

An Introduction to the Symposium on the Use of Simulation in Applied Industrial Organization

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ABSTRACT *Simulation offers a rigorous methodology for addressing policy or litigation issues that require a comparison of an observed state of the world with an unobserved one. Simulation employs a calibrated, structural oligopoly model to describe the unobserved state of the world. Calibration involves reliance on real-world observations to set the key parameter values in the model. Simulation is an increasingly important tool of the industrial organization economist, particularly in analyzing the competitive effects of mergers. Papers in this symposium illustrate merger simulations in a variety of contexts and one other application of simulation.*

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The formulation of public policy and civil litigation commonly pose questions such as ‘Will this merger reduce welfare?’ and ‘How much did that patent infringement reduce the patent owner’s profits?’ On rare occasions, nature may have performed the relevant experiment; otherwise, answering such questions involves the problematic comparison of an observed state of the world with an unobserved one. Traditionally, this comparison has been made intuitively or on the basis of rather arbitrary rules of thumb, but it can be made rigorously, using what we term ‘simulation.’ Simulation employs a calibrated, structural oligopoly model to describe the unobserved state of the world. Calibration of the model involves reliance on real-world observations, and commonly econometrics, to set the key parameter values in the model.

Simulation is an increasingly important tool of the industrial organization economist.¹ It is used when policy analysis requires not merely the sort of directional predictions that may be available through comparative static analysis,

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but also estimates of the magnitudes of effects. Simulation is also used when the direction of important effects depends on the relative magnitudes of opposing forces, so comparative static analysis is unproductive.

In a sense, any back-of-the-envelope calculation incorporating real-world data is a simulation, and in that sense, simulation has been a common practice in economics for a considerable time. Calculations simple enough to do on the back of an envelope, however, require very strong, and consequently highly unrealistic, assumptions. The sort of simulations presented in this symposium rely less on strong assumptions and use computationally complex models. Simulations such as these have become standard tools as a result of the explosion in desktop computing power and the advent of sophisticated software.

As on most things, economists are likely to differ on the role and significance of simulation. Some economists may see simulation as a minor (perhaps even trivial) adjunct to microeconomic theory and econometrics, but we see simulation as a distinct and important analytic tool. For example, we find simulation sufficiently useful that we do not view high-quality data and elaborate econometrics as prerequisites for it. Better data and more sophisticated econometrics surely make simulation predictions more reliable, but we think simulation is often well worthwhile even if the calibration is crude – based out of necessity on just informed guesses and intuition.

When econometrics is used to calibrate a simulation, economists also may differ on estimation philosophies. In specifying empirical models, there is an inherent tradeoff between variance and bias. Imposing more structure reduces variance and tends to avoid the embarrassment of impossible estimates (e.g. negative cross-price elasticities of demand for products known to be substitutes), but it introduces specification bias. We are sympathetic to the idea that the data should do the talking, but our experience suggests that there are significant limits to the number of independent parameters that the available data can be expected to estimate, and those limits are often exceeded unless assumptions are made in pursuit of parameter parsimony. We think, for example, that the benefits of extreme parameter parsimony, as from the assumption of logit demand, can be worth the cost of the prediction bias that is introduced.

The first major use of simulation in applied industrial organization was, and the most important use still is, in predicting the effects of mergers. Consequently, most of the papers in this symposium relate to merger simulation. We have advocated merger simulation in a series of papers² and practiced it in actual antitrust cases. Merger simulation uses a standard oligopoly model calibrated to observed prices and quantities to predict the effects of a merger on the prices and quantities of the merging firms and their rivals.

Merger simulation provides a practical means for predicting the price effects of mergers and for performing welfare trade-offs for mergers that both lessen competition and generate efficiencies. The effects of merger-induced marginal cost reductions are easily incorporated into simulation, so it is very straightforward to use simulations to predict the net effects of a merger on prices. Simulations in the context of certain oligopoly models also permit social welfare calculations, which account for savings in fixed costs.³

The most common form of merger simulation applies a Bertrand model to a differentiated consumer product industry. Such merger simulations are driven by econometric estimates of (or, lacking suitable data, reasonable guesses about) the relevant demand relationships among competing products. Marginal costs need not

be estimated, since they can be inferred from the calibrated first-order conditions for profit maximization; hence, only price and quantity data are needed. Detailed, high-frequency data are available for many products, particularly those sold in supermarkets for which scanner data generally is available. The first three papers in this symposium involve Bertrand merger simulations in differentiated consumer product industries.

Werden analyzes a merger involving white pan bread, which both econometric and documentary evidence indicates is a highly differentiated product. The merger analyzed was challenged by the Department of Justice in 1995. The case was settled by a consent decree, pursuant to which significant brands were divested. The paper in this symposium is a highly condensed version of a never-completed expert report prepared for use in possible litigation. Merger simulation was still in its infancy when the report was written, and had the case been litigated, it would have been the first to use merger simulation.

Werden's report uses simulation primarily to predict the price effects of the proposed merger, but also uses it in two other ways. Although not reported in detail, simulation is used in assessing the likely effect of the merger in triggering new entry and in ascertaining the incentives of supermarkets to resist wholesale price increases in white pan bread. Werden and Froeb (1998) present a greatly expanded version of the entry analysis in the report.

The estimation on which Werden relied was not novel, and so is not reported in any detail. The next two papers in the symposium, however, focus primarily on the demand estimation on which merger simulation is based. Werden assumed logit demand in simulating the price effects of the merger. Logit demand has the advantage of extreme parameter parsimony but the disadvantage of potentially significant specification bias. Saha and Simon simulate a hypothetical bread merger using a generalization of logit demand that retains much of its advantage of parameter parsimony, while potentially reducing the specification bias significantly. Saha and Simon specify a logit demand system in which price enters the exponential terms through a polynomial, rather than linearly. They find that the added flexibility substantially improves the fit of the demand estimation, making it comparable to that with AIDS estimation.

Commercially available supermarket scanner data generally provides not only price and quantity information, but also information on special in-store and out-of-store promotions, which could be significant determinants of quantity sold. Weiskopf estimates demand with and without available promotion variables. He finds the two sets of estimates to be only slightly different, but the difference is statistically significant. In hypothetical simulations, however, the slight differences are unimportant; the simulation predictions are sufficiently close that the difference is of no practical importance.

Morris applies merger simulation in a very different context – the electric power industry. His simulations are not driven by estimated demand elasticities or anything else having to do with demand, but rather by the supply side of the market, especially the transmission network that connects generators with loads. Electric power networks do not operate like telecommunication or transportation systems. Unlike telecommunication systems, electric power networks are not switched. Power flows in complex ways according to certain physical laws. Unlike transportation systems, it is not possible to steer around a congested transmission path. Consequently, simulating an electric power merger involves complex modeling of the transmission network based on electrical engineering

principles. As many other simulations have found, Morris finds that simulated effects of the electric utility merger differ substantially from those suggested by alternative analyses, including the analysis mandated by the FERC for merger applications.

Jayarathne and Shapiro use merger simulation to analyze relief options in cases in which there is a serious issue of what should be divested because the merged firm would sell more than two competing products. One option, of course, is to divest all of competing products sold premerger by either of the merging firms. This is the most obvious way, and has been the most common way, to restore the market to roughly its premerger state. Jayarathne and Shapiro, however, explain that under certain conditions (relating to the relevant own and cross elasticities and possible economies of scope) consumers would prefer the divestiture of a different package of brands. Nested logit merger simulations are used to illustrate the point. In a hypothetical case based on an actual one, they show that a merger significantly increasing concentration even after a curative divestiture plausibly enhances consumer welfare. The reason is that the divested product is a particularly close substitute for one of the merged firms' products.

In some merger cases, the competitive interaction literally is, or is best modeled as, an auction. Prominent examples are defense mergers, such as Northrup Grumman's proposed acquisition of Lockheed Martin, and the mergers that reduced the Big Eight accounting firms to the Big Six. Tschantz, Crooke and Froeb adapt the logit choice model to the auction context. The properties that make the logit an attractive model for differentiated products – its analytic and numeric tractability, and its ease-of-estimation – carry over to auctions. Tschantz, Crooke and Froeb study mergers in oral or second-price auctions and compare them to mergers in sealed-bid or first-price auctions. Their auction model has a closed-form moment restriction relating winning bids (prices) to the probabilities of winning (shares), and this gives rise to a closed-form expression for the price effects of mergers. They find that the price effects of symmetry-decreasing mergers are smaller in sealed-bid auctions than in oral auctions. Despite the difference between sealed and oral auctions, sealed-bid merger effects are closely approximated by an Herfindahl-like formula derived from moment restrictions in oral auctions.

Werden, Froeb, and Langenfeld take simulation outside the realm of mergers. They offer a simulation approach to assessing damages in a patent infringement case. Patent law entitles the owner of a patent to recover from an infringer the profits that would have been earned but for the infringement. By accounting for economic effects that generally have been ignored, simulation offers several significant refinements in the assessment of damages. For example, the courts have only rarely accounted for both the price and quantity effects of infringement. The courts also have had especially great difficulty dealing with situations in which the patent owner faced competition from others beside the infringer. The courts have either not awarded lost profits damages at all (limiting damages to a reasonable royalty) or assumed that the infringement took sales away from the patent owner and its rivals in proportion to their market shares. Simulation offers an improved damage assessment when it is reasonable to assume the infringement reallocated sales in such a way and offers a more general methodology that does not require this particular pattern of substitution. Werden, Froeb and Langenfeld illustrate the simulation approach to assessing lost profits damages in two hypothetical cases based on the facts of leading court decisions.

Notes

1. The use of simulation in industrial organization is part of the growing use of numerical methods in economics. Judd (1998) discusses such methods in several other fields of economics. Many of these models involve computing equilibria in complex models.
2. Werden and Froeb (1994, 1996) and Werden (1997a, b) advocate merger simulation. Crooke *et al.* (1999), Froeb and Werden (1996), and Werden (1997c) discuss the details of merger simulation.
3. Although all of the merger simulation in this symposium relates to horizontal mergers, vertical mergers also can be simulated. Such simulations have been performed in some actual cases, but we unfortunately were unable to include a paper illustrating vertical merger simulation.

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