Louis François Bertrand, who posited it in *Review of "Théorie Mathématique de la Richesse Social," and "Recherches sur les Principles Mathématiques de la Théorie de Richesse*, 67 JOURNAL DES SAVANTS 499 (1883). A modern translation appears in COURNOT OLIGOPOLY 73 (Andrew F. Daughety ed., 1988). For introductory presentations of the model, see DENNIS W. CARLTON & JEFFREY M. PERLOFF, MODERN INDUSTRIAL ORGANIZATION 166–72 (3d ed. 2000); LYNNE PEPALL ET AL., INDUSTRIAL ORGANIZATION: CONTEMPORARY THEORY AND PRACTICE 254–67 (1999); DON E. WALDMAN & ELIZABETH J. JENSEN, INDUSTRIAL ORGANIZATION: THEORY AND PRACTICE 167–69 (1998). 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).

[27] 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. Nash's main contribution on the subject is John Nash, *Non-Cooperative Games*, 54 ANNALS OF MATHEMATICS 286 (1951), *reprinted in* COURNOT OLIGOPOLY 82 (Andrew F. Daughety ed., 1988). Nash, non-cooperative equilibrium is basically the only equilibrium concept now used by industrial organization economists. On Nash's work and its importance to economics, see Robert J. Leonard, *Reading Cournot, Reading Nash: The Creation and Stabilization of the Nash Equilibrium*, 104 ECON. J. 492 (1994); Roger B. Myerson, *Nash Equilibrium and the History of Economic Theory*, 37 J. ECON. LITERATURE 1067 (1999).

[28] It is not known exactly how general these insights are, although several have been shown to hold as well with the Cournot model, in which the product is homogeneous and firms compete strictly on the basis of quantities produced.

[29] *See* Werden & Froeb, *supra* note 25.

[30] *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).

[31] *See* Luke Froeb, Steven Tschantz & Gregory J. Werden, Vertical Restraints and the Effects of Upstream Horizontal Mergers (unpublished paper Apr. 2, 2002); Daniel P. O'Brien & Greg

- Only exceptionally anticompetitive mergers are likely to induce non-merging firms to introduce new products or reposition existing products, if there are non-trivial sunk costs of doing so.[32]
- Marginal-cost reductions from merger synergies can prevent post-merger price increases, but the cost reductions may have to be implausibly large to do so.[33]
- Characteristics of demand curves that lead to large price effects from mergers also lead to high pass-through rates for marginal-cost reductions, potentially in excess of one hundred percent.[34]

Whether the Bertrand model is appropriate in any particular case may depend of 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.[35] Exactly how this is done is explained presently, after some mechanics of merger simulation are discussed.

The first step in a merger simulation is model "calibration"—choosing parameter values to make it fit certain features of the industry.[36] In simulating a branded

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Shaffer, Bargaining, Bundling, and Clout: The Portfolio Effects of Horizontal Mergers (Federal Trade Commission, Bureau of Economics, Working Paper 266, Dec. 2003), *available at* http://www.ftc.gov/be/workpapers/wp266.pdf.

[32] *See* Gregory J. Werden & Luke M. Froeb, *The Entry-Inducing Effects of Horizontal Mergers*, 46 J. INDUS. ECON. 525 (1998).

[33] *See* Gregory J. Werden, *A Robust Test for Consumer Welfare Enhancing Mergers Among Sellers of Differentiated Products*, 44 J. INDUS. ECON. 409 (1996).

[34] *See* Froeb, Tschantz & Werden, *supra* note 7.

[35] The price-cost margin is defined as 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.

[36] Calibrating models to observable data distinguishes the principal policy use of structural

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 share that are expected to prevail in the near future absent the merger.[37] 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. Especially using scanner data, that estimation raises a host of potentially difficult econometric issues[38] and ultimately may not bear significant fruit. When reliable estimation is infeasible, the demand elasticities can be set on the basis indications of preferences or switching patterns from surveys, marketing studies, and other documentary evidence, and to comport with observed price-cost margins. An assessment of the facts is required to determine which of many combinations of evidence and assumptions (about demand and competitor interaction) are reasonable.

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 that used to calibrate the model, because the difference between the two would only

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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 foregone conclusion, and the critical issue is whether the merger likely would raise prices substantially.

[37] By construction, the properly calibrated simulation model normally perfectly "predicts" the set 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.

[38] *See generally* ABA ANTITRUST SECTION, *supra* note 25, App. IV; Daniel Hosken et al., Demand System Estimation and its Application To Horizontal Merger Analysis (Federal Trade Commission, Bureau of Economics, Working Paper 246, Apr. 2002), *available at* http://www.ftc.gov/be/workpapers/wp246.pdf.

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. 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, and those marginal costs generally are inferred from the calibrated model. The pre-merger marginal costs are taken to those that make 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.

When marginal costs are inferred in this manner, it is very important to compare the inferred marginal costs with whatever evidence is available on actual marginal costs.[39] 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.[40]

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

[39] 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.

[40] For an illustration in which the Bertrand model was found to explain pre-merger pricing very well, see Werden, *Expert Report*, *supra* note 25.

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.

IV. 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 next few sections explore several important examples.

A. 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,[41] 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.[42] Unfortunately, it can be difficult to get precise estimates of demand elasticities, and demand estimation for residential long-distance service presented major problems.[43] 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

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

[42] For a discussion of demand estimation in the case, see ABA ANTITRUST SECTION, *supra* note 25, ch. 13.

[43] 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.

relative market shares.[44] Hence, a carrier with a share of twenty percent would gain twice as many customers as a carrier with a share of ten 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.[45]

Figure 1 presents a contour plot of the predicted increase in residential long-distance averaged over all carriers, assuming Bertrand competition among them.[46] This plot reflects values of residential long-distance demand elasticity between –1.5 and –0.5 and for 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 published estimates for branded consumer products. The contours represent combinations of the two elasticities yielding 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.[47]

Presenting merger simulation results this way makes it clear how, and by how much, the choice of values of the relevant 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 basis for the elasticity values employed (e.g., whether

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[44] 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).

[45] We use the prices and shares reported by ABA ANTITRUST SECTION, *supra* note 25, ch. 13, table 2.

[46] The same sort of analysis could be used as an initial screening device, i.e., a quick method of 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.

[47] The price increases for the merged firm are substantially greater than the industry 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.

econometrics was used) and 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.

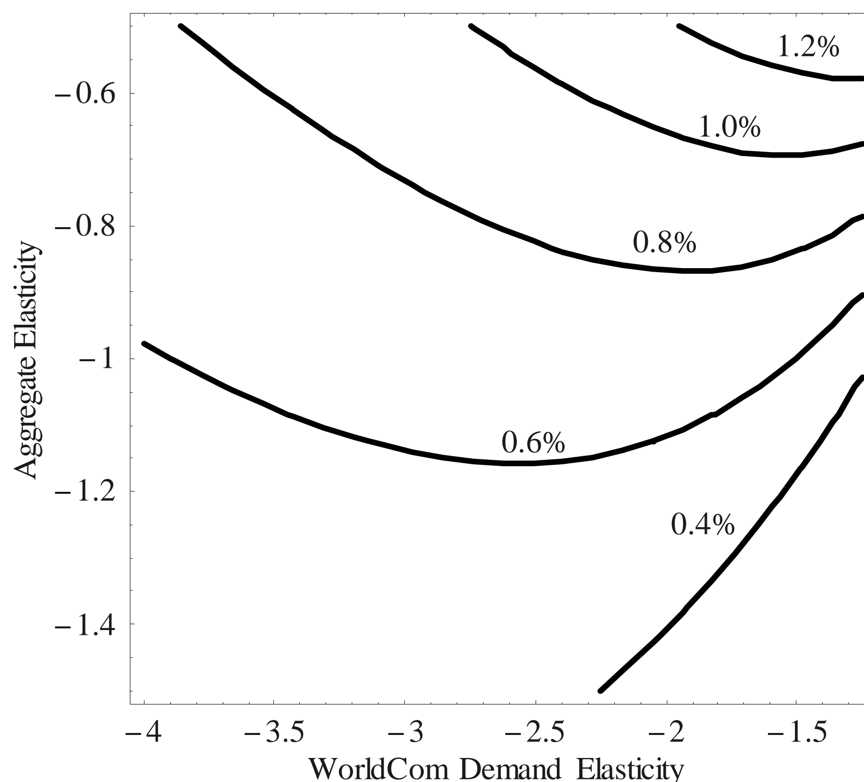

Figure 1. Industry Average Price Increases Predicted from the WorldCom–Sprint Merger

B. 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.[48] 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

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[48] 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.

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.[49] Indeed, the former two can easily yield predicted price increases several times those with 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 equal 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.

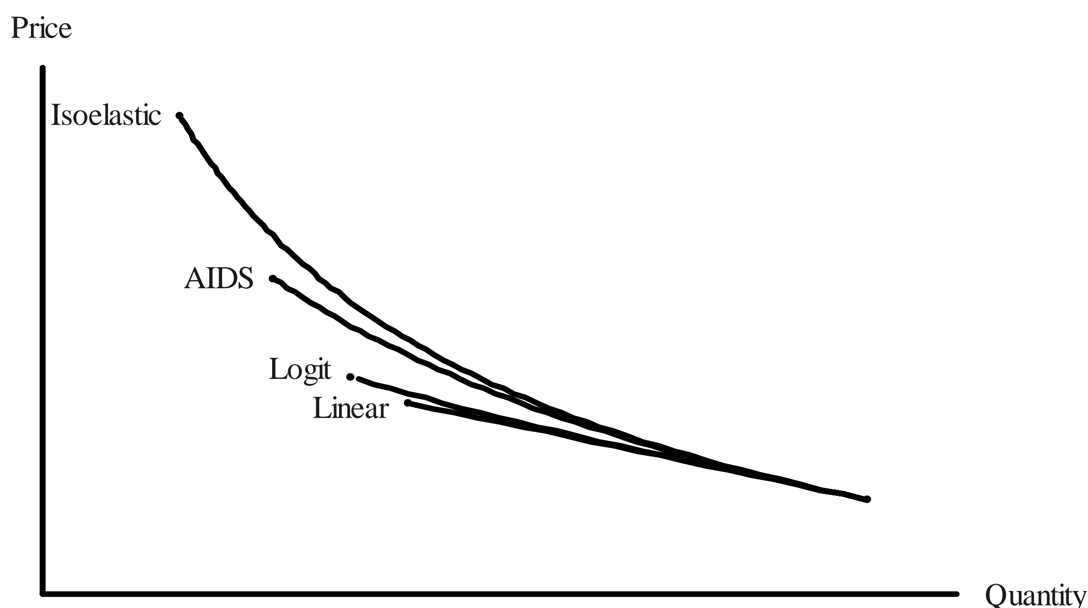

Figure 2. Four Demand Curves Plotted between the Competitive and Monopoly Prices

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 shown at

[49] *See* Crooke et al., *supra* note 30.

the left of 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.[50] 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.[51]

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[50] 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.

[51] *See* Werden, *supra* note 33. Thus, CMCRs can be used as a critical benchmark for assessing the efficiency claims of the merging parties. *See* Froeb, Tschantz & Werden, *supra* note 7. They also can be used to construct a contractual merger remedy that offsets the incentive to raise price. *See*

C. 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. 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 contractual devices to extract all of the retailers' profits.[52] 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.[53]

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.[54]

If individual retailers face no competition and charge prices that fully exploit their monopolies at the retail level, a manufacturing merger could have no affect 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

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Gregory J. Werden, Luke M. Froeb & Steven Tschantz, Incentive Contracts as Merger Remedies (unpublished paper 2004).

[52] *See* Froeb, Tschantz & Werden, *supra* note 31.

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

[54] *See id.*; O'Brien & Shaffer, *supra* note 31.

an effect on retail prices does not mean that the merger of two manufacturers escapes condemnation under Section 7,[55] 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. This presents 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 that maximize 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.[56]

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[55] *FTC v. H.J. Heinz Co.*, 246 F.3d 708 (D.C. Cir. 2001), held both that an "impact at the consumer level" was not required to condemn the merger of two baby food manufacturers, and 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.* at 719, 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.

[56] *See* Froeb, Tschantz & Werden, *supra* note 7.

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.[57] 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.[58] 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.

V. CONCLUSION

The basic economics 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 another and with retailers.[59]

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[57] *See* Werden, *Expert Report*, *supra* note 25.

[58] *See* Froeb, Tschantz & Werden, *supra* note 31. There 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.

[59] 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

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.

(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 affect on prices.