American University Washington College of Law

Digital Commons @ American University Washington College of Law

Articles in Law Reviews & Other Academic Journals

Scholarship & Research

1997

Contemporary Empirical Merger Analysis

Jonathan Baker

Follow this and additional works at: https://digitalcommons.wcl.american.edu/facsch_lawrev

 Part of the Business Organizations Law Commons

CONTEMPORARY EMPIRICAL MERGER ANALYSIS

Jonathan B. Baker[*]

Abstract: Merging parties and antitrust enforcers increasingly rely upon econometric analyses to assess the competitive consequences of mergers in differentiated product industries. Empirical studies promise to improve the evaluation of mergers among sellers of branded consumer products, particularly when point-of-sale scanner data on retail transactions is available. This article addresses several technical issues in empirical merger analysis, including the appropriate time interval for measuring demand elasticities and aspects of the simulation methodology for identifying mergers that give parties strong incentives to raise price.

INTRODUCTION

During the hearings on American industry concentration conducted by the Temporary National Economic Committee (TNEC) as the Great Depression was ending, the United States Steel Corporation (U.S. Steel) introduced empirical estimates of the demand function for steel.[1] This was surely one of the first examples of the use of econometrics in a regulatory proceeding.

Over the past five decades, the world of demand estimation has changed as computational power has dramatically increased. U.S. Steel's team of researchers[2] estimated the parameters of five simple linear regression models, with up to four independent variables. Their major computational challenge was inverting a 5x5 matrix, presumably by hand. The testimony does not indicate how long it took the company's team of statisticians to compute these results and check their answers—perhaps days or weeks. Today, a competent undergraduate using a regression package on a personal computer could probably compute all the reported results in an hour or two, with most of that time devoted to data entry. And the college student's output would be much more sophisticated than what the statistical

---

[*] Director, Bureau of Economics, Federal Trade Commission. The views expressed are not necessarily those of the Federal Trade Commission or any individual Commissioner. The author is indebted to Tim Bresnahan, Jerry Hausman, Dan Hosken, Dan O'Brien, Gary Roberts, Scott Thompson, Bob Town, Mike Vita, and Mark Williams.

[1] *Investigation of Concentration of Economic Power: Hearings before the Temp. Nat'l Econ. Comm. (Select Comm.), Iron and Steel Indus.*, 76th Cong. 13913 (1940) [hereinafter *TNEC Hearings*].

[2] U.S. Steel commissioned multiple studies from a team of eight economists and graduate students led by Dr. Theodore Yntema, a statistics professor at the University of Chicago's School of Business. The steel demand study analysis was written by H. Gregg Lewis, who later became an economics professor at Chicago and Duke.

team provided in their report—merely the coefficients on the independent variables and a goodness of fit measure. Today's computer program would immediately provide standard errors on the coefficients, a plot of the errors, and a host of other useful information that would have required a significant recovery effort in the 1930's.

In addition, contemporary econometric methods are superior to those readily available a half-century ago. The U.S. Steel report did not mention, much less address, the "simultaneity" problem of identifying a demand function from observations on price and quantity when demand and supply are both shifting,[3] though the statistical team was probably aware of the issue.[4] Today, the application of two stage least squares to address simultaneity in single equation models is textbook econometrics, and far better tools are available in the rest of the econometrician's kit. Some econometric methods of analyzing mergers in differentiated products industries employed today, for example, estimate multiple equation demand systems involving large numbers of products derived from more primitive models of utility maximization, in contrast with the ad hoc single equation models employed in US Steel's TNEC study of industry demand.[5]

Another change is on the way. With increasing computerization of market transactions, the data available for researchers appears on the brink of exploding, through disaggregation on multiple dimensions. First, U.S. Steel worked with annual data, because monthly data was not available for some of the key variables.[6] Today, we are increasingly able to observe prices and quantities sold on a weekly, daily, hourly, or even transaction-by-transaction basis.[7] Second, U.S. Steel studied the demand for a composite steel aggregate, not broken down by grades, shapes or other features. Today, in contrast, we can often observe transactions broken down into

---

[3] An "identification" or "simultaneity" problem in the estimation of demand functions arises because prices and quantities change as a result of both shifts in demand and shifts in supply. The most common technical solution relies on instrumental variables to effectively isolate in the data those situations where the supply curve is shifting along the demand function. This allows estimates of the elasticity of demand not contaminated by the effects of movements of the demand curve.

[4] *See* Carl Christ, *Early Progress in Estimating Quantitative Economic Relationships in America*, 75 AM. ECON. REV. 39 (1985) (special issue no. 6). At the TNEC Hearings, U.S. Steel's demand study was criticized by a Department of Agriculture economist who argued that it underestimated the (absolute value of the) demand elasticity. However, the underestimation was not because of the study's failure to address simultaneity of supply and demand. *TNEC Hearings, supra* note 1, at 13724, 13729-30 (testimony of Louis Bean) (highlighting the omission of the change in business activity as an independent variable and the possible misleading influence of observations for 1923 and 1937).

[5] For example, the demand systems referenced *infra* at notes 20-21 can be derived from assumptions about preferences.

[6] U.S. Steel's demand study employed yearly data for the 1920's and 1930's. Earlier data for some of the key variables was unavailable, even on an annual basis, and monthly data was not available for some of the time series. *TNEC Hearings, supra* note 1, at 13922.

[7] The contemporary academic studies do not disaggregate routinely beyond monthly data, however.

more finely-parsed product categories, such as stock-keeping units (SKUs) for products sold at retail. Consequently, we can hope to learn about the basis for buyer choice not just between, say, Coke and Pepsi, but also between regular, sugar-free, and caffeine-free variants, differing package sizes and styles, and different distribution channels. A third form of data explosion through disaggregation is on the horizon. Someday, we may be able to match transactions data with information about the buyers, study the determinants of consumption decisions for small groups of similarly situated consumers (perhaps, for example, professional couples without children living in the South) or even for individual consumers, and build up demand functions from empirical estimates of disaggregated preferences.

A final difference between demand estimation today and a half-century ago arises out of differences in the regulatory climate. In 1940, U.S. Steel wanted to demonstrate that Depression-era steel demand was inelastic, in order to suggest that steel industry unemployment was not the result of high prices.[8] If U.S. Steel were merging with a horizontal rival today, in contrast, it would likely hope that its econometric studies showed that the demand for steel is highly elastic, because steel is sold in a broad relevant product market that also includes aluminum, plastic, or other demand substitutes. Were U.S. Steel proposing to merge with a horizontal competitor, moreover, the company would also hope to demonstrate empirically that within the product market, the products sold by non-merging rival steel companies are close substitutes for the products that it sells, while the products sold by its merger partner are not close substitutes.[9] Such evidence would suggest that very little direct competition would be lost by merger, and that the remaining competition would be sufficient to protect consumers against anticompetitive conduct by the merged firm.[10]

Over the past dozen years, developments in empirical industrial organization economics, that help identify how closely the products of merging firms function as substitutes for each other, have been altering federal antitrust enforcement agencies' analysis of mergers among sellers of branded consumer products.[11] The opportunities to employ econometric

---

[8] *TNEC Hearings*, *supra* note 1, at 13588 (testimony of Dr. Theodore Yntema).

[9] Complaining customers or rivals, however, might seek to argue the reverse: that the demand for steel is inelastic and U.S. Steel's products are close substitutes for those of their merger partner.

[10] The hypothetical facts would not support the theory of unilateral adverse competitive effects of a merger among sellers of differentiated products set forth under section 2.21 of the 1992 Merger Guidelines. U.S. Dept. of Justice and Federal Trade Commission Horizontal Merger Guidelines (1992), *reprinted in* 4 Trade Reg. Rep. (CCH) ¶ 13,104 (1992) [hereinafter Merger Guidelines].

[11] Econometric tools can also be employed to identify and measure the existing market power of brands and firms. Such methods are surveyed in Jonathan B. Baker & Timothy F. Bresnahan, *Empirical Methods of Identifying and Measuring Market Power*, 61 ANTITRUST L.J. 3 (1992).

methods to analyze mergers arise only occasionally—most often in mergers among sellers of branded consumer products like beer, soft drinks, breakfast cereals, or catfood, and not always then.[12] But when such methods are employed, the results are often influential in an enforcement agency's evaluation of the proposed transaction.[13]

I. WHAT CAN EMPIRICAL MERGER ANALYSIS TELL US?

Empirical analyses of proposed mergers provide information about the fine structure of demand. This information—particularly as it bears on whether the products of the merging firms are close demand substitutes—can be critical to the application of the localized competition theory of unilateral competitive effects of mergers among sellers of differentiated products set forth in section 2.21 of the Merger Guidelines.[14] Accordingly, econometric estimates of demand elasticities, when available, are typically much more informative than market shares in helping make inferences about whether such mergers will likely enhance market power.[15]

Econometric studies of market power in the U.S. brewing industry, during the 1970's, highlight the value of going beyond market shares to understand the competitive roles of individual firms and brands.[16] Anheuser-Busch, the producer of Budweiser, was the market share leader but exercised little market power after 1975. Moreover, market shares did not strongly distinguish Pabst and Coors. These two firms had similar shares of national beer sales, and each had a high share in a distinct region of the country. Yet the two firms played distinct competitive roles: Coors

---

[12] The anticompetitive story under investigation is typically the unilateral competitive effects theory for mergers among sellers of differentiated products set forth in section 2.21 of the Merger Guidelines. Studies may be conducted by economic experts working for the merging firms or complaining rivals, as well as by enforcement agency economists.

[13] Unless the private parties share their data and help agency economists replicate their estimates, however, the agency can neither assess the sensitivity of conclusions to modeling decisions made by the parties (such as specification of functional form, assumptions about error structure, or choice of instrumental variables) nor limit party incentives to emphasize those results most suggestive of their desired outcome.

[14] Enforcement agency economists today most commonly employ unilateral theories of harmful competitive effect, including this theory, though mergers may also harm competition by making coordination more likely or more effective. *See generally* Jonathan B. Baker, *Unilateral Competitive Effects Theories in Merger Analysis*, 11 ANTITRUST, Spring 1997, at 21.

[15] Merger analysis is prospective under the Merger Guidelines, typically grandfathering existing market power, and focusing on whether the merger makes matters worse. If existing market power is obtained through anticompetitive means, those means can be challenged independently under the antitrust laws.

[16] *See* Jonathan B. Baker & Timothy F. Bresnahan, *Estimating the Residual Demand Curve Facing a Single Firm*, 6 INT'L J. INDUS. ORG. 283 (1988); Jonathan B. Baker & Timothy F. Bresnahan, *The Gains from Merger or Collusion in Product-Differentiated Industries*, 33 J. INDUS. ECON. 427 (1985).

faced few close competitors while Pabst faced many. Had Anheuser-Busch acquired either Pabst or Coors, it would have had little incentive to raise either Pabst's or Coors' prices[17]—but for divergent reasons reflecting the two firms' differing competitive roles. Budweiser did not provide much constraint on Coors' pricing because Coors was isolated in product space. In contrast, so many brands constrained Pabst's pricing that the loss of one such competitor gave Pabst little additional pricing power.

Part of the promise of using empirical methods in merger analysis is that they make market definition less important. Indeed, if a merger can be shown to harm competition directly, antitrust should not need to spend much effort on market definition—a great benefit when the array of products are broad and seamless, making market definition difficult. Yet, many read the language of Clayton Act Section 7 as requiring a court to identify the product and geographic market within which competition would be harmed by an acquisition.[18] One plausible doctrinal adaptation—harmonizing the strengths of econometric analyses with the statutory requirement —might be termed a "*res ipsa loquitur*" market definition. When a piano crashes to the sidewalk, tort law does not ask whether someone is negligent; it goes right to the question of who is negligent. Similarly, if the likely harm to competition from a merger can be demonstrated directly, there exists a market where harm will occur, but there is little need to specify the market's precise boundaries.[19]

II. SOME TECHNICAL ISSUES IN EMPIRICAL MERGER ANALYSIS

The remainder of this article highlights some technical issues that arise in the application of econometric techniques for the analysis of mergers among sellers of differentiated products. These issues are raised in implementing current popular approaches for econometric merger analysis

---

[17] Either acquisition would have given Anheuser-Busch a strong incentive to raise the price of Budweiser, however. Coors and Pabst each provided some competitive constraint on Budweiser's pricing. *Cf. infra* note 39 (plausibility of asymmetric demand cross elasticities between Coors and Budweiser).

[18] 15 U.S.C. § 18 (1994) (prohibiting acquisitions likely to lessen competition substantially or tend to create a monopoly "in any line of commerce or . . . section of the country").

[19] *See generally* Jonathan B. Baker, *Product Differentiation Through Space and Time: Some Antitrust Policy Issues*, 42 ANTITRUST BULL. (forthcoming Spring 1997). Market definition is unnecessary in Sherman Act rule of reason cases if harm is shown directly. FTC v. Indiana Fed'n of Dentists, 476 U.S. 447, 460-61 (1986). Market definition is needed to apply existing Merger Guidelines' safe harbors based on concentration, however. Merger Guidelines, *supra* note 10, §1.51. Moreover, estimates of demand elasticities may be biased if some close substitutes are excluded from the econometric analysis. For this reason, market definition can be useful even when market shares provide little information about harm to competition. Baker, *supra* note 14, at 25.

—the "almost ideal" demand system;[20] the logit model;[21] and partial residual demand functions.[22] They would also be raised to estimate other familiar demand models (from single equation linear or double-log models to multi-equation translog systems) that relate output directly to prices,[23] or to estimate models that characterize the distribution of consumer preferences across product characteristics.[24]

The focus on technical issues is not intended to suggest skepticism about the value of econometric evidence in merger reviews. Indeed, these evolving approaches to merger analysis have the potential to become the dominant methodology for analyzing mergers among firms selling branded consumer products, particularly when employed in conjunction with corroborating information from marketing documents and industry experts.

A. *The Appropriate Time Interval for Measuring Demand Elasticities*

When scanner data is available, it may provide observations separated by a shorter time period than the monthly, quarterly, or annual data routinely employed in the past. A higher frequency of sampling increases the number of observations available over a given period. Data collected over three years, for example, can offer only three yearly observations or twelve quarterly observations on the variables—surely too few to permit statistical analysis. But three years provides thirty-six monthly observations

---

[20] AIDS models, developed by Deaton & Muellbauer, evolved out of an empirical effort to test the homogeneity and symmetry restrictions placed on demand by economic theory. ANGUS DEATON & JOHN MUELLBAUER, ECONOMICS AND CONSUMER BEHAVIOR 75-78 (1980); Angus Deaton & John Muellbauer, *An Almost Ideal Demand System*, 70 AM. ECON. REV. 312 (1980). To do so, it is necessary to estimate simultaneously a demand function for every commodity. Researchers doing so typically defined the "goods" as broad aggregates like food, clothing or fuel. Hausman, Leonard & Zona first applied the AIDS system to merger analysis, reinterpreting the goods as individual brands. Jerry Hausman et al., *Competitive Analysis with Differentiated Products*, 34 ANNALES D'ECON. STAT. 159 (1994). *See also* Jerry Hausman & Gregory Leonard, *Economic Analysis of Differentiated Products Mergers Using Real World Data*, 5 GEO. MASON L. REV. (forthcoming 1997).

[21] Gregory Werden & Luke Froeb, *The Effects of Mergers in Differentiated Products Industries: Logit Demand and Merger Policy*, 10 J.L. ECON. & ORG. 407 (1994); Gregory Werden et al., *The Use of the Logit Model in Applied Industrial Organization*, 3 INT'L J. ECON. BUS. 83 (1996).

[22] *See* Baker & Bresnahan, *The Gains from Merger or Collusion in Product Differentiated Industries*, *supra* note 16.

[23] For a survey of some functional forms employed in demand system estimation, see ROBERT A. POLLAK & TERENCE J. WALES, DEMAND SYSTEM SPECIFICATION AND ESTIMATION (1992).

[24] *See generally* Steven Berry & Ariel Pakes, *Some Applications and Limitations of Recent Advances in Empirical Industrial Organization: Merger Analysis*, 93 AM. ECON. REV. (Papers & Proc.) 247 (1993); Steven Berry, *Estimating Discrete-Choice Models of Product Differentiation*, 25 RAND J. ECON. 242 (1994); Steven Berry et al., *Automobile Prices in Market Equilibrium*, 63 ECONOMETRICA 841 (1995); TIMOTHY BRESNAHAN ET AL., MARKET SEGMENTATION AND THE SOURCES OF RENTS FROM INNOVATION: PERSONAL COMPUTERS IN THE LATE 1980'S (National Bureau of Economic Research Working Paper No. 5726, 1996).

or one hundred fifty-six weekly observations. Frequent sampling raises the issue of the appropriate time interval for measuring the demand elasticities relevant to assessing the competitive effects of acquisitions.

The appropriate time interval for measuring elasticities is an economic question distinct from the statistical issue of the frequency of sampling. It is easy to slip into allowing the latter to dictate the former, however. In particular, the availability of weekly data may permit estimates of very short-run demand functions that the seller faces from week to week. Yet under some circumstances, very short-run demand elasticities may mislead when employed to analyze the competitive effects of merger.

The potential problem with using weekly demand functions to analyze the likely effects of mergers arises from short-term price promotions by sellers of consumer products, combined with short-term inventories held by consumers. Manufacturers and retailers of branded consumer products commonly offer short term promotions many times of year, allowing consumers, able to hold inventories, to stock up during deal weeks. Promotions can occur as frequently as every other week on average, and the price during deal weeks is often discounted more than 25% from the regular price.[25] The estimated own and cross-price elasticities of weekly demand could readily be dominated by the consumer response to short-term price promotions.

These very short-run elasticities may have value as guides to sellers making decisions about whether to alter the spread between regular and promotional prices, but they may not always help answer the competitive effects question posed by a merger. When seller promotions and consumer inventorying are important, the relevant demand elasticity for merger analysis should answer an intermediate-run question such as the following: if both the regular and the promotional price were to rise by a small amount, holding constant the frequency and relative size of typical promotions, how does average quantity sold change? This is an appropriate demand elasticity, because merging rivals selling branded consumer products might reasonably be expected to exercise market power by raising the average price level, while continuing to offer regular sales.[26]

Although it is difficult to assess *a priori* the direction and magnitude of the difference between weekly demand elasticities and intermediate-run elasticities,[27] under some circumstances, the monthly or quarterly demand

---

[25] *See, e.g.*, Aradhna Krishna et al., *Consumer Perceptions of Promotional Activity*, 55 J. MARKETING 4, 9, 11 (1991).

[26] Although the merged firm might instead choose to exercise market power by reducing the frequency or extent of promotions, these alternative strategies are unlikely to be profitable unless the strategy described in the text is also profitable.

[27] The relation between the two is complex: the frequency of deals, the discount off the regular price, and buyer inventory behavior are jointly determined, related to consumer behavior in both the

functions likely more relevant to merger analysis could tend to have smaller own elasticities and larger cross elasticities than weekly demand functions for the same products. Suppose, for example, that on average, consumer inventories for a product would last two weeks. This would permit a consumer who thinks a price increase is temporary to delay a week—wait for a sale or other promotion (e.g. coupon)—rather than pay the higher price or switch to a less-preferred brand sold by a competitor. But once inventories are drawn down, the consumer may conclude that the price increase is permanent, and either pay it or switch to a less-preferred brand sold by a rival. If so, weekly demand may have larger (in absolute value) demand own elasticities and smaller demand cross elasticities than quarterly demand.[28] As a result, a firm may find that an acquisition of a rival brand may make it profitable to raise price on its current brands substantially, even if very short-run demand elasticities appear to suggest otherwise.

This problem could be minimized by keying the frequency of sampling to the length of a complete promotion and inventory cycle. If promotions typically occur one week a month, and surveys reveal that average consumer inventories are two weeks, for example, demand functions estimated on monthly data might adequately represent intermediate term consumer responses. If instead, price promotions are not important or consumer inventories are small, elasticities estimated on weekly data may not mislead when applied to merger analysis. This solution is not perfect, however. Aggregation over time ignores information available from frequent sampling, and may introduce biases of its own.[29]

A better approach would recover an intermediate-run demand elasticity with weekly sampling through explicit modeling of short-run promotions and household inventories. Such an approach would effectively separate out the effects of short-term promotions and consumer inventorying on

---

very short term and the intermediate run.

[28] The FTC's economic staff recently identified the hypothesized effect on estimated cross elasticities when analyzing scanner data in connection with the recent review of a merger involving branded consumer products. That is, brand quantity did not appear to respond to variation in the price of demand substitutes as much when weekly data was used, as it appeared to respond in monthly data. The movements in cross-elasticity point estimates were often economically substantial. For example, cross elasticities estimated in the 0.1 to 0.3 range when weekly data was used were estimated in the 0.3 to 0.6 range using the same model on monthly data. Shifting from weekly to monthly data did not make as much difference to the own elasticities, in contrast. The movement in cross elasticities was large enough potentially to make a noticeable difference in the inferred incentive to raise price post-merger.

[29] *Cf.* ERNST BERNDT, THE PRACTICE OF ECONOMETRICS: CLASSIC AND CONTEMPORARY 389-93 (1991) (surveying studies of the biases associated with temporal aggregation in analyses of the effect of advertising on sales of branded consumer products). On the other hand, price variation in disaggregated data may reflect data sampling problems (such as variation across buyers in the size of the purchased product) that would be smoothed in aggregated data.

demand elasticities by looking for differences in the consumer response to transitory price changes from the response to persistent price changes.[30] But it may be difficult to model short-term promotions and inventorying, because firms may employ promotions for more than one reason: as a way of discriminating in price between two groups of buyers who differ in short-run demand elasticity,[31] or in an effort to induce buyers to shift from other products.

Pending progress in this modeling task, a robustness test may provide evidence about the magnitude of the potential problem with weekly demand elasticities in markets where short-term promotions and consumer inventorying appear to be important. In particular, if demand elasticities estimated on weekly data do not change substantially when the model is reestimated using monthly or quarterly sample periods, it is unlikely that the weekly elasticities will mislead when used in merger analysis.[32]

---

[30] This approach also promises to help clarify the time series structure of the errors, and make clear how best to account for autocorrelation of the disturbances in estimating the demand functions. Autocorrelation may arise if the demand shocks resulting from promotions or advertising are not independent over time. For example, buyer demand may respond to promotions over a number of weeks (perhaps with unusually high demand during promotional periods and unusually low demand when inventory levels are high), and respond to brand advertising over a number of months (presumably with the greatest response during and shortly after the ad campaign). Autocorrelation of the errors may bias statistical significance tests of elasticity estimates.

[31] Customers with unpredictable demand and high costs of storing inventories might have inelastic short-run demand, for example.

[32] A second advantage of estimating the model on monthly or quarterly, rather than weekly data, is that it may be easier to identify a demand function in a simultaneous equation system in monthly or quarterly data, for two reasons. First, it may be possible to collect monthly or quarterly data on many exogenous cost-shift variables, the most common instruments for identifying demand when the brand price is endogenous, even if weekly data on those variables are unavailable. Second, an alternative approach to identification, the methodology employed by Hausman, Leonard & Zona, rests upon an assumption that, for many industries, may be more plausible when data is sampled at longer intervals. Hausman et al., *supra* note 20, at 165. *See* Jerry Hausman & William Taylor, *Panel Data and Unobservable Individual Effects*, 49 ECONOMETRICA 1377, 1386 (1981). In particular, Hausman, Leonard & Zona assume that the nationwide component of individual city prices (in a data set including multiple cities) reflects variation in the manufacturer's production and distribution costs, rather than demand shifts not controlled for in the estimated demand function. If so, the nationwide component of prices will be an appropriate instrument for identifying city demand because it will be correlated with a city's price, but not correlated with the component of the city's price related to unobservable demand shocks. For many industries, this assumption may be more plausible when monthly or quarterly data is employed than when weekly data is used. Demand for branded consumer products may be more stable over months rather than weeks (after controlling for predictable seasonal shifts and observable variation in the level of brand advertising), to the extent aggregation over time smooths the short-term effects of price promotions that simultaneously take place in multiple cities (e.g. promotions at all locations of a regional or national retailer). In contrast, the price of key inputs into production, marketing, and distribution may be more likely to vary substantially month-to-month than week-to-week, and thus tend to dominate the nationwide component of individual city prices in monthly or quarterly data.

B. *What Do the Elasticities Mean? Issues in the Use of Simulations*

With full knowledge of the demand system (own and cross elasticities), the nature of oligopoly behavior (including the behavior of prospective entrants), and costs for all firms in an industry; with knowledge of these functions not just locally but in a significant range; and with knowledge of how costs and behavior would change with a proposed merger; merger analysis would become merely a matter of computation. This information would permit the direct calculation of the post-merger equilibrium, and thus a determination of how prices would change.

In practice, such computations cannot be performed; the information demands are simply too great. But it is possible, and increasingly common, to simulate mergers by combining estimates about some of the necessary information with assumptions about the rest. Simulations synthesize a great deal of empirical information in a logically consistent way to help identify mergers that give the parties strong incentives to raise price.[33] They also provide a means of determining the sensitivity of such conclusions to uncertainty about the estimates and disagreements about the plausibility of the assumpions.[34] Because the simulation procedure necessarily combines estimates and assumptions about which there may be significant uncertainty, the output of the procedure—a set of projected price changes—is better viewed as an indicator of the strength of incentives, rather than as a forecast.[35]

Four issues about appropriate simulation methodology will be highlighted below. First, the value of simulations that make assumptions about demand elasticities, rather than incorporating empirical evidence,[36] de-

---

[33] *See generally* Gregory Werden, *Simulating the Effects of Differentiated Products Mergers: A Practical Alternative to Structural Merger Policy*, 5 GEO. MASON L. REV. 363 (1997). The simulation approach that has to date been the most developed is that suggested by Werden and Froeb. Gregory Werden & Luke Froeb, *Simulation as an Alternative to Structural Merger Policy in Differentiated Product Industries*, *in* THE ECONOMICS OF THE ANTITRUST PROCESS 65 (Malcolm Coate & Andrew Kleit eds., 1996). Hausman & Leonard propose an alternative method of simulating post-merger prices from information on premerger prices and estimated demand elasticities. Hausman and Leonard, *supra* note 20.

[34] Moreover, simulations can be valuable for educating intuitions. Even when it is difficult to venture a good estimate of every element that goes into computing likely post-merger price changes, experimentation with the simulation model can help identify the critical parameters on which the magnitude of anticompetitive incentives depends, and thus guide the collection and analysis of qualitative evidence on the most critical issues.

[35] Another indicator of incentives to raise price can be derived from the estimation of partial residual demand functions. *See* Baker & Bresnahan, *The Gains from Merger or Collusion in Product Differentiated Industries*, *supra* note 16.

[36] Econometric estimates of demand elasticities are not based purely on empirical evidence. The specification of the econometric model invariably also incorporates assumptions justified by experience, insight derived from economic theory, or mathematical tractability. Empirical estimates are nevertheless data-driven, while assumptions about demand elasticities are not.

pends on the strength of the qualitative evidence used to justify those assumptions. In particular, some benchmarking methodologies for analyzing mergers rely on assumptions about the degree of substitution among products—most commonly, that all products in the market are equally good substitutes.[37] Evidence to support such an assumption is required because the cross elasticities among products within a market can have any relationship: there is no basis, theoretical[38] or empirical,[39] for presuming absent evidence from the market at issue that the cross elasticities are symmetric or related to market share, for example. Accordingly, in order for simulations based upon assumptions about elasticities to aid merger analysis, the assumptions should be suggested by non-statistical evidence, as from marketing documents.[40]

Second, the value of simulation results that employ accounting estimates of average variable cost as a proxy for marginal cost depends on the quality of the proxy. Marginal cost estimates are relevant in simulating the effect of mergers because profit-maximizing firms determine price as a markup over marginal cost.[41] With information on pre-merger marginal

---

[37] For examples of benchmark methodologies based entirely or largely on assumptions about demand elasticities (or closely related concepts like diversion ratios), see Merger Guidelines, *supra* note 10, § 2.211; Carl Shapiro, *Mergers with Differentiated Products*, 10 ANTITRUST 23 (Spring 1996); Luke Froeb & Gregory Werden, *Simulating the Effects of Mergers Among Noncooperative Oligopolists*, *in* COMPUTATIONAL ECONOMICS AND FINANCE: MODELING AND ANALYSIS WITH *MATHEMATICA* 177 (Hal Varian ed., 1996) (imposing symmetric substitution among the products within a nest); R. Preston McAfee et al., *Horizontal Mergers in Spatially Differentiated Noncooperative Markets*, 40 J. INDUS. ECON. 349 (1992).

[38] Demand theory does constrain the relationship among own and cross elasticities for all products in the economy, but that economy-wide aggregation constraint provides no practical limitation on the elasticities within a product market. *See, e.g.*, JAMES HENDERSON & RICHARD QUANDT, MICROECONOMIC THEORY: A MATHEMATICAL APPROACH 33 (3d ed. 1980). It may be convenient to impose additional constraints in order to develop mathematically tractable demand systems, but such additional assumptions are not mandated by economic theory.

[39] The plausibility of asymmetric cross elasticities is suggested by an interpretation of the relative competitive roles of Budweiser and Coors during the 1970's. *See supra* notes 16-17 and accompanying text. Most of those customers who considered Budweiser and Coors to be their first and second choices, and were close to indifferent between the two brands, appear to have selected Budweiser at the then-current prices. Hence a Budweiser price rise would have induced marked substitution to Coors, while a Coors price rise would not have induced much substitution to Budweiser. Had the price of Coors been lower, the likely brand switchers might have largely selected that brand instead. Under such circumstances, Coors demand would have exhibited a significant cross elasticity with Budweiser, and the cross elasticity of Budweiser with Coors would not have been as great.

[40] In some cases, it may not be possible to obtain good empirical evidence on demand elasticities, either because data is unavailable or the available data is not informative (e.g. because prices of the substitutes are collinear). Under such circumstances, it may be necessary to rely on non-statistical evidence exclusively.

[41] A profit-maximizing firm selling a single product sets price or output by equating the Lerner Index of markup over marginal cost (price less marginal cost, as a fraction of price) with the inverse of the elasticity of the residual demand function it perceives itself as facing. (Equivalently, and more familiarly, the firm selects output by equating marginal revenue with marginal cost). The residual demand elasticity is in turn a function of own- and cross-elasticities of demand, as well as parameters

cost, the pre-merger markup of price over marginal cost can be computed. In combination with demand elasticity estimates, this markup information can be used to make an inference about the nature of the pre-merger oligopoly interaction (the intensity of pre-merger competition).[42] Errors in estimating marginal cost can lead to mistaken inferences about the magnitude of pre-merger markups and the intensity of pre-merger competition. For example, if a firm's marginal cost at its pre-merger output is underestimated, its inferred price-cost margin will be biased upward and its pre-merger conduct will appear less competitive than it actually is. A poor picture of the pre-merger interaction can lead to a misleading conclusion about the incentives to raise price post-merer.[43]

Accounting measures of average variable cost that exclude all expenditures on advertising and other promotion may underestimate marginal cost,[44] and thus lead simulations to suggest a misleading conclusion about the incentives to raise price post-merger. The marginal cost relevant to pricing includes those advertising and promotional expenditures that would change were the firm to adopt a different pricing strategy over a full promotion and inventory cycle.[45] Hence, an estimator of marginal cost that excludes all promotional expenditures on the ground that they are predetermined in the very short run may systematically understate the incremental cost related to the intermediate-term pricing decision most relevant to merger analysis.

Even if some promotional expenditures are included in a measure of

---

reflecting oligopoly behavior. *See generally* Baker & Bresnahan, *Estimating the Residual Demand Curve Facing a Single Firm*, *supra* note 16.

[42] Alternatively, that inference may be used to confirm the plausibility of an assumption about the oligopoly solution concept.

[43] For example, a marginal cost underestimate (markup overestimate) limited to one of the merging firms may lead to an overstatement of the competitive danger from merger. Suppose firms A and B merge, the marginal cost of all industry firms except firm B is estimated without error, and firm B's marginal costs are underestimated. Although the merged firm may have only a limited incentive to raise the price on firm A's products, that incentive may be overstated because it may appear as though A would profit greatly by internalizing the benefit of diversion to the products of firm B.

If marginal cost is underestimated across-the-board (for all firms), and in consequence all markups are overestimated, the simulations will likely also misstate the incentive to raise price post-merger. The forces at work go in opposite directions. On the one hand, it may mistakenly appear as though the industry participants have previously obtained much of the potential gains from the exercise of market power, suggesting that the simulations would understate the competitive danger. On the other hand, it may mistakenly appear that the remaining firms will respond passively to the loss of competition between the merging firms, and not expand output aggressively, thus overstating the incentive of the merged firm to raise price.

[44] Estimators of marginal cost that infer cost from market share by making an assumption about the nature of premerger oligopoly behavior (e.g. presuming that firms with high market shares sell more because they have low cost) raise similar problems.

[45] The stock of reputational capital arising from brand advertising often has a half-life measured in months. *See* BERNDT, *supra* note 29, at 392. This observation suggests that a great deal of brand advertising expenditures affects pricing rapidly.

average variable cost, that measure may understate the incremental cost of expanding output in branded consumer product industries because of the nature of product differentiation. The characteristics of any individual differentiated product—including styles, features, manufacturer reputation for quality and service, etc.—typically appeal more to some customers than others. Firms selling such products may therefore experience decreasing returns to scale in promotion and distribution, and face upward sloping supply functions, even if they experience constant returns to scale in production. The extra expenditure the firm must make to induce a purchase by an additional buyer, either by increasing advertising or otherwise varying product characteristics, represents an element of marginal cost that may not be reflected in average variable cost data.

Non-quantitative evidence may be brought to bear to determine whether average variable costs adequately capture the incremental costs relevant to pricing. In particular, industry marketing documents might be reviewed and industry participants queried to identify the costs on which firm pricing decisions are based. This information may suggest how well accounting measures of average variable cost incorporate the costs relevant to antitrust merger analysis.[46]

The third issue about appropriate simulation methodology is the usefulness of evidence about the way the firms interact (the oligopoly solution concept) pre-merger. Some simulation approaches, for example, presume Bertrand-Nash behavior; this is often the most convenient assumption for mathematical tractability. Yet economic theory does not dictate the choice of solution concept. Even if firms understand what they are doing as setting price rather than outputs, for example, as may be common among sellers of branded consumer products, and thus act consistently with one theoretical predicate for Bertrand-Nash competition, their behavior may be more consistent with Cournot-Nash conduct[47] or some other oligopoly solution concept.

Empirical methodologies for estimating the solution concept are well developed.[48] When estimation is not practical or successful, however, it

---

[46] Marginal cost is difficult to estimate. Indeed, the new empirical industrial organization literature treats marginal cost as unobservable, and infers the price-cost margin from the response of firms to a variety of exogenous shocks, rather than computing the margin directly from price and cost data. Timothy F. Bresnahan, *Empirical Studies of Industries with Market Power*, *in* 2 HANDBOOK OF INDUSTRIAL ORGANIZATION 1011, 1012 (Richard Schmalensee & Robert D. Willig eds., 1989). On the other hand, the merging parties and antitrust enforcers (through compulsory process) have access to information on the determinants of firm pricing and output decisions, from which to evaluate accounting proxies for marginal cost, that are typically unavailable to academic researchers.

[47] David M. Kreps & José A. Scheinkman, *Quantity Precommitment and Bertrand Competition Yield Cournot Outcomes*, 14 BELL J. ECON. 326 (1983).

[48] Timothy F. Bresnahan, *The Oligopoly Solution Concept is Identified*, 10 ECON. LETTERS 87 (1982). *See generally* Baker & Bresnahan, *supra* note 11, at 9-13.

may be useful to test the robustness of simulation results that assume Bertrand competition to alternative solution concepts—for example, to some other solution concept such as Cournot-Nash equilibrium that presumes that products are strategic substitutes rather than strategic complements (as the Bertrand assumptions presume).[49]

Finally, simulation results may be sensitive to assumptions about the out-of-sample behavior of demand functions. Mergers create large changes in market structure, and thus may generate discrete, not localized, movements in output and prices. As a result, a merger may move the industry partial equilibrium to a position on the demand curve not observed in the historical data. Changes in the assumed curvature of the demand function as the industry equilibrium moves to out-of-sample prices and outputs—more precisely, the elasticity of the demand elasticity—can be very influential in determining the price changes that result from merger.[50] If industry demand grows highly inelastic when industry output falls slightly, an anticompetitive merger may lead to a large increase in price. Conversely, if industry demand grows highly elastic when output rises slightly, firms have a great incentive to pass through variable cost reductions from merger, and an acquisition may actually lower price by more than the reduction in marginal cost.[51] In evaluating the conclusions of simulation modeling, it should be helpful to determine whether the results are sensitive to reasonable variation in the assumed out-of-sample behavior of demand.

CONCLUSION

Empirical merger analysis mixes estimation and simulation, and both tasks are conducted using simplifying assumptions.[52] Differences in those assumptions can lead to divergent inferences about the incentives to raise price following merger. In one recent transaction considered by the FTC, for example, one outside economist concluded that the price of a leading brand sold by a merging firm would rise only 2%. Another outside economist, working for a different party, concluded that the same price

---

[49] Simulation results will be affected if the solution concept is Cournot but is mistakenly assumed to be Bertrand much as they would if marginal cost were overestimated across-the-board. *See supra* note 43.

[50] This problem arises regardless of the demand system used in inferring incentives to change price following merger.

[51] As a rule of thumb, a monopolist facing a linear demand function (or an oligopolist perceiving that it faces a linear residual demand function) and constant marginal cost, will pass through half of any marginal cost decline through to buyers as lower prices. Demand must become more elastic as price falls for the firm to pass through more than the marginal cost reduction.

[52] *See supra* note 37.

would rise 14%. A third outside economist, working for a third interested party, found that the price would rise by 27%.

This story should not be taken to suggest that the demand estimation and merger simulation tools are not helpful in merger analysis. Our review of these studies permitted us to identify the critical assumptions leading to the differing results, thus enabling us to determine what assumptions were most consistent with the qualitative evidence uncovered in the investigation and to identify the most credible inferences about the strength of incentives to raise price. This example highlights the importance of testing the sensitivity of parameter estimates and simulation results to critical assumptions, by reworking the models with alternative assumptions over a reasonable range.[53] It also points out what is perhaps the most important way these new tools can improve merger analysis: they help identify the most critical assumptions and, in so doing, guide a search for additional evidence that will improve decision-making.

[53] When statistical specification tests are employed in lieu of robustness analysis to show that a critical assumption is not rejected in the data, it is important to understand the power of those specification tests. This may involve identifying the range of alternative assumptions that would also not have been rejected in the data.