Empirical Methods in Antitrust Litigation: Review and Critique

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1. Introduction

The use of empirical methods in antitrust has been growing at an exponential rate. It is now commonplace for multiple regression and other statistical methods to be utilized in merger cases, especially those involving predictions of the price increases that may result from the strategic decisions of the merging firms. These methods are also prominently employed in civil nonmerger investigations by the federal antitrust enforcement agencies (including price fixing, monopolization, and exclusive dealing cases) and in private litigation (including damage claims and class action suits). This article surveys the methodologies that have been used and the range of questions that they address. It also provides a critical examination of the growing set of statistical tools that are available for use in antitrust analysis.

Why has the use of empirical methods grown so rapidly? There are important demand and supply-side explanations. On the supply side, the rapid improvement in computer technology has made empirical

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methodologies feasible and economical. What were once prohibitively time-consuming analyses on mainframe computers can now be carried out in a few minutes or even seconds on a personal computer. These processing improvements have made it possible to collect and to analyze vast quantities of data. Accordingly, the enforcement agencies and economic and marketing experts in the private sector now make frequent use of supermarket scanner data available commercially from two firms, Nielsen and Information Resources, Inc. (IRI).[1] Coincident with the improved technology has been the development of a number of empirical methods that have been utilized with some success by industrial organization economists.[2]

On the demand side, the interest of the courts in using statistical methods has also been growing by leaps and bounds. Courts are finding, to a greater and greater degree, that reliable statistical evidence can be invaluable in deciding questions of impact, harm, and damages in a range of cases, including antitrust. Accordingly, the Federal Judicial Center's *Reference Manual on Scientific Evidence* contains a chapter on statistics and a chapter on multiple regression.[3]

Within the confines of antitrust, the increased demand for empirical methods is certainly coincident with, and may be the result of, the greater judicial willingness to evaluate evidence about the economic effects of mergers and the effect of alleged anticompetitive practices rather than re-

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1. Both Nielsen and IRI use scanning devices to record supermarket sales data for a national random sample covering a range of metropolitan and rural areas. In the IRI Infoscan Data Base, for example, samples are drawn from a supermarket universe that includes stores with annual sales greater than $2 million (which accounts for 82% of U.S. grocery sales). Scanner data was employed, for example, by Professor Jerry Hausman in support of Kodak's petition for modification or termination of a 1921 consent decree restricting Kodak's ability to sell private label film. Professor Hausman estimated that the cross-price demand elasticities between Kodak and Fuji film were high and used that evidence to support his opinion that Kodak did not have market power. Relying in part on Hausman's testimony, the court agreed. *U.S. v. Eastman Kodak Co.*

2. See generally, Bresnahan (1989, 1997), Baker and Bresnahan (1992).

3. Freedman and Kaye (1994) and Rubinfeld (1994). These materials seek to explain empirical methods and highlight issues a court should consider in evaluating the admissibility and probative value of statistical evidence. Admissibility issues are often framed as a question of the interpretation of judicial rules intended to exclude "junk science." See generally, *Daubert v. Merrell Dow Pharmaceuticals, Inc.; Kumho Tire Co. v. Carmichael.*

lying exclusively on presumptions about the anticompetitive consequences that flow from a particular industrial structure.[4] In the merger area, the erosion of the structural presumption is reflected in part by an increased preference at the enforcement agencies for analyzing the likely competitive effects of mergers under "unilateral" theories that do not require coordination among all firms in the market.[5]

The great promise of statistical methods is that they permit a systematic synthesis of the quantitative evidence, weighting the most informative data points the most heavily. For example, in a school milk price-fixing case, liability might turn on whether the price of school milk rose in the school districts in which bid-rigging conspiracies were alleged to have been effective. Statistical methods permit the analyst to compare prices charged to the allegedly victimized school districts with the prices charged to other school districts, to control for factors other than the alleged conspiracy influencing prices (including cost differences), and to give more weight to the most telling pricing observations (perhaps those in districts with multiple procurements, the most bidders, or the largest contracts).

Empirical methods can help courts identify what happened and why. This can often be accomplished through a multiple regression analysis that distinguishes among a number of competing factors that were correlated with a fact pattern—allowing the court to isolate a key relationship or critical influence using models that describe the statistical relationship between one variable and a number of others.

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4. Compare *U.S. v. Philadelphia Nat'l Bank* (high and increasing market concentration creates a nearly conclusive presumption of harm from merger) with *U.S. v. Baker Hughes Inc.* (Thomas J., joined by R. Ginsburg, J. and Sentelle, J.) (concentration is merely "a convenient starting point" for a "totality-of-the-circumstances" analysis).

5. See U.S. DOJ and FTC *Horizontal Merger Guidelines* (1997). Proof of coordinated competitive effects has historically relied on market concentration as an indicator of the likelihood of collusive anticompetitive behavior. The theory is that, with fewer firms, the prospects for reaching an oligopolistic consensus or preventing cheating (as through rapid detection and response) are enhanced. The *Merger Guidelines* suggest that the government can also prove that a merger enhances the prospects for coordination with evidence that does not depend on the structural presumption: by showing that the merger leads to the loss of a "maverick" that previously constrained the likelihood or effectiveness of coordination. Unilateral competitive effects cases depend on a qualitative or quantitative analysis of the likelihood that merging firms will unilaterally raise prices knowing that a portion of the sales that would have been diverted to other firms premerger will not be lost postmerger.

Consider, for example, the Ampicillin Antitrust Litigation.[6] The plaintiffs in the case, a number of cities, counties, and states that had purchased ampicillin, sued Bristol-Myers on the theory that Bristol's exclusive license from a British company Beecham for the right to manufacture and sell bulk ampicillin powder in the United States was anticompetitive. At issue was Beecham's agreement not to market the bulk powder in the United States. To explain what happened and why, defense experts performed a multiple regression analysis in which the dependent variable—the price of ampicillin—was determined by a set of cost variables, a measure of manufacturing competition in the industry, a measure of generic competition, and a group of time dummies (indicator variables that account for shifts in price between time periods). The lack of significance of the generic competition variable provided support for the view that, had generic houses been able to obtain bulk ampicillin powder, they would not have been able to compete effectively in the marketplace.[7]

Statistical methods can also facilitate simulation and thus permit comparisons between what actually happened and a but-for world. This approach is often adopted in cases involving antitrust damages, as is illustrated by the Plywood Antitrust Litigation.[8] The central question in the case was whether the use of a uniform and superficially artificial method of quoting prices for Southern pine plywood harmed competition. A test of violation and an estimate of the degree to which damages were incurred was formulated by asking whether the growth and development of the southern plywood industry, in coordination with an allegedly conspiratorial method of quoting delivered prices, served to raise plywood prices in the South above the competitive level. To answer this question a plywood pricing model was estimated during the alleged conspiratorial period and used to forecast prices forward into the nonconspiratorial period (after the pricing mechanism had been changed). If forecasted prices had been significantly and substantially higher than actual prices, the re-

6. The case is described in Rubinfeld and Steiner (1983). One opinion can be found at *In re Ampicillin Antitrust Litigation.*

7. The case was settled before issues relating to the regression analysis could be evaluated.

8. *In re Plywood Antitrust Litigation*, 655 F. 2d 627 (5th Cir. 1981), *cert. granted sub nom. Weyerhauser Co. v. Lyman Lamb Co.* and *cert. dismissed.* See Rubinfeld and Steiner (1983) for discussion.

gression approach would have provided support for a finding of violation and also provided a direct means of measuring damages.[9]

These examples just touch the surface of the ways antitrust litigation may rely on empirical methods to summarize the past and simulate alternatives. Another common example involves determining whether to certify a proposed class of plaintiffs. Under the Federal Rules of Civil Procedure, certification requires plaintiff to show, among other things, that there are common legal and fact issues among the members of the class.[10] Typically this involves a showing by the plaintiff that damages can, in principle, be evaluated through a common method.[11]

Still another common example comes from merger analysis. The federal antitrust enforcement agencies, applying the unilateral competitive effects analysis in the merger guidelines, frequently wish to estimate the incentive a firm will have to increase the price of one (or more) of its products after a competitor's product has been acquired. That incentive depends on the extent to which the firm will be able to recover sales that would otherwise be diverted to competitors when the firm decides to raise its price—a factual issue related to demand cross-elasticities, which can be estimated. In both merger and nonmerger cases, moreover, the empirical analysis of the price elasticity of demand for a product is relevant to market definition.

Because the range of applications of these empirical techniques is so broad, we have chosen in our survey to emphasize methods that are used or can potentially be used by the antitrust enforcement agencies. Throughout, we seek to identify critical statistical issues in application of the techniques and discuss the merits of alternative ways of resolving them. As an organizing principle, we have opted to focus on empirical techniques rather than legal categories. The major division is between reduced

9. Plaintiffs were successful at trial, despite the lack of support given by the econometric test. There are a number of variants on the violation-damage approach just outlined. In some cases one can backcast in time from one period (e.g., conspiratorial) to another (e.g., nonconspiratorial), or one can include a variable reflecting possible violation in a regression model to be estimated, with violation and damage measurement flowing directly from the estimated regression coefficient. Which approach is to be preferred depends on the nature of the available data and the alleged violation.

10. See Rule 23(a), Federal Rules of Civil Procedure.

11. See, for example, *Alabama v. Blue Bird Body Co., Inc.* and *In re Domestic Air Transportation Antitrust Litigation.*

form methods and methods that identify the structure of demand or supply. Section 2 describes a number of applications for traditional statistical methods that rely on reduced form estimation using cross-section or time-series data. Section 3 examines the application of methods that uncover the structure of demand. Three classes of techniques are considered. The first, and perhaps the most familiar, involves estimating demand elasticities from data on market transactions. The second class of methods uses transactions or bidding data, perhaps merged with information on buyer characteristics, to learn about the structure of preferences and to make inferences about the extent of buyer substitution between alternatives. The third class of methods relies upon survey techniques to learn about demand. Section 4 looks at the potential applicability to antitrust litigation of methods for inferring market power commonly employed in empirical industrial organization research; these can be understood as techniques for analyzing the structure of supply. A brief concluding section highlights the way empirical analyses interact with nonstatistical evidence, including documents and testimony, in antitrust litigation.

2. Reduced Form Methods

The most common statistical method employed in antitrust litigation involves the estimation of reduced form price equations. This technique explains the variation in a particular price by variables related to cost, demand, and market structure, and a series of indicator (dummy) variables that allow the intercept to differ among relevant groups of observations. The model is called "reduced form" because the price equation is thought of as derived from other, prior economic relationships—in this case, the interaction of a demand function with a supply relation. In consequence, the parameters of a reduced form equation are typically themselves functions of a number of the structural parameters (the parameters of the underlying economic relationships).[12]

Reduced form relationships are frequently easier to estimate than are the structural relationships from which they are derived. It can be difficult

12. Thus, if a demand function is given by $Q = a - bP + cI$, where P is price, Q quantity, and I income, and a supply function is given by $Q = d + eP - fC$, where C is cost, the reduced form price equation, obtained by equating demand and supply and solving is given by $P = (a - d)/(b + e) + [c/(b + e)]I + [f/(b + e)]C$.

to identify demand, for example, both conceptually (i.e., to distinguish demand functions from supply relations) and empirically (because of insufficient data or insufficient variability in the data). As a result, when reduced form estimates of parameters will answer the questions relevant to the litigation, an attractive strategy can be to concentrate one's empirical effort on obtaining reduced form parameter estimates. There are potentially significant costs, however. Reduced form parameters are generally less tied to economic theory than are the parameters of structural equations and must therefore be used with care in the analysis of events in which structure changes.[13] Also, simulations based on the parameters of reduced form equations necessarily presume stability of the underlying structural parameters. Without an understanding of the underlying structure, it may be difficult to have confidence that this presumption of stability is warranted.

In the subsections that follow, we show how reduced form estimation can be used in a number of substantive antitrust areas.

A. Price-Fixing Litigation

Reduced form equations are perhaps the most commonly employed in price-fixing cases. In this litigation setting, the goal is typically to determine whether and how much prices rose as a result of the alleged cartel, as a basis for finding liability and measuring damages. This can be accomplished by estimating a reduced form price equation, controlling to the extent possible for fluctuations in cost and demand that might affect price. The price effect of the alleged conspiracy is measured by the coefficient on a dummy variable that takes on the value of one during the period (or in the markets) in which the conspiracy is in operation.

For example, in a recent reported decision, a federal district court granted class action plaintiffs' motion for class certification based in large part on the plaintiffs' proposal to use the reduced form method to as-

13. Further, the functional form of the equations in the structural model (including the nature of the error terms) will affect the functional form of the reduced-form equations. Failure to account for this could lead to biased or inefficient reduced-form parameter estimates. Suppose, for example, that the structural demand and supply equations were known to be linear in the logarithms of the variables. Then the appropriate functional form for the reduced form would also be linear in the logarithms. Estimation of a strictly linear reduced form equation would then generate biased results.

sess damages.[14] The motion turned on plaintiffs claim that at trial that they would use evidence common to all members of the proposed class to demonstrate supracompetitive prices (and thus harm to the class) and to prove the amount of damages. To make this showing, plaintiffs told the court that they intended to rely on an econometric study to be performed by their expert, Professor Martin Asher. Although the study had not yet been performed, its design was evaluated because the court sought to determine whether the evidence likely to be offered would be common to the members of the proposed class. Professor Asher proposed to estimate a reduced form equation to explain the price of polypropylene carpet.[15]

Although the court opinion does not spell out all the details of Professor Asher's proposed regression model, it appears similar to price equations commonly used to measure damages in litigation settings. Specified as a linear regression model, the typical reduced form price equation takes the following form:

$$\mathbf{P}_{it} = \alpha + \beta \mathbf{w}_{it} + \gamma \mathbf{y}_{it} + \delta \mathbf{s}_{it} + \lambda \mathbf{D}_{it} + \varepsilon_{it} . \qquad (1)$$

In this notation, $\mathbf{P}_{it}$ represents the price of a product at time t paid by customer i (or, in many specifications, in region i), $\mathbf{w}$ is a vector of variables other than scale (output) that affect cost (e.g., factor prices), $\mathbf{y}$ is a vector of variables affecting demand (e.g., the price of substitute products), and $\mathbf{s}$ is a vector of variables related to market structure (e.g., seller concentration or measures of entry conditions). The variable $\mathbf{D}$ is a vector of indicator (dummy) variables that allow the intercept α to vary among relevant groups of observations.

Equation (1) presumes that observations are drawn from a panel that has both cross-section (i) and time series (t) elements. The linear form encompasses models that are linear after transformation of the variables, such as log-linear models (in which price, quantity and other variables are measured as logarithms). The random error ε_{it} can be thought of as derived from random shifts in demand, marginal cost or oligopoly conduct.

14. See *In re Polypropylene Carpet Antitrust Litigation*. The case is currently in litigation.

15. We do not take any view as to whether Professor Asher's proposed methodology (choice of variables, specific functional form employed, and so on) was appropriate for identifying the magnitude of the price effect of the alleged conspiracy in the polypropylene industry. We discuss the proposed study here solely as a convenient means to illustrate one common type of empirical analysis.

Typically the random error is assumed to be independent of, and therefore uncorrelated with, all of the right-hand variables in equation (1). Thus, for example, an increase in firms' costs of production not reflected in the included cost variables may cause price to increase, but it is assumed that the resulting price increase will not in turn affect market structure.

Equation (1) is termed a "reduced form" equation because it is thought of as describing the determinants of price in the partial equilibrium reached by the intersection of a demand function and a supply relation for a single industry, with the jointly determined output variable having been removed by algebraic substitution.[16] The cost and demand-shift variables included in these regressions are typically viewed as "exogenous" (i.e. determined independently of the dependent variable and therefore unaffected by it).[17] Variables related to market demand appear in the reduced form price equation for two economic reasons. First, shifts in demand may alter marginal cost by changing the scale of firm operations. Second, any oligopoly, whether acting completely or only partially like a monopolist, has an incentive to increase its markup of price over marginal cost when demand grows more inelastic. Variables related to market structure may appear in the reduced form price equation because they may be related to the extent to which the firms are able to exercise market power.

Professor Asher proposed to implement this modeling strategy by measuring a number of variables affecting cost and demand. His cost-shift variables included measures of the cost of polypropylene yarn, the cost of latex backing, and labor costs. Professor Asher intended to include the volume of purchases by each customer as a regressor, most likely in order to capture the cost savings involved in filling a larger order.[18] He also proposed incorporating a measure of the degree to which payment terms

16. For an example, see note 12 supra.

17. While that common assumption is often innocuous, the partial equilibrium may be nested within a dynamic general equilibrium in which some of the right-hand variables (such as prices of factors of production, prices of substitute products, and aspects of market structure) are determined, making those right hand variables endogenous. See Evans, Froeb, and Werden (1993) (discussing the possible endogeneity of a market concentration variable). Methods of obtaining consistent estimates of the parameters when right hand variables are endogenous are discussed subsequently in section 3.A.1.

18. If even the largest individual transactions are small relative to the size of the market, it may be reasonable to treat this variable as an exogenous cost-shifter.

may vary among customers, perhaps on the view that the measure is related to the interest costs associated with different payment terms. To account for demand, Professor Asher proposed right-hand variables related to business cycles and general economic conditions. His proposed study apparently would not include any variables related to market structure.

Professor Asher appears to have intended to estimate his model on time-series observations on individual sales and to measure the impact of the conspiracy by the coefficient on a dummy variable that takes on a value of 1 during the period of the alleged price-fixing agreement. This would measure the difference between actual transaction prices during the alleged conspiracy period and estimates of what the prices would have been absent the conspiracy. This approach thus seeks to compare prices in a period when the conspiracy was alleged to have been operating with prices in a control period thought to be competitive. In other cases, proof of injury to competition has been based on the cross-sectional comparison of prices in markets alleged to have been cartelized with markets thought to behave competitively.[19]

The court accepted that Professor Asher's proposed methodology would "follow valid econometric principles," would "possess probative value," and, of particular importance for class certification, would "primarily use common evidence."[20] In the context of arguing against class certification, defendants' main challenge to the proposed study was based on their expert's testimony that the diversity of the polypropylene carpet

19. For example, *Ohio v. Louis Trauth Dairy, Inc.* (school milk prices in Southwestern Ohio were found to be 10% higher than those in a "baseline area" in North-Central Ohio, based on a pricing study controlling for "differences in raw milk prices, distance, specifications, and demand"); *Colorado v. Goodell Brothers, Inc.* (comparing prices on suspect highway construction bids with prices on those "presumed competitive," controlling for "time, quantity, number of bidders, and the engineer's estimate.")

20. See 996 F. Supp. at 27. The court observed that Dr. Asher's proposed technique for estimating damages in a price-fixing case "is accepted by many practitioners of econometric techniques," citing Finkelstein and Levenbach (1983) and Rubinfeld (1985, p. 1087) ("in a price-fixing case... a regression model that explains price in a period of nonviolation can be used to predict what the price would have been during the period of violation."). See 966 F. Supp. at 29. But the court also noted questions about the practical utility of this approach raised by Fisher (1980, p. 729) ("Although it will be possible to test whether the difference in price is significant, it will probably be very hard to decide how much of that difference is due to random error. ... [I]f what is involved is prediction over a long time, this forecasting may be worth trying, but it is not likely to be useful.").

market would require a reduced form price equation that included many more than six explanatory variables, perhaps as many as 140. Defendants contended that, in consequence, a reliable regression analysis would require data that varied widely among the proposed class members. The court rejected this argument based on its view that defendants had no evidence other than the "speculation" of their expert that the 140 unidentified variables would be "crucial to a reliable regression analysis" and concluded that plaintiffs had met their burden to show that they would rely predominantly on evidence that is common to all members of the proposed class to prove that the alleged conspiracy harmed the class.[21]

As this example suggests, reduced form models are attractive because their requirements are limited. They can help answer critical questions—here, whether prices were higher during the alleged conspiracy—even when the analyst lacks the information necessary to isolate the structure of demand and supply separately. They typically make only limited computational demands; the techniques for estimating single equation linear models using ordinary least squares are at the front of most econometrics textbooks.[22]

This example can also be used to illustrate the kinds of criticisms that might arise in the estimation of reduced form models. First, the omission of relevant variables can bias the results. In the case of the polypropylene damages study, the key variable is the coefficient on the dummy variable that indicates the period of the alleged price-fixing conspiracy. If costs were high during those periods because of the influence of variables not included in the regression model, or if demand grew more inelastic during that period in ways not captured by the included demand-side variables, then the dummy variable might have a large positive coefficient for reasons unrelated to the existence of the alleged conspiracy. The sponsor of a regression study can often defend against this potential criticism through judicious use of nonstatistical evidence, including the testimony of industry experts about the possibility of other nonconspiratorial explanations for the high prices during the conspiracy period.

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21. See 996 F. Supp. at 28. Once such a study is completed and offered into evidence as basis for determining damages, the court will still need to determine the validity and probative value of the study as applied in this particular case. The court has only reviewed the study proposal, not the validity of the data or the study results.

22. For example, Pindyck and Rubinfeld (1998).

Second, the results might not be robust to the choice of functional form. The dummy variable might have a large positive coefficient, suggesting an effective cartel was in operation when a linear model was estimated, but the coefficient might not be large when a log-linear model was estimated, for example.[23] In other words, the inference that the cartel led to supracompetitive prices can be made with greater confidence if the coefficient on the dummy variable is not merely large in the linear model but also large (when expressed in comparable units) when other functional forms such as the log-linear model are employed.[24] If the results are not robust, the data analysis cannot be said either to confirm or rule out price fixing; the data may simply be uninformative. Although economic theory sometimes helps one to specify structural relationships, it typically does not help in deciding what functional form to prefer for a reduced form model. The common linear models (or transformed linear models, such as log-linear models) are typically justified as local approximations to an unknown functional form. One way to deal with this question other than robustness testing is to estimate a more flexible functional form such as the translog or Almost Ideal Demand System (AIDS) and let the data select the best local approximation.[25] But this approach may require more data than are available, and the addition of unnecessary variables can reduce the precision of estimates (making it difficult to isolate the relationship at issue).

Third, simulations using reduced form price equations may not be reliable if the underlying structural parameters would be different in the but-for world. This could be a problem even in a simple simulation exercise that involved predicting the price that would have existed had the firms not conspired. If buyers think they may be dealing with a possible antitrust law violator from whom they may some day collect treble

23. The term "large" is used to suggest practical economic significance, that is, a magnitude that matters economically. Practical significance should be distinguished from statistical significance, which addresses the precision with which a parameter or parameters are measured. A parameter can have statistical significance without practical significance if, for example, it is estimated accurately to be a very small number that is greater than zero, but not practically different from zero.

24. It is also important to test the sensitivity of the results to variation in functional forms when making out-of-sample predictions using the estimated regression equation, as sometimes occurs in simulation studies.

25. These functional forms are discussed subsequently in section 3.A.2.

damages, they will view an expected damage recovery as a reduction in the effective price charged by the cartel. In consequence, demand may increase (i.e., the quantity demanded will be higher at any observed market price) when the cartel is in operation.[26] A simulation that does not account for this possibility may overstate the magnitude of the overcharge to buyers, though this possibility could be ruled out through the use of nonstatistical evidence to show that buyers were unaware that sellers had fixed prices. This difficulty may also be avoided by estimating the structural demand function rather than a reduced form price equation.

B. Merger Litigation

Reduced form equations are also employed in litigation settings other than price-fixing cases. They were used in two ways by the Federal Trade Commission's (FTC) econometric expert, Professor Orley Ashenfelter, in recent litigation arising from the FTC's challenge to Staples's proposed acquisition of Office Depot.

1. Measuring Pass-Through of Cost Changes. First, Professor Ashenfelter estimated a reduced form price equation in order to identify the rate at which Staples had historically passed-through firm-specific cost changes to prices.[27] The pass-through rate is a building block for assessing the net effect of the transaction on prices paid by buyers. For example, if a proposed merger appears likely to increase prices by 5% because of the loss of rivalry between the firms (that is based on considerations other than the possibility of cost savings accruing to the merging parties), and the merger will permit the parties to reduce marginal costs by 10%,

26. Baker (1988) and Salant (1987) show that in equilibrium, the victim and violator essentially contract around the expected future damage payment, leaving output at the same level it would have been were the cartel able to operate without fear of a private suit for damages. But the market price is higher than it would be absent the threat of private damages, by the amount of the expected future damage payment.

27. See generally, Ashenfelter et al. (1998). The magnitude of the firm-specific pass-through rate depends upon the curvature (second derivative) of the demand curve faced by the firm. Intuitively, the rate is less than (greater than) one-half if the firm's residual demand function grows more (less) elastic when price rises relative to the change in elasticity associated with linear demand. Because the curvature of demand is not constrained by economic theory, the magnitude of the firm-specific pass-through rate must be determined empirically.

prices would still be expected to rise unless the pass-through rate for cost reductions is 50% or greater.

In the *Staples* litigation, the defendants had projected that two-thirds of their cost savings would flow to consumers in the form of lower prices, although they did not proffer a statistical study to support that assertion. Professor Ashenfelter estimated the historical pass-through rate with data that included monthly measures of price and average variable cost for 30 products (disaggregated to the stock-keeping unit level) at approximately 500 Staples stores over two years.[28] The data set also included a measure of the average Office Depot cost (averaged over all Office Depot stores) for each product in each month. Inferences about the firm-specific rate were made from estimating a reduced form price equation relating Staples price (p^S) to its own costs (c^S) and its rival's costs (c^D), along with a series of fixed effects variables (**D**), as in the following equation (from which store and time subscripts have been omitted):

$$\mathbf{p}^s = \alpha + \beta_1 \mathbf{c}^S + \beta_2 \mathbf{c}^D + \lambda \mathbf{D} + \varepsilon . \tag{2}$$

The fixed effect variables are a collection of dummy variables that control for time-invariant store-specific attributes, cross-section invariant time effects, and product-specific effects. In this model, the competitor's cost variable is thought of as a proxy for industry-wide costs. With industry-wide costs included, the Staples cost variable would pick up only the effect of Staples-specific cost variation on prices. Using this method, Professor Ashenfelter concluded that Staples had historically passed-through only 15% of firm-specific cost reductions to consumers, and the court accepted this figure rather than the two-thirds rate suggested by defendants in reaching its decision to enjoin the merger.[29]

The issue of whether the underlying structural parameters would remain invariant with respect to the simulated change did not arise in the litigation, but could be an issue with this type of study. The historical firm-specific pass-through rate, which was identified in the regression study, may not be the appropriate rate to apply to the efficiencies that would be

28. Defendants' primary challenge to this study in the litigation was to argue that the products in the sample were too few in number and too unrepresentative to permit conclusions to be drawn about the average firm-wide pass-through rate.

29. *Federal Trade Commission v. Staples.*

achieved through merger, given that the merger might change the extent to which the firms competed. [30]

2. Relating Market Structure to Market Performance. Professor Ashenfelter's testimony in the *Staples* case also provides an example of the use of reduced form price equations in antitrust litigation to assess the impact of changes in market structure on industry performance.[31] This work extends the academic "price-concentration" literature by relating price to changes in the identity of rivals as well as their number.[32] This refined approach to representing market structure takes into account the insight of spatial competition models that some rivals may be closer substitutes than others. Mergers that extinguish localized competition among sellers of close substitutes may lead to higher prices, as discussed in the unilateral competitive effects section of the Department of Justice (DOJ) and FTC *Horizontal Merger Guidelines*.[33]

In estimating his pricing model, Professor Ashenfelter worked with monthly observations on a price index for consumable office supplies created by the opposing econometric expert. The data were a panel covering more than 400 Staples stores (in more than 40 cities) for more than 18 months. Market structure was taken into account with variables reflecting the number and identity of nearby office superstore rivals and the number and identity of potential nonsuperstore rivals (discount mass merchandisers, warehouse club stores, and computer superstores). Professor

30. This may not have been a problem with Professor Ashenfelter's study. The FTC staff, in an analysis not presented in court, included variables related to market structure in the regression model and found that the estimated firm-specific pass-through rate was not very sensitive to changes in them. Defendants did not question whether the premerger pass-through rate could be projected to the postmerger setting, where competition might be reduced, perhaps for this reason. They may also have had a different reason: because the issue would not arise under their view that the merger itself would not change the degree of competition among office supply retailers.

31. For more detailed discussions of Professor Ashenfelter's testimony, including an analysis of statistical issues not highlighted here, see Baker (1999) and Gleason and Hosken (1999).

32. A long and rich tradition in empirical industrial organization economics has sought to determine the cross-industry relationship between market structure and measures of market performance. See generally, Schmalensee (1989). Perhaps the most successful of these academic studies have related seller concentration to the level of price, in comparisons undertaken within a single industry (across markets or over time); see Weiss (1989) (collecting studies).

33. See U.S. DOJ and FTC *Horizontal Merger Guidelines* §2.21.

Ashenfelter's models included indicator (dummy) variables for each sample period and also, in many specifications including his preferred specification, "fixed effect" indicator variables for each store. After estimating the regression model, Professor Ashenfelter used it to forecast (simulate) the price increase resulting from merger in the metropolitan area markets where the merging firms stores overlapped.

Professor Ashenfelter's reduced form price equation showed that prices were higher in metropolitan areas where Staples faced no competition from Office Depot (or any other office superstore). One representative regression model, based on an equation identifying the price effect of superstore rivalry from cross-market comparisons (and thus not including fixed effects for each store), led to a forecast that the merger would lead to a price increase of 7.1%. Defendants suggested that this result was not causal but rather was the misleading artifact of omitting unobservable cost variables. In particular, they highlighted the possibility that high prices reflected high costs arising from factors not included in the regression (perhaps due to zoning regulation or congestion) and that the apparent relationship between high prices and the absence of superstore competition in a metropolitan area arose because rival entry was deterred by the same cost factors leading to higher prices. This concern is a general one. When reduced form price equations are employed to distinguish between anticompetitive and alternative explanations for high prices, the omission of variables controlling for costs can be particularly troublesome because high costs can provide an economic reason for high prices unrelated to market structure (the absence of competitors) or anticompetitive conduct (cartel behavior).

To control for this possibility statistically, as is commonly done in the academic literature, Professor Ashenfelter incorporated fixed effects for individual stores into his regression model. With this specification, the regression effectively controls for price variations across stores; the estimated effect of superstore rivalry on Staples pricing comes solely from pricing variation within markets over time. Because the unobservable costs were unlikely to vary over an 18 month period in any one location, the model with store fixed effects accounts for the possibility that what appears to be the effect of market structure on price should actually be attributed to unobservable cost variation. Professor Ashenfelter found that the fixed effects model gave similar estimates to those obtained from

the cross-sectional model. His forecast that the merger would lead to a 7.6% price increase, using a fixed effects model, was similar to the 7.1% price increase forecast he made based on a cross-sectional model.[34] This demonstrated statistically that the relationship observed in cross-market comparisons was unlikely to have been biased by the failure to control for unobservable cost variation across stores.

The wide range of discovery available in litigation can permit the effective use of nonstatistical methods to rule out the possibility of bias resulting from unobservable cost variation, as the *Staples* experience also demonstrates. The marketing documents of the merging office superstore chains—which included extensive and detailed analyses of pricing—gave no suggestion that important omitted variables influenced Staples pricing or rival superstore chain entry (except in one city, for unique reasons). This evidence alone would likely have been sufficient to confirm the absence of bias resulting from the effects of unobservable cost-shift variables on prices and entry had the statistical methods of confirming the cross-sectional analysis been uninformative (e.g., if confidence intervals in the fixed effects regressions had been very large). The general point is that if variables unobservable to the econometrician are important in pricing, they must nevertheless be observable to executives who make pricing decisions. Accordingly, testimony and documentary evidence can be marshaled to improve the measurement of marginal cost or confirm that existing measurements are reasonable.

3. Identifying Mavericks. The potential applications of reduced-form price equations in antitrust analysis go beyond their current uses at the antitrust enforcement agencies. One promising approach is to use reduced form equations to determine whether an acquisition might make coordination more likely or more effective.[35] A method is suggested by the possibility that coordination by firms may yield supracompetitive

34. The experts for both sides in the litigation agreed that competition from Office Depot held down Staples prices—in each case based on models that included individual store fixed effects. Their differences turned in part on differences in measuring a key aspect of market structure, the extent to which each Staples store faced competition from nearby Office Depot stores. See Baker (1999). The two sides also disputed whether the price-reducing incentive derived from cost-savings would offset the price-increasing effect of the loss of rivalry between the superstore chains.

35. See U.S. DOJ and FTC *Horizontal Merger Guidelines* §2.12.

prices while falling short of creating the perfect (joint profit-maximizing) cartel.[36] If firms can rapidly detect deviations and respond well before the price cutter sees much of a shift of demand, any high price equilibrium satisfactory to all the firms can be sustained, even if it does not achieve the first-best outcome for the cartel (perhaps because firms will choose not to reveal private information when negotiating an agreement or because side payments are unavailable). Picture, for example, a hypothetical location where the only gas stations for miles are neighbors and that each posts prices on a large sign seen by all. No station would find it profitable to cut price from a high price equilibrium in order to increase sales, because its rivals would be expected to match the price cut before many drivers had responded by shifting their business.[37] In this setting, price does not rise without limit. At some point, one firm will choose not to increase price further. That seller's preference for the common industry price controls what the tacitly colluding firms can achieve. The firm that opts out of raising price first can be described as a maverick even if it never cuts price: its preference for a lower industry equilibrium price constrains the coordinated price not to rise to the preferred by its rivals.

There is no reason to expect all sellers to desire the identical coordinated industry price in such a market. If firms are asymmetrically positioned, a seller with a small market share relative to its ability to expand output cheaply may prefer a lower coordinated price than would its rivals. In the gas station example, if one station has more self-service bays than its rivals, it may prefer a larger overall market and lower industry price than the competitors (although the gas station will presumably be willing to allow the price to rise above the competitive level). The aggressive gas station constrains the effectiveness of industry coordination; it is a maverick in the sense of the *Merger Guidelines*.

The loss of such a maverick through merger may lead to a price increase. If the constraining gas station merges with a high market share rival, for example, the merged firm may balance the benefits of raising the industry price (the high contribution margin on the sales it keeps) and the costs (the lost sales as the market shrinks) differently from the way the maverick did before the merger. Its market share may be larger relative to its ability to expand, and it may in consequence be willing to see

36. For example, Green and Porter (1984).

37. See Carlton, Gertner, and Rosenfield (1997).

the industry price rise further. If no other firm prefers an industry price as low as the price desired by the premerger maverick, the merger will lead to a price increase.

Under some circumstances, it may be possible to identify maverick firms through statistical evidence. The theory set forth above implies that at the premerger equilibrium price, some firms (the constraining or maverick sellers) are indifferent between no price change and a further price increase, while other firms strictly prefer a higher price. As a result, the industry price will be determined by common (industry-wide) cost and demand shift variables, and firm-specific cost and demand shift variables for the maverick firm or firms, but not firm-specific cost and demand shift variables for the other sellers.[38] If firm-specific cost and demand variation is observable, mavericks can be identified by estimating a reduced form price equation for the industry, with both common and firm-specific cost and demand shift variables included in the regression. Those firms whose firm-specific cost and demand shift variables affect price are the mavericks whose preferences constrain coordination.[39] This empirical strategy puts a premium on careful measurement of firm-specific costs. It has not

38. The firm-specific cost and demand shift variables for the mavericks will appear in the reduced form equation because they will affect the parameter that reflects the nature of the oligopoly in a supply relation, while firm-specific variables for other firms will not. Accordingly, mavericks could also be identified by estimating a structural supply equation (of the sort discussed in section 4 below), and determining which sellers' firm-specific variables affect the oligopoly solution concept parameter.

39. If the industry is perfectly competitive, no seller's firm-specific cost and demand shift variables will affect price; only common costs will matter in the reduced form price equation. Conversely, if the industry is very effective at coordination, and has found ways to reward recalcitrant firms for raising price (through side payments), the industry may be able to reach a coordinated outcome in which every firm considers the coordinated industry price the best. Under such circumstances, all firms are effectively mavericks, and firm-specific variables for each would be expected to affect price. An additional analysis may be needed to determine how much price is likely to rise as a result of a merger leading to the disappearance of a maverick. More generally, the empirical analysis may serve multiple purposes. First, it may be undertaken in order to understand the features of the market structure (e.g., a high proportion of excess capacity relative to market share or a unique ability to expand resulting from vertical integration) that lead a firm to desire a lower industry price than its rivals. Second, that information may be used to identify the firm(s) that would constrain coordinated industry pricing after the proposed merger. Third, the study may be used to determine how much higher the new maverick(s) would likely allow the industry price to rise.

yet been employed in academic research or antitrust litigation, but it may provide another application for reduced form price models in the future.

C. Evaluation

Reduced form price equations are the workhorse empirical methods for antitrust litigation for several reasons. First, they can provide evidence on a wide range of problems. Second, they are among the most straightforward regression models to explain to generalist judges or juries with little or no background in statistical techniques. Third, they are among the least demanding in terms of data and computational difficulty. These methods can nevertheless raise a diverse array of common regression problems—not just the omitted variables issues highlighted above but also, for example, the possibility of biased estimates resulting from error in data measurement and the potential endogeneity of some of the right-hand variables (particularly those accounting for market structure).

Reduced form models are least desirable when the key question for litigation depends on structural parameters, as these are typically very difficult to recover from reduced forms. That dependence may be direct, as when market definition turns on a demand elasticity, or indirect, as when simulation methods respond to the possibility that the underlying structural parameters can vary. Accordingly, our survey turns next to examine the use of structural models in antitrust litigation, particularly those aimed at identifying the structure of demand.

3. Methods for Identifying the Structure of Demand

The exercise of market power—a topic often at issue in antitrust litigation—requires that the firm or firms involved (collectively) face a downward-sloping demand curve. Only then could it be profitable for firms to raise price by reducing output. Whether the force of demand substitution is sufficient to prevent the exercise of market power depends in part on the extent to which consumers will substitute away in the event price were to rise (the own elasticity of demand). Moreover, identifying the set of products that must be controlled in common to generate market power—an issue related to both market definition and the identification of localized competition in evaluating the unilateral competitive effects of merger—depends importantly on the cross-elasticities of demand.

Information about the extent and nature of demand substitution can be obtained in multiple ways, not all quantitative. We focus on three classes of empirical methods for doing so that have been employed in antitrust: the empirical estimation of demand elasticities, the use of transactions or bidding data to learn about the structure of preferences, and the use of survey techniques. The wide range of techniques available increases the prospects for obtaining quantitative information on consumers' demand for the product or products at issue in antitrust litigation.

A. Demand Elasticity Estimation

When demand elasticities are estimated in antitrust applications, the most common regression models work with inverse demand functions, with the following general linear form:

$$\mathbf{P}_{it}^{1} = \alpha + \beta \mathbf{q}_{it} + \gamma \mathbf{y}_{it} + \varepsilon_{it} . \tag{3}$$

In equation (3), the price for product 1 is thought to depend on a vector of quantities sold ($\mathbf{q}$). These include product 1, along with a number of actual or potential substitutes. (In some applications, the output data are collected as market shares rather than quantities, but that difference is not important to the econometric issues we highlight below.) Inverse demand is also thought to depend on a vector of demand-shift variables ($\mathbf{y}$). Equation (3) presumes that the data are a panel: that observations are drawn from multiple markets (such as geographic areas indexed by i and at a number of times [typically weeks, months, quarters, or years] indexed by t). The own- and cross-elasticities of inverse demand are the parameters of the vector β.

Demand elasticities played several important roles in a recent dispute concerning the possible anticompetitive effects of the acquisition by Kraft General Foods Post Cereal Division of Nabisco's Shredded Wheat cereal products.[40] A short time after the merger had been consummated, the State of New York sued, asking the court to require either a divestiture of the acquired assets by Kraft or that the acquired assets be returned to Nabisco. On the issue of market definition, the State of New York proposed a relevant market containing only adult cereals, which included the

40. See *State of New York v. Kraft General Foods, Inc.*

two significant merging products, Post Grape Nuts and Nabisco Shredded Wheat. The defendant's expert, Professor Daniel Rubinfeld, argued that the relevant market should be all ready-to-eat (RTE) cereals, in part based on evidence of relatively high cross-price elasticities between adult cereals and kid cereals. The elasticities were estimated (in a panel with both cross-sectional and time-series variation) as part of a demand system in which the prices of numerous cereal products were specified to be a function of own price, the prices of other RTE products, measures of marketing and advertising, and a series of product and geographical fixed effects. The Court eventually chose to define the market as including all RTE cereals, rather than the smaller set of adult cereals.

A second significant use of the estimated elasticities in *Kraft* was in the empirical analysis of unilateral competitive effects. Merger simulation techniques that relied on the same estimated elasticities were used by experts for both sides to debate the significance and magnitude of the price effects that could arise from the merger. Because the trial focused more heavily on market definition and theories of coordinated effects than on unilateral effects, the merger simulation results played a relatively minor role in the litigation.

In some antitrust applications, residual demand functions (rather than the more traditional Marshallian (structural) demand functions) are estimated.[41] An inverse residual demand function takes the form:

$$\mathbf{P}_{it}^{1} = \alpha + \beta \mathbf{q}_{it}^{1} + \gamma \mathbf{y}_{it} + \delta \mathbf{w}_{it} + \varepsilon_{it}. \tag{4}$$

Compared with the Marshallian demand function, equation (4), the residual demand function, omits the quantity variables for products other than the one of interest and adds a vector of cost-shift variables ($\mathbf{w}$) thought to affect the price and output of the omitted products. A variant of equation (4), the partial residual demand function, includes the cross-quantity of one specific rival (such as a prospective merger partner), while continuing to omit all other quantities.[42] Partial residual demand functions provide information about the extent of localized competition between the products of the two firms and thus are relevant to the analysis of the unilateral competitive effects of merger among sellers of differentiated products.

41. See Baker and Bresnahan (1988).
42. See Baker and Bresnahan (1985).

Whether structural or residual demand elasticities are preferred depends upon the question asked and the data available. The elasticities of the structural demand function provide information about buyer preferences exclusively; they show which products are close substitutes and which are more distant substitutes. They summarize the way buyers would respond to price or output changes by the firm at issue, assuming that no rival firm changes its decision variables. The elasticities of the residual demand function summarize the way buyers would respond under a different assumption about rival behavior: that the rivals respond to price or output changes by the firm at issue in the future as they have in the past.[43] Either approach can provide information relevant to identifying single firm market power or to determining whether a merger between sellers of differentiated products would permit the merged firm to exercise market power unilaterally, for example. Both approaches have been used by the federal antitrust enforcement agencies in their internal analyses and by outside experts submitting studies for agency review.

1. Identification. Identification is a central empirical issue in estimating a demand function, regardless of whether the demand function is structural or residual. Price and output are jointly determined by the intersection of demand and supply, i.e., they are both "endogenous" variables.[44] As a consequence of the presence of an endogenous variable on the right-hand side of the regression, ordinary least squares estimation of equations (3) or (4) may not generate unbiased estimates of the coefficients on output and may therefore lead to biased estimates of the own- and cross-elasticities of demand.[45] If price and output vary in the data primarily because of shifts in supply, ordinary least squares performs well in estimating a demand function. But if price and output vary in the data because of both shifts

43. Landes and Posner (1981) relate a firm's market power to the elasticity of the residual demand function faced by the firm; they highlight the importance of taking into account the response of rivals (along with buyer substitution) in identifying market power. Although Landes and Posner formally model only one form of rivalry—a dominant firm and competitive fringe—their concept of market power encompasses rival responses arising from the full range of oligopoly interaction.

44. An example is set forth above in note 12.

45. Recall, from our earlier discussion of reduced-form models, that it is usually assumed that all right-hand variables are exogenous.

in demand as well as supply, then the ordinary least squares regression results will generally not identify the demand function.[46]

Variables that shift costs provide the most natural "instruments" for isolating a demand function in the data, because they identify when price and output are changing mainly because of shifts in supply. These instruments might include, for example, important input prices. In the rare event that there are measurable cost shifting variables for all of the products at issue, identification and estimation of demand are likely to be straightforward. In many cases, however, the number of cost shifters is small, and in particular less than the number of endogenous prices. In this case, identification is possible only if further assumptions about the nature of the demand system are made.[47] When a demand function cannot be identified econometrically, the questions that can be answered empirically may be limited to those for which reduced form methods provide an answer.

One common identification strategy when the number of cost-shift variables is small is to restrict the parameters of the demand system, for example by constraining all products in a group to enter the demand system with a common parameter or by imposing symmetry on the cross-elasticities. If the number of free parameters is limited, then even a handful of cost-shift variables may be sufficient to identify them. The attractiveness of this strategy depends importantly upon the strength of the nonstatistical evidence justifying the restrictions. For example, it is likely to be reasonably effective when objective measures provide a good indicator of "closeness" in product space; these measures can be used to constrain the relationship among the demand cross-elasticities.

The strategy of restricting the parameters of the demand system is almost invariably adopted when estimating demand functions for individual goods in differentiated products markets with a substantial number of

46. One exception may arise in time series analyses in which the variables are observed over short time intervals (e.g., weekly data). In some industries, prices may be set sufficiently in advance of consumer purchases so that they are predetermined, thus avoiding simultaneity problems in measuring the demand elasticities with respect to short term price promotions. But the use of high-frequency data may require careful modeling of the relationship between consumer inventorying and seller promotions in order to recover the demand elasticities with respect to intermediate term price variation. See Baker (1997, pp. 352–55).

47. For a general survey of the econometric issues involved in identification, see Manski (1995).

products, as often arises in analyzing mergers in branded consumer products industries where product space is densely packed. The analysis of the price effects in such situations can be both theoretically and empirically demanding. The theoretical issues are complex because the increase in prices of the products of merging firms can induce increases in rivals' prices, and because the analysis of these effects can be sensitive to assumptions about the form of demand functions (e.g., linear or nonlinear), demand symmetries (e.g., symmetric cross-price elasticities), the nature of the interaction among firms (e.g., Bertrand or Cournot competition) and the possible presence of economies of scale and scope.[48] In cases involving consumer products, the analysis may also be sensitive to the assumptions that are made (or not made) about the timing of consumer purchasers. Failure to account for inventorying of consumer goods could, for example, affect one's estimates of demand parameters.[49]

The empirical issues are also complex because with numerous products, a parsimonious empirical analysis will necessitate a parameterization of the multiple brands or their attributes. To make the specification and estimation of the demand system tractable, analysts often assume that some cross-price elasticities are zero and that there is symmetry in the nonzero cross-price elasticities. In the RTE cereal industry, for example, there are approximately 200 products; this would necessitate the estimation of 40,000 (200×200) own- and cross-price elasticities in a constant elasticity demand model. Without some strong assumptions, estimation would be impossible.

In one approach to restricting the parameters of the demand system,[50] these restrictions are achieved by characterizing demand decisions according to a multilevel decision-making process, by aggregating individual brands into sensible aggregates, and by assuming that the demands for

48. See, for example, Denekere and Davidson (1985).

49. See Baker (1997, pp. 352–55). Moreover, firms selling branded consumer products may not compete solely on price. Other marketing variables, including advertising and promotion and possibly some physical product characteristics, may affect buyer substitution patterns. If such variables are important in buyer decision-making, they should be considered in the analysis of demand, although we do not address their modeling and measurement here.

50. See, for example, Hausman, Leonard, and Zona (1994).

products in one "branch" or segment of the "tree structure" are separable from the demands of products in other branches.[51] For example, one might think of cereal choice as occurring at the third stage of a three-stage decision-making process. The top level determines the demand for RTE cereal, the second level divides the choice of the 200 cereal brands into three segments (kid cereals, family cereals, and adult cereals), and the third stage determines the demand for brands within one of the three segments. The multistage model would thus reduce the choice among 200 brands into a choice among three segments and then, with the aggregation of brands within segments, a further choice of, for example, eight product categories—drastically reducing the number of elasticities that must be estimated to 201 (192 within-segment own- and cross-elasticities and nine between-segment elasticities). As the number of parameters is reduced, the analyst has greater flexibility in the specification of the structure of demand; flexible functional forms that require more parameters than constant elasticity demand functions are now possible options even in data sets that are limited in size.

While the benefits of reducing the number of parameters—to facilitate identification when instruments are few, to simplify computations, or to deal with limited data—are appealing, the results achieved can be quite sensitive to the restrictions that are made. In particular, the decision to include a product or group of products in one segment rather than another can substantially affect the conclusion that one reaches concerning the definition of the relevant antitrust market.[52] For example, the division of cereals into kid, family, and adult segments increases the likelihood that Kellogg's Sugar Frosted Flakes and General Mills's Cap'n Crunch (both kid cereals) will be found to be relatively close substitutes for each other, while decreasing the likelihood that Kellogg's Sugar Frosted Flakes will

51. Separability of demand and multistage budgeting are not equivalent. Weak demand separability is necessary and sufficient for the last (lowest level) of the budgeting process. For the higher stages, the assumption that expenditures can be allocated among groups depends on stronger separability assumptions or on other restrictions on preferences. See generally Deaton and Muellbauer (1980b, Chapt. 5).

52. This point was made by Rubinfeld in *State of New York v. Kraft General Foods, Inc.* with respect to the State's position that RTE cereals should be segmented between adult and kid cereals.

be found to highly substitutable with Kellogg's Corn Flakes (a family cereal) or Post Shredded Wheat (an adult cereal).[53]

Jerry Hausman and several coauthors have proposed a different solution to the identification problem that employs the nationwide component of individual city prices as an instrumental variable for identifying demand; he and a coauthor used this approach in analyzing a recent merger on behalf of the parties.[54] In particular, Professor Hausman assumes that whatever the underlying structural model, the reduced form price equation for an individual product sold in city i in period t takes the form:

$$\mathbf{P}_{it} = \alpha_{it} + \beta \mathbf{c}_t + \varepsilon_{it}, \tag{5}$$

where c_t is the marginal cost in period t. The key feature of this equation is that cost is taken to have a nationwide component (no subscript i). Demand and cost shocks enter the error term, but equation (5) assumes that there are no nationwide demand-shift variables. If this assumption holds, the nationwide component of price (the common variation in price across cities) reflects the impact of cost-shifts but not the influence of demand, and thus can be employed as an instrument to identify the determinants of demand.

This instrumental variables approach can be an attractive method for exploiting scanner data containing prices in multiple cities when it is difficult to observe cost-shift variables in the same frequency as the price data *if* the nationwide component reflects mainly nationwide variation in

53. Intuitively, this grouping of cereals is likely to make any two kid cereals appear to be closer substitutes than they are in fact because a restricted number of products within the kid segment are competing to be close substitutes. Moreover, this grouping is likely to make a kid cereal and a cereal in, say, the adult segment appear to be less close substitutes than they are in fact. This is because the estimated cross-price elasticity of demand between any two specific products in different segments will be constrained to be similar to the average cross-price elasticity between the goods in each segment. For example, the inferred cross-price elasticity of Corn Flakes with respect to the price of Sugar Frosted Flakes in a model with kid and adult segments depends in part on the elasticity of the aggregate of all kid cereals with respect to the price of Frosted Flakes and in part on the elasticity of demand for Corn Flakes with respect to a change in the average price of all adult cereals. As long as each of the two segments in question contains a substantial number of products, each of these two elasticities involving aggregates is likely to be quite small, even if certain products in different segments are, in fact, close substitutes.

54. See Hausman and Leonard (1997); Hausman and Taylor (1981). Our discussion of this strategy draws in part on an unpublished critical essay by Timothy Bresnahan.

product cost rather than demand. The approach may have generated reasonable estimates in one data set involving breakfast cereals.[55] But when the method is employed in other industries (or other time periods in the same industry), where the critical assumption cannot be tested, it would be useful to have some basis for believing that shocks to the nationwide component of prices in the industry and time period under study mainly result from variation in cost, not demand.[56] Timothy Bresnahan is skeptical, emphasizing in an unpublished essay the possibility that the consumer response to national advertising campaigns will induce retailers in various cities to change a product's price at about the same time.[57] In some industries, it may be possible to bring more evidence to bear. For example, marketing executives may have views about the typical allocation of nationwide shocks between cost and demand. Here, as in many other ways, the nonstatistical evidence available in the antitrust litigation context can complement the statistical evidence and make expert testimony more compelling.

2. *Functional Forms.* Even if the demand function can be identified, other econometric issues must be addressed if demand elasticities are to be appropriately estimated.[58] One prominent question involves the choice of functional form.

The general linear form in which equation (3) is specified includes both linear and log-linear specifications. This class of specifications is well suited to estimating the average own- and cross-demand elasticities, but it constrains the way the demand elasticities change as price changes. The possibility that the demand elasticity may vary with price has long

55. See Nevo (1999).

56. Baker (1997, p. 355, n. 35) suggests that for many industries the assumption that variation in the nationwide component of prices reflects cost rather than demand variation may be the most troublesome in high frequency data (e.g., weekly observations). Aggregation over time may smooth the short-term effects of price promotions that simultaneously take place in multiple cities, while the price of key production inputs may be more likely to vary substantially month to month than week to week.

57. It may be difficult to measure and to control for the effectiveness of national advertising campaigns in the regression, in part because it is easier to observe advertising inputs than advertising outputs.

58. Specification issues related to the omission of advertising and promotion when buyers hold inventories, and the time period over which the demand elasticity is measured, are considered in Baker (1997) and are not discussed further here.

been understood. For example, in the familiar "*Cellophane* fallacy" the Supreme Court's product market definition was criticized for failing to recognize that buyers would be more willing to substitute to other products at a monopoly price than at a competitive price; the demand cross-elasticities would be expected to vary with price.[59] In order to investigate statistically the extent to which demand elasticities change with price, it is necessary to employ more flexible demand systems. It is not clear whether the most common choices, the translog system or the almost ideal demand system, however, are flexible enough.[60]

Greater flexibility in functional form does not in general come without cost. In order to achieve flexibility, it may be necessary to impose other constraints, such as those built into a multilevel demand system, in order to economize on data or reduce computational difficulties. Frequently the tension between the desire for functional form flexibility and the need to restrict parameters can best be addressed by incorporating restrictions that facilitate estimation, while testing the sensitivity of the results to alternative plausible assumptions. Indeed, we believe that robustness testing is often undertaken less frequently than it should be in work that we have seen.

3. The Reliability of Simulations. Estimating the elasticity of demand may not be an end in itself. In evaluating mergers under the section of the *Merger Guidelines* dealing with unilateral competitive effects for firms selling differentiated products, for example, the goal is to understand the power of the incentive for the merger partners to raise prices after the loss of the localized competition the partners previously posed for each other.[61] The elasticities of demand themselves may provide indicators of

59. In *U.S. v. E. I. du Pont de Nemours & Co. (Cellophane)*, the Supreme Court concluded that cellophane was not a product market (and thus that du Pont, the primary cellophane producer, was not a monopolist) because the cross-elasticity of demand between cellophane and other flexible packaging material was high. Commentators have suggested that had the Court estimated the cross-elasticity at the competitive price for cellophane (rather than at the higher monopoly price), it would have concluded that buyers would not readily substitute other products, defined a cellophane product market, and found du Pont to be a monopolist.

60. See generally Pollak and Wales (1992); Deaton and Muellbauer (1980a). Professor Jerry Hausman has popularized the use of AIDS models for this purpose in antitrust analysis.

61. See U.S. DOJ and FTC *Horizontal Merger Guidelines* §2.21.

the strength of these incentives,[62] or they may be combined with information or assumptions about cost and oligopoly behavior to simulate the effect of the merger on price.[63] Under some circumstances, the price increase forecasts provided by simulations may be more informative indicators of the strength of merged firm incentives to raise price than what can be gleaned merely from the structural demand cross-elasticities or the residual demand elasticities.[64] And, simulations provide a valuable method of assessing the sensitivity of such forecasts to uncertainty in parameter estimates and to alternative assumptions about the underlying demand and supply functions and market structure.

The simulation exercise is not without risk, however. Analysts using the simulation approach need to confront issues relating to cost determination, to the identification of the nature of oligopoly behavior, and to modeling the way cost and demand may change with the output reductions associated with the exercise of market power (including the possible need to make out-of-sample projections).[65] These difficulties may mean that in some cases complex simulations will contribute little more than can be learned about the anticompetitive incentive of the merging firms to raise price from the demand elasticities alone. Indeed, the federal district court reviewing the State of New York's challenge to the merger involving branded breakfast cereals reached the conclusion that a merger placing these brands under common ownership would provide little incentive for the merged firm to raise price based on estimates of a low cross-price elasticity between Grape Nuts and Shredded Wheat,

62. For example, Baker and Bresnahan (1985) use partial residual demand elasticities for this purpose.

63. See, example, Hausman and Leonard (1997); Nevo (1999); Werden (1997).

64. If the simulation does not incorporate supply-side information (about the slope of costs and reactions of rivals), but merely presumes some convenient parameterization (such as constant marginal cost and Bertrand conduct), its value is primarily in transforming the demand elasticities into a more informative metric.

65. See generally Baker (1997, pp. 356–60). If accounting measures of price-cost margins are trustworthy, and the oligopoly solution concept (e.g., Bertrand-Nash) known, that information could be used to back out relationships among the own and cross-elasticities of demand (using the first order condition relating the Lerner Index of markup to the demand elasticities). If these relationships are accepted, their consistency with the demand elasticity estimates can be tested or, alternatively, they may be exploited to improve the precision of the elasticity estimates. (Alternatively, if demand elasticities are estimated and the oligopoly solution concept is known, one can back out estimates of marginal costs using the Lerner relationships.)

without need for a more sophisticated indicator of postmerger pricing incentives.[66]

B. Other Methods for Identifying the Structure of Demand

Sometimes the available data are not conducive to the direct estimation of demand elasticities. When those occasions arise, alternative statistical methodologies may be useful for learning about consumer preferences. These include (1) the use of auction models to make inferences from bidding records; (2) inferring preferences from an analysis of the attributes of goods and services actually purchased by consumers; and (3) eliciting preferences from survey responses to hypothetical questions involving product attributes.

1. Using Auction Models to Infer Valuations from Bidding Records. Data limitations may make it impossible to infer consumer preferences directly from information about actual market choices and prices.[67] This often occurs when choices are made through a bidding process, whether the auctions are formal or bidding is informal. Our discussion begins with the application of methods that seek to compare the process of bid formation across firms in order to identify bid rigging. However, most of our attention is devoted to another set of methods, which exploit information about the first, second, and third choices of actual and potential customers from firms' win/loss reports and other marketing studies to project the competitive effects of mergers. We do not survey the diversity of empirical approaches in the auction literature; we instead focus on a few representative examples. We also do not distinguish between methods employed to analyze settings where a buyer auctions its demand in a competition among multiple sellers (procurement or purchase settings) and methods employed where a seller auctions its output to multiple buyers, but we do try to be clear which setting is involved as the examples are discussed.

66. See *State of New York v. Kraft General Foods, Inc.*

67. Bidding may be infrequent, for example. Also, a great deal of data may be required to uncover preferences if buyers have unit demand so purchase decisions are limited to a binary choice.

Bid rigging is shockingly common and costly to consumers, as has been shown through the large number of criminal cases brought by the DOJ's Antitrust Division in the last two decades. Econometric tools have been developed to distinguish bid rigging from competitive bidding in formal auctions.[68] One approach seeks to identify phantom bidding by cartel members (noncompetitive bids submitted by firms feigning competition). The method is based on estimating a regression model to explain the bidding behavior of firms that are assumed not to be involved in the bid rigging, using the resulting estimated bid functions to predict the "competitive" bidding of those firms alleged to involved in bid rigging, and comparing the predicted bids to the actual bids.[69] Significant deviations that are otherwise consistent with a bid-rigging theory would be taken as support for the presence of the conspiracy to rig the bidding process.[70] This approach has been applied to the bidding process in New York State highway paving jobs on Long Island in the early 1980s and to the procurement process for Ohio school milk auctions throughout the 1980s.[71] In both cases the authors found empirical evidence consistent with the assumption that bids were rigged. The success of this method turns importantly on accurate measurement of the variables that might predict differences in behavior across sellers in the absence of bid rigging, such the differences in the costs of serving various buyers.[72] This method also needs a noncollusive reference group.

Auction modeling can also be useful in a merger setting, where the concern is the loss of localized competition between firms selling close

68. See example, Porter and Zona (1993, 1999).

69. If the competitive bid functions are thought to depend only on bidder characteristics and the characteristics of the contract or procurement being auctioned, then the bid functions can be thought of as describing preferences. If the competitive bid functions also depend on variables related to the degree of rivalry among bidders, such as the number and identity of firms in the auction (and that number varies across observations in the data), then the bid functions are not, strictly speaking, merely uncovering preferences.

70. This approach requires that the value of the contract or procurement to bidders be based on observable bidder characteristics or be identical across the firms.

71. These studies are described in Porter and Zona (1993, 1997).

72. A somewhat different approach is taken in Froeb, Koyak, and Werden (1993). The authors do not assume stability between the conspiracy and nonconspiracy periods. Rather, they alternatively backcast but-for prices from the nonconspiracy period into the conspiracy period and forecast but-for conspiratorial prices from the conspiracy period into the nonconspiratorial period.

substitutes in a differentiated products market.[73] Relying on theoretical models of oligopoly, an analyst can estimate parameters that describe the process by which the goods and services in a market are "auctioned." Such an approach has been used recently to predict the hypothetical effects of various mergers in forest timber markets[74] and in the context of hospital mergers.[75]

The timber market case—involving oral auctions by sellers in which the winning bid is the highest price—provides a useful illustration. In these auctions, the valuations that firms put on winning the auction depend on their size (due to scale economies) and their distance from market (due to transportation costs). Smaller and more distant firms must outbid the more economically favored larger, closer timber mills in order to win an auction. Actual information about winning and losing bids can be used to estimate the means and variances of the underlying distribution of bids for each firm (conditional on an assumption about the functional form of that distribution). Once these distributions have been estimated, the effects of mergers or the effects of possible bidding cartels can be simulated by using the estimated distributions of each of the potential bidders in the auction and the (premerger) market shares. The process is appealing conceptually because empirical analysis has the potential to reflect differences in valuations among bidders (due, for example, to differences in costs) and to reflect institutional aspects of the bidding process (e.g., restrictions in bidding eligibility).

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73. The U.S. DOJ and FTC *Horizontal Merger Guidelines* §2.21 n.21 explicitly extends this theory to the auction setting, by recognizing that sellers may be distinguished by their relative advantages in serving different buyers. This differentiation among sellers may come from differences in seller costs of serving buyers (as auction models often assume) or from differences in the product sold.

74. Brannman and Froeb (1997) analyze bidding competition in asymmetric oral auction markets. The asymmetry arises because individual bidders are assumed to differ in their valuation of timber. For further conceptual discussions of auction markets, see Thomas (1998) and Waehrer and Perry (1999).

75. Dalkir, Logan, and Masson (forthcoming) describes a methodology that is applied to bidding markets such as the sale of services to Preferred Provider Organizations (PPOs) by hospitals. PPOs provide health insurance coverage to individuals; they obtain discounts from hospital list prices by asking hospitals to bid for long-term contracts for their client base. The theoretical framework relies on private-value auction theory, with the assumption that each firms knows its costs and the distribution of its rivals' costs.

Auction models apply more broadly than in traditional auction markets. They may be useful in informal bidding situations when there are not sufficient market data to estimate demand functions directly, but it is possible to find out a good deal about the winning and losing bids.[76] The information about the bids that are made—especially winning bids—can be used to infer preferences. For example, one can regress the winning bid in an informal bidding competition against factors that would affect the individual sellers' bids (e.g., estimates of individual seller costs, volume of product to be sold, delivery conditions). The resulting regression (whose functional firm might ideally be suggested from information about the structure of the underlying market) could then be used to evaluate whether the merging firms are close substitutes (e.g., similar bidding patterns could reflect similar costs). To the extent that one is concerned that the merger will lead to the loss of localized competition in a differentiated products market, the information gleaned from the regression analysis can be used to predict the price effects of a proposed merger.

Another approach would analyze the choice of firms that were invited to bid by the seller in the procurement bidding situations being studied. Because the evaluation of bid proposals is costly, one might presume that only those bidders that offer relatively close substitutes will be invited to bid. This allows the development of a measure of closeness based on bidding appearances. The more frequently that pairs of firms bid in a particular auction, other things the same, the closer one presumes their products to be.[77] A preliminary analysis of the closeness of products could be achieved simply by using contingency tables to evaluate whether the probability of Firm A bidding in a particular auction conditional on Firm B's bidding is significantly different from the unconditional probability

76. For a detailed analysis of bidding functions in the auction by which public entities purchased ampicillin, a synthetic penicillin, see Rubinfeld and Steiner (1983). For a methodology for predicting the competitive effects of mergers in auction markets based on a logit second-price auction model, see Froeb, Tschantz, and Crooke (1999).

77. Relatedly, it may be possible to measure closeness from qualitative information comparing the winning and losing bids. For example, in a procurement setting, the buyers may provide information on which rejected proposals from sellers nearly won each procurement, and which proposals were far out of the running. This information may provide a basis for identifying the extent to which sellers differ from the perspective of various groups of buyers, and thus a basis for simulating the extent to which a merger among sellers would remove localized competition and lead to higher postmerger prices.

(with a higher conditional probability denoting relatively close products). A regression analysis could accomplish the same thing, with regressors added to hold constant other factors related to closeness.[78]

To see how an auction approach might work, consider the DOJ's recent investigation of two proposed accounting firm mergers—of Coopers & Lybrand (CL) and Price Waterhouse (PW), and Ernst & Young (EY) and KPMG Peat Marwick (KPMG). While the particular empirical results (and the underlying data) are confidential, we can describe in a general way the methodological issues that the Antitrust Division confronted. In the market for auditing services, in which each client chooses its auditor by informal auction, accounting firms routinely develop industry specializations. They develop this expertise through industry-specific investments in software, personnel, and marketing. Because industry specialization is attractive to audit clients, other things equal, the merger of two firms with expertise in the same or similar markets could lead to higher auditing fees.

In analyzing the auditing market the division relied in part on a substantial historical data set on the audit fees of each of the big six accounting companies. Most audit fees are the outcome of negotiations between auditors and client firms and do not directly involve competing bids from the auditor's rivals. When negotiations fail or are on the brink of failure, however, the client has the option to conduct a bidding competition for a new auditor. This is an informal auction setting because the hypothetical auction is in effect used as an outside option by the client.[79]

Relying on information of this type, one could estimate a price equation that explains audit fees as a function of audit costs, client characteristics (e.g., sales volume, assets, costs, industry) and a measure of the market share of the auditing firm in the client's industry in prior years. The estimated regression would be used both to test whether auditors have valuable expertise in auditing clients in particular industries, as the localized competition theory would require, and to simulate the effects of

78. A more sophisticated approach might seek to account for differences between the distribution of historical customers and future ones. For example, one might regress this measure of product closeness on firm, product and customer characteristics and use that estimated relationship to project the extent of localized competition between the merger partners that would otherwise have occurred in the future given the anticipated future distribution of customers.

79. For a discussion of the theory underlying such negotiations, see Osborn and Rubinstein (1990).

merger. The presence of valuable industry expertise would be reflected by a positive coefficient on the industry market share variable, on the view that current expertise derives from the investments that gave rise to the firm's historical market share.[80] To the extent that there are gains from industry specialization, the removal of one or two competitors that compete significantly in particular industries could result in substantial post-merger price increases.[81] This price effect could be simulated by aggregating the industry shares of the merging firms in the price model, for example.[82]

The techniques just described have potential as empirical devices for predicting unilateral price effects in mergers. They are not, however, without limitations. As a general rule, the predictions generated by such models can be quite sensitive to the assumption made about differences in costs, if any, among competing bidders, and to the assumption made about the nature of competition in the market (form of auction, one shot or repeated play, and so on). Further, it may be difficult to provide statistical measures that characterize the reliability of the resulting predictions. Nevertheless, the promise of such techniques is very high.

2. Inferring Buyer Preferences from Market Shares. Another approach to mapping buyer preferences, and thus learning about the nature of localized competition in differentiated product industries, is based on uncovering the valuation buyers place on individual product characteristics from the distribution of buyer first choices (market shares).[83] We highlight this literature because of its future promise for the antitrust policy arena, but

80. The use of lagged rather than contemporaneous market share also helps address the possible endogeneity of market share in a price equation. If prior market share is reasonably viewed as a predetermined variable, then this regression model could be understood as a reduced form price equation rather than a structural equation requiring identification.

81. Note, however, that specialization could result in lower fees if it allows accounting firms to audit accounts in fewer hours and as a consequence at a lower cost. Further, a more complete analysis could take into account the fact that auditing combines informal monitoring by the firm being audited as well as formal external monitoring by an accounting firm.

82. For a more sophisticated simulation of the price effects, it may be possible to tie the empirical estimates of the preferences of the clients to a set of assumptions about the structure of the industry and the nature of the bidding process.

83. See Berry and Pakes (1993); Berry, Levinsohn, and Pakes (1995); Bresnahan, Stern, and Trajtenberg (1997); Nevo (1998a, 1998b). This is only one of a number of approaches that rely on the discrete modeling of consumer behavior, building on the

our discussion is limited to a brief sketch because these empirical tools remain under development.

In the underlying model, buyers are heterogeneous. Each selects the good that gives him or her the most value, taking into account product characteristics and price.[84] Accordingly, the distribution of buyer preferences can be characterized by relating market shares to observable product characteristics, given some assumption about the distribution of unobservable buyer tastes.[85] One advantage of this approach is immediately apparent: the number of characteristics is typically much smaller than the number of products, so the number of parameters to be estimated is substantially less than the number of own- and cross-elasticities of demand—even if a very large number of products are in the choice set.[86]

The market share equations will not characterize the data perfectly; in this framework the error is interpreted as reflecting attributes of product quality not observed by the econometrician (though known to buyers and sellers). The parameters of the preference (demand) functions are selected to make the distribution of buyers' first choices fit market shares closely, given some distance criterion and some assumption about the distribution of the errors—or, more precisely, an assumption about the distribution of unobservable buyer tastes from which the error distribution is derived. The assumption about the distribution of buyer tastes is critical because that distribution restricts the way in which products can be substitutes; a restricted distribution function constrains the substitution patterns that will be inferred in this type of analysis in much the way that a restricted functional form for demand constrains the substitution patterns (cross-elasticities) that will be inferred from structural demand parameter estimates.

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path-breaking work of McFadden (1973, 1984). For further discussion and references to a more extensive bibliography, see Berry (1994).

84. The literature to date assumes that each buyer chooses only one product. This may be a reasonable approximation, however, especially if the period of observation is short (e.g., daily rather than quarterly).

85. If buyers differ along observable dimensions, this analysis can be conditioned on demographic variables.

86. In some ultimate sense, these methods are merely a new way to estimate demand functions. We distinguish them from demand estimation in this review, however, because they do so indirectly: by mapping the distribution of buyer preferences from which demand functions are derived.

Moreover, unobservable product quality (the error in the regression) is not independently distributed. Rather, it is likely to be correlated with price, because buyers can be expected to pay more for better products.[87] Under such circumstances, instruments for price are required in order to generate consistent parameter estimates;[88] this is analogous to the problem of identifying demand when supply (here product quality) varies simultaneously. The natural instruments—variables correlated with price but not with the error—are taken from the supply relation: input prices or variables related to the degree of rivalry among the firms (such as the number of firms with products in a narrow region of product space surrounding each good).[89] With consistent estimates of the parameters of the distribution of preferences, it is possible to derive implied demand cross-elasticities between, for example, the products of merging firms.

One advantage of this approach is its explicit allowance for the likely prospect that when individuals substitute away from a good whose price has increased they will substitute toward goods with similar product characteristics. This advantage arises, however, only to the extent the functional form for preferences—which may be chosen with an eye toward mathematical tractability—is sufficiently flexible to capture the way in which preferences depend on product characteristics.[90] The tradeoff is a familiar one. Estimating additional parameters permits greater flexibility,

87. Thus, absent some correction for this problem, the effect of a simulated price increase might be overstated when individuals chose to consume the product less because of its relatively low price and more because the product has a particular unobservable characteristic that they value. (In the literature, unobservable product quality is assumed not to be correlated with right hand variables other than price and observable product characteristics. We do not know the sensitivity of the methodology to this assumption.)

88. The academic literature implementing this methodology employs a generalized methods of moments (GMM) estimation technique, a natural choice for fitting sample moments to a distribution. (Least squares regression can be thought of as a special case of the GMM technique, just as it can be thought of as a special case of the more familiar maximum likelihood estimation approach. See Pindyck and Rubinfeld (1998, chap. 10).)

89. Working with a panel data set in which the were no obvious good choices as instruments, Nevo (1999) used the nationwide component of individual city prices as an instrument to increase the precision of parameter estimates. Methodological issues related to this approach have been discussed previously in section 3.A.1.

90. See Bresnahan, Stern, and Trajtenberg (1997).

but the computational difficulties can be severe, with the results sensitive to the particular choice of numerical estimation technique.[91] Moreover, when these models have been estimated in the academic literature, it has not always been possible to pin down the relevant parameters precisely.[92] Here, as with other methodological approaches that infer demand cross-elasticities empirically while building in restrictions on buyer substitution, it can be highly valuable to evaluate the robustness of the empirical results.

The promise of this new empirical approach is that it will permit the analyst to characterize demand by allowing preferences to vary across buyers in an unrestricted way, potentially providing a richer description of the bases of consumer choice than even the most flexible functional form for demand. Relative to this goal, the academic literature is in an early stage. Moreover, the approach has not yet (to our knowledge) been applied in practice by the enforcement agencies in situations in which data sources are often limited along with the available time for discovery and analysis. Accordingly, its practical value for antitrust enforcement remains to be seen.

C. Using Conjoint Survey Methods

Survey methods have provided a valuable set of tools in private litigation for a substantial period of time, in such diverse areas as Lanham Act cases involving allegations of harms created by false information and in census cases involving the appropriate use of sampling methods.[93] A properly designed survey (including the frame of the survey and the survey instrument) can avoid a number of problems that are inherent in market-based data. For example, a survey design can ensure that explanatory variables are exogenous, rather than endogenous. Despite the appeal of the survey approach as an alternative to statistical estimation, to this point there has been a reluctance to utilize survey methods in antitrust anal-

91. These additional parameters can, for example, introduce complex nonlinearities into the function that is minimized, making a numerical search for the best parameter values more difficult.

92. GMM estimators are not always as efficient as their maximum likelihood counterparts.

93. See Diamond (1994) for an overview of the use of survey methods and its many applications.

ysis to predict but-for behavior on the basis of answers to hypothetical questions.

While there are good reasons to treat such survey responses as suspect, especially when the respondents are not faced with choices that involve real economic constraints, we believe that (appropriately utilized) the survey approach can provide a valuable technique. It can, in principle, be used to predict the price effects of a merger or to evaluate the extent of harm causes by a firm's exclusionary practices. In the following pages, we briefly outline how such a methodology can work.[94] We focus on *conjoint analysis*, a technique that has proved useful in the past as a marketing tool for deciding whether to match a competitor's price increase, for pricing new brands, and for setting new prices among the bundle of existing brands.

To apply the conjoint approach to the determination of the demand for a group of products, an analyst would show a group of respondents a series of descriptions of the important characteristics of each of the products at issue, including their prices (actual and/or hypothetical). Respondents are asked to allocate a fixed sum (e.g., 100 points) across each set of product options to be chosen, with the options again including the prices of each of the products. (The fixed sum provides an artificial "budget constraint.") The responses are taken as measures of the likelihood that individuals will make actual purchase decisions, conditional on the prices and product attributes that they face. With a judicious choice of product descriptions, the stated consumer preferences can be used with an appropriate estimation technique (e.g., conditional logit estimation) to estimate a discrete choice demand model.

A central issue in the conjoint approach is the choices of product profiles to be shown to the survey respondents. Suppose, for example, that there is a proposed merger involving four products, each of which can be characterized by five attributes. Suppose, also that there four possible attribute levels associated with each product at issue. Even in this relatively simple case, there are 1,024 (4^5) different combinations of the attributes of the four goods that respondents might be questioned about. A successful conjoint analysis chooses an experimental design with a subset of all

94. This discussion relies heavily on Green and Wind (1975) and Green and Savitz (1994).

possibilities that is sufficient to estimate the underlying consumer demand functions for the products with reasonable accuracy.[95]

The survey approach just described has substantial potential. It can provide empirical answers to questions for which alternative empirical approaches would fail because of a lack of data. Further, because it is based on a coherent experimental design, it is subject to statistical testing and to the calculation of statistical indicators of reliability. There are, however, a number of potentially significant concerns. First, because the survey answers are responses to hypothetical questions, they may not accurately reflect the choices that individuals would make under actual market conditions. Second, because the empirical methodology typically relies on the aggregation of responses (e.g., the percentage of respondents in each category), the technique does not utilize all available information about individual preferences. Third, because the individual responses do not flow from a utility-maximizing constrained optimization problem, the predicted price effects of a merger, or for that matter any predicted effects, could significantly misstate the actual effects. Finally, to the extent that one wishes to account for the interactions among product attributes, the experimental design may need to be quite complex and the data needs may be great, all of which add substantially to the cost of applying a conjoint-type analysis.

Survey methods have, to our knowledge, been utilized on only a few occasions by the antitrust enforcement authorities. One interesting application of the survey methodology, which relied in part on the conjoint methodology arose in 1997 in *United States v. Vail Resorts, Inc.*[96] At issue was a proposed merger between Vail and Ralston, the two largest owner/operators of ski resorts in Colorado. According to the Antitrust Division of the DOJ, the proposed acquisition would have increased the concentration among ski resorts in the Colorado "Front Range," the market for day and overnight ski trips for the population located along the major interstate (I-25). According to the division, Vail controlled 12% of the market and Ralston 26%, with the resulting merger raising prices on ski passes in the market (directly or by reducing discounts).

The case was eventually settled with the parties agreeing to divest the Arapahoe Basin ski resort in Summit, Colorado. The survey methodol-

95. For a specific application see Mahajan, Green, and Goldberg (1982). See also Green and Krieger (1992).

96. *U.S. v. Vail Resorts, Inc.* (competitive impact statement).

ogy was applied to get at the issue of whether the day and overnight ski market should be distinguished from the much broader and less concentrated "destination ski" market. The Antitrust Division relied on traditional surveys of ski usage done in the past in its initial analysis. From these surveys the division characterized the relevant market as having a post-merger Herfindahl-Hirschman concentration index of 2,228, with the index having increased by 643 as a result of the merger. Then, using conjoint-based survey responses about the likelihood of switching between Vail and Ralston as the result of a price change, and using likely values for elasticities obtained from market literature and past market and price data, the division estimated that the merger would cause an increase in discounted lift-ticket prices of 4%, or $1 per ticket.[97]

D. Evaluation

Techniques for identifying the structure of demand are extremely valuable in antitrust analysis. By identifying demand elasticities and more general the shape of demand curves, we can evaluate questions of market and monopoly power, and we can estimate the price effects of a merger or of anticompetitive behavior. As a general rule, the methods that we have discussed are not as straightforward as reduced-form methods and they typically require more data. But in many cases they can generate answers to questions that reduced form methods cannot address. Even when both reduced form and structural methods would be informative, the latter can often exploit qualitative information about market structure to improve the precision of parameter estimates and treat problems arising from the potential endogeneity of some of the right-hand variables in a regression. We are cautiously optimistic that the newer or less utilized approaches we described—those involving auction models, inferring buyer preferences from market shares, and conjoint survey methods—will prove to be useful in antitrust practice.

4. Methods for Identifying Oligopoly Conduct

The substantial academic literature on empirical methods of inferring the nature of rivalry has yet to make its way into antitrust practice,

97. The division's conjoint survey work was done in response to a survey analysis undertaken by N.E.R.A., the defendants' experts.

notwithstanding the antitrust interest in the extent of rivalry among oligopolists. These methods can be understood generally as techniques for analyzing the structure of firms' supply relationships.

Assuming profit maximization, it is straightforward to show that the following industry supply relationship characterizes seller behavior:

$$P = MC + \theta(s)[P - MR], \tag{6}$$

where MC refers to industry marginal cost and MR to the marginal revenue function associated with the industry demand function.[98]

In equation (6), the function $\theta(s)$ reflects the intensity of competition among sellers, while s is a vector of variables related to market structure (such as seller concentration and measures reflecting entry conditions).The function θ takes on values between 0 (perfect competition) and 1 (monopoly). Many dynamic oligopoly models allow for regimes of successful short-run coordination interrupted by occasional price wars. If, under such circumstances, θ is measured over a period during which the firms switched between regimes, θ can be interpreted as the average "collusiveness" of their rivalry. Equation (6) and the demand function are the two structural equations determining the partial equilibrium in the industry.[99]

Equation (6) asserts that price is greater than marginal cost if oligopoly behavior is not perfectly competitive ($\theta > 0$) and industry demand not perfectly elastic (P-MR > 0). Thus, demand-shift variables and market structure variables would not appear in the supply relation if the oligopoly is performing competitively; only variables that affected marginal cost would influence price.

One useful objective for antitrust purposes would be to make inferences about θ, the parameter describing oligopoly behavior. The general approach to identifying the level of θ is to isolate in the data instances in which demand grows more elastic and to examine the extent to which the firms are able to take advantage of that demand response to raise

98. This representation originated with Bresnahan (1982) and Porter (1983). For more general expositions of methods for estimating supply relationships, see Bresnahan (1989) or, less technically, Baker and Bresnahan (1992, pp. 9–13). Equation (6) can be thought of as the static (single period) realization of the equilibrium of an oligopoly supergame.

99. Solving the equations jointly generates two reduced form equations, one for price and one for output.

price. (As oligopoly behavior moves from competitive toward monopoly outcomes, the firms are better able to exploit inelastic market demand to raise price.) The most common empirical difficulty is in distinguishing between two possible reasons for high prices: high marginal cost (e.g., because a firm is nearing a capacity constraint) and market power.

The simultaneity of the supply relation with demand typically will require that exogenous demand shift variables be employed as instruments in estimating supply. This method may not suffice, however, if oligopoly conduct is consistent with a dynamic model in which some demand-shift variables set off price wars. For example, if exogenous variables making demand more inelastic also lead the firms to behave more competitively, simple estimates of the average collusiveness of oligopoly conduct using those demand-shift variables as instruments will be biased downward.[100]

Methods based on estimating supply relations can also be used to identify the influence of changes in market structure on oligopoly behavior. The promise of this type of method for antitrust is suggested by an academic study by Bresnahan and Suslow (1989). Their results imply (among other things) that every 100-point reduction in the Herfindahl-Hirschman index of concentration in the North American aluminum industry during the 1960s and 1970s led to a price reduction of about 2.7% during cyclical downturns (where the firms were operating at excess capacity). This kind of result could provide a starting point for analyzing the competitive effects of a merger in this industry, for example by suggesting the magnitude of the incentive to increase prices that must be offset by the price-reducing incentive arising from efficiencies in order for the merger not to lead to higher prices.[101]

5. Concluding Comments

Empirical methods offer powerful tools for understanding what has happened in the past and for simulating the likely effects of alternative scenarios. They can, in consequence, provide valuable information to courts in many areas, including class certification, the assessment of antitrust liability, the evaluation of anticompetitive harms suffered by consumers and

100. See Corts (1999); Genesove and Mullin (1998).

101. See U.S. DOJ and FTC *Horizontal Merger Guidelines* §4.

producers, and the estimation of antitrust damages. In this article, we have given a broad overview of the empirical methodologies that have been utilized, and we have suggested a few promising, but as yet largely untested, approaches. We hope that this review will stimulate others to think about this issues and to evaluate the use of these techniques in individual cases.

Because empirical analyses often appear complex to the lay person, there may be a tendency on the part of the courts or others to separate the evaluation of the evidence resulting from these methodologies from other factual evidence. We believe that such a separation is inadvisable. Data analysis does not exist in a vacuum; it interacts with the analysis of nonstatistical information. As more nonstatistical information is brought to bear, the systematic empirical evidence can often answer the key questions at issue in litigation more precisely. Conversely, the effort to come to grips with systematic empirical evidence often pays dividends by helping direct the search for non-statistical evidence in documents or testimony.

We also note that antitrust analysis differs from academic empirical industrial organization research in four important ways. First, the data sets that the antitrust agencies and the parties rely on are often richer than the data available for research. Firms involved in antitrust cases may be motivated to plumb their confidential business records in order to come up with evidence that might persuade an enforcement agency or court, and to take the time to explain their data to economists analyzing it.[102] These rich data sets come at a cost. They are typically confidential, so it is not always possible for outside academic experts to fully evaluate the methods and results.[103] The enforcement agencies and courts instead test the studies adversarially, by relying on analyses by economists within the agency or economists offered as expert witnesses by litigants in court.

Second, in antitrust enforcement it is often possible, as well as highly beneficial, to use documents and deposition or oral testimony to confirm the specification of the model being utilized in an empirical study. To do so requires an appropriate mix of historical data, hypotheticals, and assumptions about behavior based on qualitative techniques. The range of qualitative evidence that can be brought to bear is typically greater in

102. Indeed, they may even develop new data sets when they think doing so would aid their argument.

103. Typically, results presented in open court are public but the underlying data are not.

the antitrust enforcement and litigation context than in academic work, because a wide range of documentary evidence from firm files and testimonial evidence from executives and other industry experts is generally available. A quantitative analysis conducted without reference to this rich vein of evidence is likely to be a missed opportunity for deep understanding.

Third, in antitrust analyses the goal is to understand the industry and the practices at issue in the case, and find the "best" answer possible. In contrast, in the academic world, some studies are conducted with the primary objective of illustrating a methodological problem or the application of a new technique. Thus, antitrust places a premium on finding an empirical methodology that is well suited to the problem and data at hand; new techniques are appropriate only when they are the best ones for the job.

Fourth, the adversarial setting may place an even greater importance on careful work and robustness testing than is already demanded in the academic context. Small errors in data entry or computer programming, with little effect on the result, have been used to challenge credibility in court. If key results go away under alternative specifications, they will not be convincing unless those alternative specifications can be shown to be implausible, perhaps because they imply nonsensical things about other variables or because they are inconsistent with the qualitative information available about the industry.

Notwithstanding these differences between the antitrust and academic settings, empirical antitrust analysis draws heavily on the empirical literature in industrial organization economics. The questions raised by antitrust cases, and the data sets uniquely available under such circumstances, can provide a powerful stimulus to the development of new empirical methods, to the benefit of both the academic and the antitrust worlds.

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