The Use of Econometrics in Merger Reviews

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Often, the central question in merger reviews is whether a proposed merger is likely to cause anticompetitive effects through the merged firm unilaterally increasing prices or decreasing quality. This note describes three econometric analyses that inform likely unilateral competitive effects in different ways.

- Demand Estimation and Merger Simulation: This method uses measures of how substitutable the merging firms' products are in conjunction with standard economic models to predict the likely price effects of a merger.
- Event Studies: This method uses past changes in market structure to infer likely harm from a proposed merger.
- Price-Concentration Studies: This method relates contemporaneous market structures to prices or sales to infer merger harms. Price-concentration studies pose well-known econometric issues, and thus generally are less preferred than merger simulations or event studies. However, in some cases available data only allow for such analyses, and careful use of econometric tools can sometimes mitigate problems caused by econometric issues.

These analyses can be used independently or in combination depending on data availability to assess the likely competitive effects of a proposed merger.

Demand Estimation and Merger Simulation

The 2010 Horizontal Merger Guidelines explain that in evaluating mergers "the Agencies may seek to quantify the extent of direct competition between a product sold by one merging firm and a second product sold by the other merging firm by estimating the diversion ratio from the first product to the second product."[1] Technically, diversion ratios measure the proportion of sales that are lost through a price increase that go to another competitor—e.g., the diversion ratio from product A to product B measures the proportion of product A sales that are lost through a price increase that are diverted to product B. The usefulness of diversion ratios in merger reviews derives from their implications for the unilateral pricing incentives of merging firms. That is, prior to the merger, merging firms that produce substitute products (or services) are constrained in their ability to increase prices, in part, for fear of losing business to the other merging party's product. After the merger, the pricing constraint is removed, and that constraint removal puts upward pressure on prices.

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[1] U.S. Department of Justice and the Federal Trade Commission, Horizontal Merger Guidelines (Issued 2010), available at https://www.justice.gov/atr/horizontal-merger-guidelines-08192010 [hereinafter HMG (2010)], at 6.1 "Pricing of Differentiated Products"

Diversion ratios are used in two main ways in merger reviews. First, diversion ratios can be used in the evaluation of the likely competitive effects of a proposed horizontal merger. Diversion ratios are often combined with profitability measures (i.e., gross margins) to measure the incentive of merging firms to unilaterally increase price(s) post-merger. One commonly used metric that derives from diversion ratios and margins is the 'General Upward Pricing Pressure Index' (hereinafter GUPPI).[2]

Second, diversion ratios can be useful in defining relevant markets. Generally, relevant markets are defined by sets of products that, when combined, would cause it to be profitable for the owner of those products to increase prices by a small but significant amount. Diversion ratios can be used not only in the selection of products, grouping close substitutes, but also in determining when a set of products is sufficiently large that it constitutes a relevant market.

Because diversion ratios are central to modern antitrust analysis, econometric estimates of own- and cross-price elasticities that can be used to construct diversion ratios can be particularly valuable. In the case of consumer products—e.g., ready-to-eat cereal or over-the-counter drugs—detailed price and sales data from retail scanners ("scanner data") from third-party data sources such as A.C. Nielsen (Nielsen) or Information Resources Incorporated (IRI) may be available. These data are particularly useful for estimating diversion ratios because they contain information on prices, quantities, and sometimes product attributes for not only the merging parties' products but also for the products of their competitors. The typical scanner dataset consists of detailed pricing, sales, and distribution[3] measures by week/store/product combination.[4]

In practice, diversion ratios most often are derived from elasticity estimates from an econometric model of consumer demand—i.e., models that relate the quantity demanded of a product to the price of that product and the prices of competitor products, while controlling for other factors that may cause shifts in consumer demand. Two examples of econometric models of demand are the Almost Ideal Demand System ("AIDS") model and the Constant Elasticity of Substitution ("CES") model. Both models measure how small changes in the price affect sales.[5] When using scanner data to estimate a demand model, the economist must consider many factors, which include, for example:

- Unit of Measure
    - When analyzing a product with many, widely-varying sizes, such as hand soap, a uniform measure such as ounces may be preferable to the unit of sale. However, for other products per unit metrics may be preferable.[6]

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[2] For a more detailed summary of the GUPPI formula, *see* Pittman, Russell. (2018). Three Economist's Tools for Antitrust Analysis: A Non-technical Introduction: Building Institutions in Emerging Markets. 10.1007/978-3-319-76644-7_9

[3] The distribution metric most often used is 'All Commodity Volume' (ACV), which measures, generally, the "percent of stores selling" a product. *See* Robin Simon, "The 2nd Most Important Measure: % ACV Distribution", available at https://www.cpgdatainsights.com/distribution/2nd-most-important-part1/

[4] Depending on a party's Nielsen subscription, 'store' level data might be at the banner (i.e., Total Walmart xAOC) level or region (i.e., Walmart Atlanta xAOC) level

[5] In the AIDS model, changes in price are related to changes in market share, while in the CES model changes in price are related to changes in quantity (i.e., units) sold

[6] When analyzing products with widely-varying sizes, the econometrician must be careful to recognize that observed price differences may be due to differences in the proportions of the combined products instead of actual price differences. For example, a 14-ounce bottle of hand soap might be more expensive per-ounce than a 64-ounce bottle. If one aggregates

- Aggregation
    - When aggregating scanner data, the economist may choose to leave the data relatively disaggregated—e.g., allow the unit of observation to be a *region-brand-week*, or the economist may choose to aggregate in one or more dimensions—e.g., aggregate to the *region-product-month* level of observation. Disaggregated data provide more data points and variation. However, when products are purchased and stored, weekly data may overstate own-price-elasticity estimates and understate cross-price-elasticity estimates because "consumers often buy large quantities of items which are on sale and take them into household inventories."[7]
- Sensitivity
    - Reliable econometric estimates of diversion ratios should be stable. For example, does dropping small and large markets have a drastic impact on elasticity measures? Alternatively, does dropping outlier observations have a significant impact on those same measures? Models should be tested and the model's sensitivity to small changes should be considered when using diversion ratio estimates.

After elasticity estimates are recovered and converted into diversion ratios,[8] they can be used as an input into an upward price pressure metric such as a GUPPI. A GUPPI on Product 1 is equal to the Diversion Ratio from Product 1 to Product 2 multiplied by Product 2's price-cost margin.[9] Larger diversion ratios and larger margins are associated with larger GUPPIs. GUPPIs between the merging parties' products can be set against expected merger efficiencies to determine whether the merger is likely to cause anticompetitive harm—i.e., when GUPPIs exceed merger efficiencies, a proposed merger is likely to cause anticompetitive harm.

Diversion ratio estimates also can be used in the definition of relevant markets. For example, one way to define a relevant market is to begin with one of the merging parties' products and add closest substitutes, as indicated by diversion ratios, until a hypothetical monopolist owner of the set of products could increase prices. Such market definition exercises are not only useful in the production of well-known concentration metrics (e.g., shares and HHIs), but they may also be useful illustrative tools for big-picture market definition questions, such as whether private label and branded products belong in the same relevant product markets.

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these sizes together to create one price metric, periods with greater sales of the larger bottle would show lower prices even though the underlying price for each bottle did not change

[7] Hosken, D., D. O'Brien, D. Scheffman, and M. Vita (2002) 'Demand System Estimation and its Application to Horizontal Merger Analysis', Bureau of Economics Federal Trade Commission; For a study on stockpiling and the impact it has on demand estimates, *see* Hendel, I., & Nevo, A. (2006). Measuring the Implications of Sales and Consumer Inventory Behavior. Econometrica, 74(6), 1637-1673. Retrieved February 5, 2020, from www.jstor.org/stable/4123086

[8] Specifically, a diversion ratio can be decomposed into measures of cross-price elasticity, own-price elasticity, and the quantity ratio between the products (or brands or firms).The formula for the diversion ratio from Product 1 to Product 2 is as follows: $(\epsilon_{21} * q_2)/\ (-\epsilon_{aa} * q_a)$

[9] We note that the full GUPPI formula ends by multiplying by the ratio of the (Price of Firm 2 / Price of Firm 1)

Event Studies

When evaluating competitive effects, in addition to the demand estimation exercises described above, "[t]he Agencies also look for historical events, or 'natural experiments,' that are informative regarding the competitive effects of the merger."[10]

For example, studying the impact of previous mergers within the same industry can be useful in the determination of the potential impact of a current merger. Such merger retrospectives often are considered in FTC and DOJ investigations,[11] and recently have been used in merger litigations by the government and private parties. For example, in the AT&T/Time Warner litigation the Judge found merger retrospectives, showing that "the harmful effects that the DOJ claimed should have happened were not there," particularly compelling.[12]

Economists also have found that entry events may be useful in the study of potential merger effects.[13] And the agencies often will study entry events in their merger reviews and litigations. For example, when analyzing the potential for anticompetitive effects of Whole Foods' acquisition of Wild Oats, the FTC's economic expert partially based his inferences of merger harm on studies that indicated that Wild Oats' margins decreased when a Whole Foods store entered nearby.[14]

The usefulness of event studies depends crucially on the quality of the data. When working for merging parties, it often is the case that only the parties' own data are available. One still can study the effect of, for example, the effect of a previous merger or entry by one party on the other party's pricing and profitability without third-party information. Indeed, one of the benefits of event studies is that factors that are fixed over time, such as the presence of third-party competitors, are implicitly controlled for without access to third-party data.

A good time-series of data is desirable for a useful event study—e.g., weekly or monthly data covering a full calendar year before and a full calendar year after an event. One must be careful to identify for study "clean" events—i.e., events that are not confounded by other events during the same time period.

Once data are gathered and events are identified, one must formulate an appropriate econometric framework. One common way to assess the effects of an event is known as "difference-in-differences" or "DID" analysis.[15] For example, in a retail setting, DID works by comparing changes in variables of

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[10] HMG (2010) at 2.1.2 "Direct Comparisons Based on Experience"

[11] For a list of retrospective studies completed by the Bureau of Economics (hereinafter BE) at the FTC, see "List of FTC Bureau of Economics Retrospective Studies", available at https://www.ftc.gov/system/files/attachments/press-releases/ftc-announces-agenda-14th-session-its-hearings-competition-consumer-protection-21st-century/list_of_be_retrospective_studies.pdf

[12] Dennis Carlton, Mark Israel, & Allan Shampine, "LESSONS FROM AT&T/TIME WARNER", available at https://www.competitionpolicyinternational.com/wp-content/uploads/2019/07/CPI-Carlton-Israel-Shampine.pdf

[13] *See* Hosken, Daniel S., Luke M. Olson, and Loren K. Smith. 2018. "Do retail mergers affect competition? Evidence from grocery retailing." Journal of Economics & Management Strategy, 27(1): 3–22

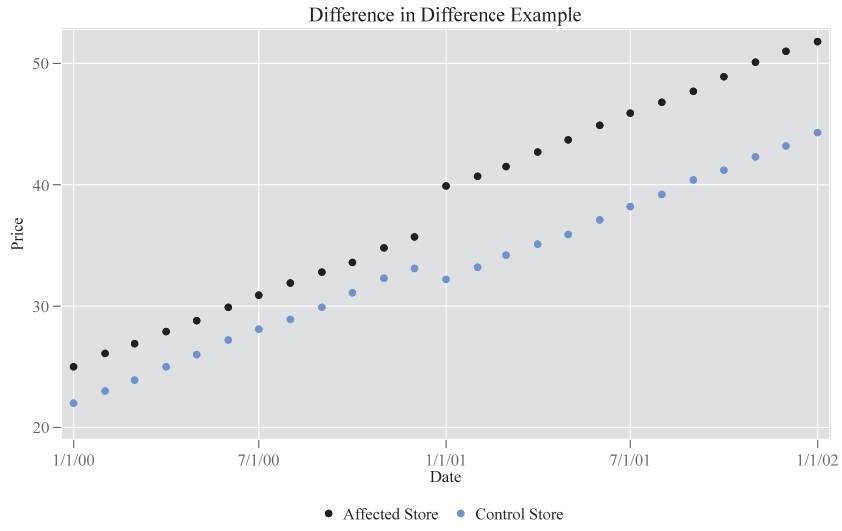
[14] *See* the FTC website for a redacted copy of Dr. Kevin Murphy's expert report, available at https://www.ftc.gov/sites/default/files/documents/cases/2007/08/070823murphy.pdf

[15] See n. 13

interest—e.g., prices or margins—at store locations that are directly affected by an event to a group of control stores that are not directly affected by the event.

Selection of a valid control group requires careful consideration. For example, in a retail setting control stores are meant to provide a benchmark measure of what would have happened at treatment stores in the absence of the event. In the absence of better information, economists typically try to match control and treatment groups according to characteristics that might affect the economic outcomes of interest. For example, an economist might consider store size, pre-merger trends in the variable of interest, and store location (urban or suburban) to be useful variables to consider when choosing a control group. Methods for incorporating characteristics into the control group selection process vary in formality, and it is not uncommon for an economist to use multiple selection criteria and methods.[16]

To understand the purpose of a control group, consider the following example. In the figure below, considering only time-varying information—i.e., the size of the increase in the impacted store's margin as illustrated by the discrete change in the black dots—would underestimate the impact of the event on margins. By contrast, considering only cross-sectional comparisons—i.e., the difference in margins at the treatment and control store following the event—would overestimate the impact of the event (because the control store had smaller margins than the treatment store in the period before the event). A DID estimator exploits both time-series and cross-sectional variation to compare changes in margins at the treatment store to its benchmark from before to after the event—in this case calculating the difference between the increase in margin at the treatment store and the decrease in margin at the control store—thereby accounting for preexisting differences in store margins *and* changes in store margins that would have occurred even in the absence of the event.



[16] For example, economists often limit the control group to sets of stores that were experiencing similar demand and supply conditions similar to those experiencing the event, as well as those that have a statistically similar pre-event trend (in either prices or margins). *See Id.* Recent literature has discussed the creation of a 'synthetic control' group, with the purpose of formalizing "the selection of the comparison units using a data driven procedure." Alberto Abadie. 2019. Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects. Article Prepared for the Journal of Economic Literature. Available online at https://economics.mit.edu/files/17847

After a valid control group has been defined, one can estimate the treatment effect using an econometric regression model. For example, one might regress the measure of interest (usually log of price or log of margin) on dummy variables for 1) the treatment store (i.e., a dummy variable equal to one for all of the stores affected by the event), 2) the time period of the event (i.e., a dummy variable equal to one if the event has occurred), and 3) the interaction of #1 and #2 (i.e., a dummy variable equal to one if the store was impacted *and* the event has occurred). In this specification, the coefficient on the interaction term is the variable of interest, measuring the impact of the event on the stores that were affected compared to non-affected stores (or the control stores).

Price-Concentration Studies

In industries that lack useful events to study, economic indicators such as margins, prices, and sales may still be useful in the evaluation of mergers through careful use of data and econometric techniques. The goal of a reduced form econometric study of the impact of a proposed merger is to determine how the changes in market structure caused by the merger are likely to affect prices. Price-concentration studies do this by comparing prices across markets with different market structures.

For example, in a retail setting, economists sometimes measure the importance of the number of independent competitors nearby on a store's pricing (or margins). Antitrust Agencies might be interested in how many competitors in a local area are necessary to achieve competitive pricing. For example, if one can show, econometrically, that there is a significant decrease in price when increasing from three competitors to four, but no price effect when increasing from four competitors to five, local areas with five competitors (two of which are the merging parties) might pose little risk of anticompetitive effects (while local areas where the merging parties are two of only three or four competitors might raise concerns).

To perform a price-concentration study, in addition to detailed data on one of the parties' margins or prices as described above, one needs a comprehensive dataset on the number and location of third-party competitors. One way to identify competitors for each store is to create a draw area around each store—i.e., the distance travelled by customers that account for X percent of sales. With draw areas in hand, one can count the number of independent competitors for each store.

A naïve price-concentration regression may relate price or margin (for a given store, week, product) to a dummy variable equal to one for no competitors, a continuous variable for number of competitors, and market level controls (all for a given store, week, product). In principle, the coefficient on both the dummy variable and the number of competitors measures how competition impacts price or margin. The econometric challenge with price-concentration studies is that markets with different market structures did not get that way by accident—e.g., generally, markets with less desirable demand conditions will have fewer competitors. And, all else being equal, this causes estimates of the relationship between prices and concentration to understate the likely effects of a merger. This phenomenon is known to economists as endogeneity bias.[17] This endogeneity bias has been studied specifically in the context of concentration regressions.[18]

[17] The problem of endogeneity has been extensively studied. Although we do not intend to go into detail here, price endogeneity often is accounted for through the use of instrumental variables. *See* Wooldridge, Jeffrey M., Introductory

Econometrics: A Modern Approach, 5th Ed. (2012) (hereinafter, Wooldridge (2012)), at Chapter 15. For other methods, *See* n. 18.

[18] Evans, William N., Luke M. Froeb, and Gregory J. Werden. 1993. Endogeneity in the Concentration-Price Relationship: Causes, Consequences, and Cures. Journal of Industrial Economics 41:431–38. For a general review of analyses involving market structure and price, *See also* Davis, P., & Garcés, E. (2010). Quantitative Techniques for Competition and Antitrust Analysis. Princeton University Press at 246-255