

What Is a “But-For World”?

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A CENTRAL QUESTION IN ANTITRUST class actions is whether there exist common, well-accepted methodologies and evidence that reliably show that defendants’ alleged conduct caused common impact (i.e., antitrust injury) and damages to all or substantially all class members. In many, perhaps most, antitrust class action cases, the plaintiff alleges that anticompetitive conduct caused prices to increase above competitive levels, and the task for economic experts is to analyze how actual prices compare to prices in a “but-for world” in which the alleged anticompetitive conduct did not occur. Since many class action antitrust cases concern prices paid for products or services, we will refer here to the outcome of interest in the but-for world as “prices.” More generally, class actions also can involve analyses of factors that affect the value of market exchange to the class, such as prices paid by direct or indirect purchasers, wages paid, or the quantity or quality of items available for purchase.

What constitutes a proper “but-for world” and how one estimates “but-for” prices in that world are central points of contention in many antitrust class action cases. In this article, we provide an economic analysis of this important issue, and we accompany our analysis with real-world examples from our experience as testifying experts in recent cases.

Connecting Market Outcomes to the Challenged Conduct

A first step in the economic analysis of antitrust injury and damages is to connect the outcomes class members experienced to the challenged anticompetitive conduct, using data, economic models, and statistical estimation techniques. The economist must determine whether the alleged conduct

resulted in increased prices, holding constant other competitively neutral factors that simultaneously affected prices. This is referred to as analyzing the causal impact of the alleged conduct on prices, conditional on observable market factors.

An expert economist generally begins the analysis of antitrust impact or damages by specifying the alleged anticompetitive conduct, e.g., colluding to fix prices, and what would have occurred in the absence of the alleged conduct. This “description of the defendant’s proper actions in place of its unlawful actions and a statement about the economic situation absent the wrongdoing”¹ defines the but-for world that guides the economic and statistical modeling the economist will employ to estimate prices in the but-for world. Antitrust injury and damages can be analyzed by comparing actual and but-for prices. This requires an analysis of a but-for world that holds all factors constant with the exception of the alleged conduct.

This basic characterization of a but-for world has substantial support. In perhaps the first formal definition of causation, philosopher David Hume wrote in 1748: “We may define a cause to be an object followed by another . . . where, if the first object had not been, the second never had existed.”² For example, in a cartel pricing-fixing case, if the cartel had not been, then the higher price would never have existed. In the many years since Hume’s statement, economists and scientists more generally have developed sophisticated theories of causation.³ In an important synthesis of the field, Nobel prize-winning economist James Heckman states:

Causality is a very intuitive notion that is difficult to make precise without lapsing into tautology. Two ingredients are central to any definition: (1) a set of possible outcomes (*counterfactuals*) generated by a function of a set of “factors” or “determinants” [e.g., an economic model of the market] and (2) a manipulation where one (or more) of the “factors” or “determinants” is changed.⁴

For example, an assumption about the existence of a price-fixing agreement is changed from “present” to “not present” for the purposes of analyzing antitrust injury and damages. Then, as Professor Heckman states: “The outcomes are compared at different levels of the factors or generating variables. Holding all factors save one at a constant level, the change in the outcome associated with manipulation of the varied factor is called a causal effect of the manipulated factor.”⁵ For example, in an antitrust context, actual prices are compared to but-for prices.

Thus, the but-for world “differs from what actually happened only with respect to the harmful act,”⁶ that is, the but-for world holds all other factors except one—the alleged conduct—the same in order to measure what prices would have been but for the alleged conduct. As discussed below, economic experts apply this fundamental approach to isolate price effects caused by alleged anticompetitive conduct. They do so by developing an economic model of the market that holds constant the effect of market factors unrelated to that conduct.

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Modeling Market Outcomes in the But-For World

In a but-for world, the economist generally assumes that the market would have been competitive in the absence of the alleged conduct, which in antitrust cases typically constitutes conduct that reduces or restricts competition, thereby increasing the ability of firms to exercise market power. The concept of a competitive market is fundamental in economics. One example of a competitive market is the canonical model of perfect competition,⁷ in which many small firms sell a homogeneous product to many small buyers. Both buyers and sellers have perfect information regarding the marketplace, and there are no barriers to entering or exiting the market.⁸ Any market that satisfies the criteria of this model of perfect competition will be competitive. Firms in competitive markets earn a competitive rate of return on their investments. Economists refer to this as zero economic profits. (A firm's economic profits equal its operating returns minus the opportunity cost of the capital employed, i.e., the value of that capital in its best alternative use.)

However, while markets that satisfy the assumptions of the canonical model of perfect competition are competitive, not all competitive markets satisfy these assumptions. Other examples of markets that can be, but are not necessarily, competitive include markets in which products are differentiated, markets with many sellers (monopolistically competitive markets), and markets that have a few number of sellers (i.e., oligopolies) but minimal barriers to entry and, thus, are subject to rapid entry by potential entrants (i.e., entrants can quickly enter in response to positive economic profits, thus the threat of entry keeps profits at competitive levels).

This concept of zero economic profits can be illustrated by considering a hypothetical farmer growing soy beans. If the price of soy beans falls relative to what the farmer could earn investing her land, time, effort, and resources in growing corn, she will move resources out of soy beans and into corn. The same can be said for a firm that invests in alternative lines of research and development for new products, i.e., investment capital moves to areas of higher return until the returns are equalized across all development lines. The beauty of the competitive market concept is that we only need to assume that arbitrage is possible, i.e., firms can observe and act on arbitrage opportunities to maximize profits by entering and exiting markets.⁹ This force drives the economic profits of firms in a competitive market, on average, to zero.

In the context of analyzing antitrust injury and damages, the approach of assuming a competitive market in the but-for world is appealing for several reasons. Specifying the competitive market outcome as the outcome that would have happened in the but-for world does not require many rigid and specific assumptions about the exact market structure (e.g., number or identity of firms) that would exist in the but-for world. As discussed above, several different models of competition yield competitive outcomes. This is apparent empirically—most markets are sufficiently competitive that economic profits of the average firm are approximately zero

despite having distinctly different market structures.

One of the co-authors of this article (Williams) and others have analyzed economic profits using a global database for the period 1999 through 2010 with 13,342 firms in 57 industries from 43 countries, and total 2010 revenues of \$38.5 trillion (61 percent of world GDP).¹⁰ They find that the median economic profit rate is -2.0 percent. That is, the median firm earned 2.0 percent less than the competitive, zero profit economic rate of return. For this reason, assuming that firms in a but-for world would earn the competitive, zero profit economic rate of return is generally a conservative assumption. If, to the contrary, the but-for world is one in which firms earn positive economic profits, the cash flow model can be adjusted (by increasing the but-for prices) so that the firm's operating returns exceed the opportunity cost of capital employed by an amount that equals the but-for level of positive economic profits. Such an adjustment would be based on a determination that, even in the absence of the allegedly anticompetitive conduct, conditions in the relevant market would enable a representative firm to earn positive economic profits during the damages period. Such a determination would require a case-specific analysis of the relevant market evaluating, for example, the presence of barriers to entry.

Because the concept of a competitive market outcome is not driven by a large number of assumptions but is instead a *general* concept, calculating the but-for price is simple, robust, and transparent. If the market in the but-for world is a competitive market, the data required to estimate but-for prices are input costs and a measure of the opportunity cost of the capital employed by the firm. By calculating input costs and opportunity costs of investments, the expert can provide an estimate of what the competitive outcome would have been in the absence of the alleged anticompetitive conduct in a transparent way that does not require specifying an exact model of competition in the but-for world.

An Example from the Cable Industry. Two recent antitrust tying cases in the cable industry illustrate this approach. In one case, Cox Cable was accused by a class of plaintiffs in Oklahoma City of illegally tying its premium cable television services to the rental of its set-top boxes.¹¹ In its decision on class certification, the court found that "there is direct, common evidence of classwide policies, practices, and statements that Cox customers had to rent a Cox set-top box in order to participate in the full panoply of digital services."¹² For the purposes of analyzing antitrust injury and damages, the plaintiffs' expert economist studied the nature of competition in the market for the retail sale of set-top boxes. The study focused on retail markets for the sale of similar electronic devices by retailers such as Best Buy, as well as retail markets in Canada for the sale of set-top boxes. (Canadian cable companies do not tie their premium cable television services to the rental of their set-top boxes.) The results of the study demonstrated that retail markets for the sale of set-top boxes are competitive.

Based on these results, the plaintiffs' expert estimated the but-for rental rates that Cox subscribers would have paid in the absence of the disputed tie. In the ordinary course of business, Cox had prepared spreadsheets calculating its rate of return on investments in set-top boxes. The spreadsheets analyzed the relevant cash flows, including up-front acquisition costs, periodic maintenance costs, and rental payments by subscribers over the expected lifetimes of different types of set-top boxes. The but-for rental rates were calculated using these same spreadsheets. The first step was to set the rate of return on investments in set-top boxes equal to Cox's own estimate of its opportunity cost, i.e., its cost of capital for investments in the retail rental of set-top boxes. This step ensured that in the but-for world, Cox's subscribers acquired set-top boxes at a competitive price, assuming that Cox's opportunity cost of capital was representative of opportunity costs for firms in the market. The second and final step was to hold constant Cox's acquisition and maintenance costs for each type of set-top box and calculate the rental rates that produced a rate of return equal to the competitive rate of return, i.e., Cox's cost of capital.

The second cable case involved a similar class action by subscribers of Cablevision in the New York City metropolitan area, alleging that the firm illegally tied its two-way cable services (i.e., (1) the interactive program guide, (2) the ability to order pay-per-view events using a remote control, (3) Video on Demand, and (4) iO Games), to the rental of its set-top boxes.¹³ The plaintiffs' expert calculated but-for rental rates for set-top boxes using a similar cash flow model. Again, the critical economic element of the model was the requirement that in the but-for world, Cablevision's subscribers acquired set-top boxes in a competitive market.

An important aspect of both models is that they did not require the expert to specify detailed aspects of the but-for competitive markets in which subscribers acquire set-top boxes. For example, once the competitive rate of return has been specified, the expert need not determine which specific retailers in the but-for world would sell set-top boxes to which specific subscribers. Retailers' prices in the but-for world would be those that yield the competitive rate of return on investments in set-top boxes, reflecting the competitive nature of the but-for retail markets for set-top boxes.

The parties and their experts disagreed on whether numerous additional details, such as the following, must be specified to properly define the but-for world used to show common impact in support of class certification:

1. The video packages that the defendant cable company would offer to its subscribers.
2. The prices of those video packages.
3. The video package selected by each subscriber.
4. The manner in which set-top boxes compatible with the defendant's cable system would be distributed, e.g., through big-box retailers, the internet, and/or the defendant cable company.
5. The set-top box models that would be distributed.
6. The prices of those set-top boxes.
7. The set-top box model selected by each subscriber.
8. The manner in which each subscriber purchased the set-top box services, i.e., through lease, lease-to-own, or purchase.
9. How long each subscriber would keep a compatible set-top box (whether leased or purchased).
10. How, and to what degree, each subscriber would be affected by other changes in the but-for world, such as a change in the quality of the defendant cable company's video services offerings and/or set-top boxes.

The approach described above for deriving competitive price levels based on the competitive rate of return on investments in set-top boxes in the but-for world does not require specification of these features. Indeed, an effort to specify such features would require the use of highly technical methods from the field of "dynamic oligopoly games,"¹⁴ but even these state-of-the-art techniques would be incapable of specifying the many features described above.

Briefly, dynamic oligopoly games are used to understand under what assumptions researchers can uncover the factors governing competition, profits, prices, and outputs with limited industry data, and then use those assumptions and factors to conduct simulations in counterfactual worlds (e.g., what would happen to prices if firms colluded). These approaches are used in academic research circles to push the bounds of economic theory, but are not necessary or appropriate for analyzing antitrust impact and damages. The models are generally complex and require substantial "structure," i.e., assumptions, on what firms believe, what potential actions they can take, and what statistical distributions govern each model component.

Thus, while dynamic oligopoly models push the boundaries of current computation and estimation techniques, they necessarily involve many assumptions. For example, what is a firm's belief regarding rivals' responses to its actions? What are the set of actions firms can take? What are the demand and profit functions? Assumptions regarding these and other features of a given model may not hold in any specific real-world market, but the assumptions are often required because computation has to be limited to a small set of possible outcomes. In sum, despite the limited ability of state-of-the-art industrial organization economics to specify counterfactual parameters, economists have argued that plaintiffs' expert economists in antitrust class actions must specify numerous characteristics of a but-for world that are both unnecessary (in the terms of counterfactual theories of causation), as well as impossible (in terms of the state-of-the-art in industrial organization economics).

Finally, some of the asserted features of the but-for world described above are literally impossible to calculate. Take for instance the assertion that one must determine what video packages the defendant cable company would offer to subscribers in the but-for world. The defendant cable company had over 570 all-digital channels. As a theoretical matter,

the number of possible packages that can be formed using 570 channels approximately equals 3×10^{171} , which exceeds the number of atoms in the universe.¹⁵ It is neither feasible nor necessary to compute all combinations of packages offered (existing and possible), all potential entrants, all technological innovations, all possible price discriminatory contracts, all actual and potential customers over a long time horizon, their choices in every permutation of the possible market place, and their welfare in all possible permutations.

In sum, specifying a general characteristic of a competitive outcome in the but-for world harnesses a fundamental and general economic principle of zero economic profits to transparently and robustly generate but-for prices. Supporting this assumption is often straightforward, as many diverse markets are characterized by competitive outcomes. Basic information on per unit costs and opportunity cost of capital allow for straightforward and transparent estimation and calculation.

Estimating Prices in the But-For World with Regression Analysis

The opportunity-cost-based approach to analyzing common impact and damages given in the cable example above is not always feasible. For example, the required input cost data may not be available or may not have a clear, per-unit relationship with output. In such cases, economists can use what is referred to as a “before-during” analysis. The before-during methodology can be applied in a number of ways, including (1) analyzing supply and demand conditions (discussed separately below), and (2) applying multivariate regression analyses to explain variation in observed prices as a function of cost and demand factors, and in turn to estimate what prices would have been, all else equal, in the damages period in the absence of the alleged anticompetitive conduct.¹⁶

With the regression approach, the economist is estimating in part how input costs relate to price in lieu of having actual per unit costs of production, coupled with information on the rate of return. The regression approach yields but-for prices that reflect the level of competition in the before period. If that competition yields a competitive outcome, then the implied rate of return would be the competitive rate of return, i.e., zero economic profits. If, instead, competition in the before period was between oligopolists earning supracompetitive profits, that would be reflected in the but-for prices.

Regression methods using the before-during model can be used to analyze common impact and damages issues. As discussed in the ABA monograph on econometrics, “Because econometric analysis can be used to control for numerous individual variables that affect pricing, it is widely recognized as an acceptable methodology for showing antitrust impact, or injury (i.e., determining the ‘but for’ price by isolating the effect of allegedly wrongful conduct on price).”¹⁷ Effectively, prices in a time period before the alleged conspiratorial conduct occurred can be compared to prices during the conspiratorial conduct, holding constant a number of

cost and demand factors. Explanatory variables included in the regression should measure marketplace fluctuations that are outside the influence of the cartel.¹⁸

Regression analysis presents inherent econometric challenges in demonstrating the existence of common impact,¹⁹ but determining the common impact, if any, attributable to allegedly collusive behavior generally involves analyzing differences in actual and but-for prices. Two periods are typically identified. First, a damages or impact period is defined as the period in which the alleged collusion occurred. Second, a benchmark or control period is defined as the period in which the alleged collusion did not occur.

One critique of this regression approach is that, without a well-specified model of competition in the before period, the economist may not know which supply and demand control variables should be included in the regression; but there are well-established techniques to identify such variables. First, the economist can incorporate supply and demand factors present in the peer-reviewed literature as well as in documentary evidence and models produced by industry participants. Variables can be included even without specifying exact cost and demand functions. If parsimony is a question (concern over too many potential variables to include relative to the size of the data sample, or apparent contradictions in existing scientific and industry studies), well-established penalized regression models (e.g., Least Absolute Shrinkage and Selection Operator (LASSO)), can be used to select the strongest predictors of prices using predetermined routines that minimize the potential for including irrelevant or highly collinear variables.

Thus, the before-during approach is a robust and transparent method, grounded in industry facts and well-established economic principles, for estimating but-for prices and analyzing common impact and damages in ways that do not depend on the specific model of competition in the but-for world. Such regression models can be implemented in situations where per-unit costs and opportunity costs are not available or do not apply to the specific features of production and competition in the market.

Illustrating the Regression Approach with the Fresh Potatoes Price-Fixing Class Action Case. To illustrate the regression approach, we use the recently concluded *Fresh Potatoes* class action.²⁰ In that case, the defendants (including individual potato growers, owners, and packing sheds; marketing and shipping agencies working as agents of individual growers; and regional potato cooperatives), were alleged to have conspired to raise the price of fresh potatoes by illegally restricting the supply of potatoes through explicit agreements. The proposed class consisted of all persons residing in the United States who, at any time from June 2006 forward directly purchased fresh or process potatoes from defendants or their alleged co-conspirators. Since fresh potatoes are a commodity and sellers cannot price discriminate, all or substantially all buyers pay the same price for a given quality of fresh potatoes at a given point in time.

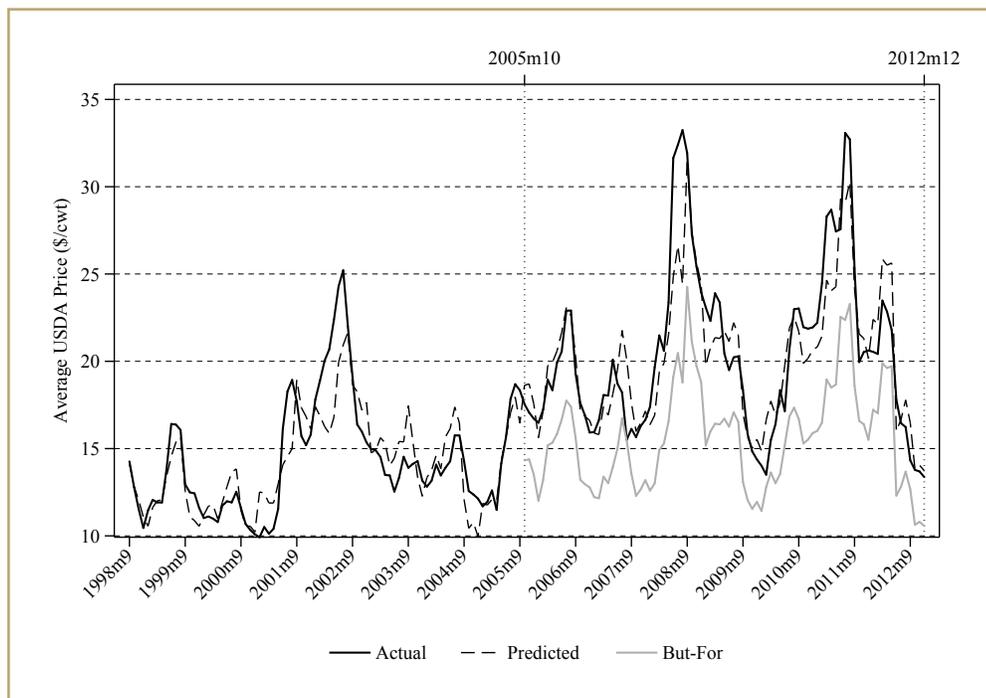


Figure 1. Actual, Predicted, and But-For Shipping Point Prices of Fresh Potatoes

Here, a production cost function was not known (unlike in cable where one set-top box purchased at wholesale with a known price produced one set-top box rental unit). Instead, the relationship between price and cost needed to be estimated while also controlling for demand factors that could influence price. Therefore, a regression model of price as a function of demand and cost factors was used to quantify damages. From an economic perspective, antitrust damages (in a given period) equal the difference between: (1) the price class members paid for the product in the actual world; and (2) the price that would have existed but for the alleged conduct, multiplied by the quantity purchased by class members. The coefficients in the estimated regressions were used to predict the but-for price for each month in the damages period. Figure 1 shows the actual, predicted, and but-for prices estimated using the regression models for fresh potatoes at the shipping point level.²¹ (The shipping point level is the point in the distribution chain where growers sell their potatoes, generally at packing sheds.) The average overcharge at a national level attributable to the alleged collusion equals 30 percent for fresh potatoes. Note that this estimate falls within the range of estimates derived from analyzing supply and demand elasticities. (See discussion below.) The vertical dotted line indicates the start of the alleged damages period, October 1, 2005.²²

Thus, in this approach, data from the benchmark and alleged damages periods were used to estimate a standard dummy-variable regression model. In such a model, the effect of collusion on price is measured by an indicator variable equal to one during the alleged collusion period and zero in

the non-collusion period, hence the name “dummy variable.”²³ The dummy-variable regression model utilized common evidence to estimate the prices that class members would have paid but for the alleged agreement. Again, this regression-based approach did not require the plaintiffs’ expert economist to specify numerous, unnecessary characteristics of a but-for world, but instead relied on well-established economic principles, industry facts, and transparent statistical analysis. For example, this approach did not require counterfactual determinations of the number of pounds of potatoes shipped from individual packing sheds at each point in time. Thus, common impact was reliably demonstrated with the regression approach, noting again that fresh potatoes are a commodity over which sellers cannot price discriminate.²⁴

Estimating Prices in the But-For World with Supply and Demand Elasticities

As noted above, an alternative approach to calculating but-for prices is to analyze supply and demand elasticities in the periods before and during an alleged conspiracy. The elasticity of demand for a product shows by how much the quantity demanded falls in response to a given increase in price. In particular, the elasticity of demand equals (1) the percentage change in quantity divided by (2) the percentage change in price. This approach may be followed when industry estimates of supply and demand elasticities are available, but reliable data on predictors of price are not, or to test statistical calculations and estimates derived from the prior two approaches.

Illustrating the Supply and Demand Approach with the Fresh Potatoes Price-Fixing Class Action Case. In the *Fresh Potatoes* price-fixing class action case, the empirical results of peer-reviewed research show that the elasticity of demand for potatoes is “inelastic,” i.e., less than 1.0 in absolute value.²⁵ This means that a given percentage decrease in quantity demanded results from a much larger percentage increase in market price. For example, a price elasticity of -0.5 means that a 10 percent increase in price results in a 5 percent reduction in quantity demanded. Table 1 shows percentage price increases given (1) the estimated price elasticities of demand for potatoes in the peer-reviewed literature²⁶ and (2) different percentage reductions in the supply of potatoes caused by the alleged agreement.

Table 1: Percentage Increase in the But-For Price of Potatoes Caused By the Alleged Agreement

Percentage Reduction in Quantity Supplied	Elasticity of Demand			
	-0.14	-0.30	-0.40	-0.50
2	14.3	6.7	5.0	4.0
7	50.0	23.3	17.5	14.0

Note: The percentage increase in price equals (1) the percentage reduction in quantity supplied divided by (2) the elasticity of demand.

In June 2006, the United Potato Growers of Idaho cooperative concluded that its acreage reduction program had reduced the production of Idaho potatoes by approximately 8.4 million hundred weight.²⁷ The Idaho reduction equals 2.0 percent of total U.S. potato production in 2005.²⁸ Using the elasticity formula described above, the percentage reduction of 2.0 percent in quantity supplied resulting from the acreage restriction program implies price increases ranging from 4.0 percent to 14.3 percent. This calculation conservatively uses all potatoes as the denominator. However, the alleged cartel targeted fresh potatoes. The reduction of 8.4 million hundred weight amounts to 7.0 percent of total U.S. production of fresh potatoes. The percentage reduction of 7.0 percent in quantity supplied of fresh potatoes resulting from the acreage restriction program implies price increases for fresh potatoes ranging from 14.0 percent to 50.0 percent.

This application of the before-during methodology using the textbook model of supply and demand uses common evidence to show common impact given, as discussed above, that fresh potatoes are a commodity over which sellers cannot price discriminate. The analysis shows that class members paid higher prices as a result of the acreage reduction plan (which the plaintiffs asserted was put into place by the alleged agreement) than they would have paid but for that plan.

Moreover, this approach does not require the plaintiffs' expert economist to specify numerous characteristics of a but-for world that, as discussed above, are either unnecessary or impossible. For example, this approach does not require counterfactual estimates of the quantity of potatoes produced by each grower, as well as each grower's use of fertilizer, pesticides, labor, and capital. Thus, common impact can be proven with common evidence, based on a but-for world that "differs from what actually happened only with respect to the harmful act,"²⁹ i.e., the reduced output of potatoes.

Conclusion

The fundamental nature of a but-for world has been the subject of extensive research in the field of economics. For purposes of antitrust class action cases, the essential premise of this work is that a but-for world differs from the actual world only with respect to the harmful act. The examples and discussion above show how fundamental economic the-

ory on industrial organization that relates prices to competition, cost, and demand factors, coupled with transparent statistical models, can be applied to identify market factors and common evidence that define the but-for world and provide robust, reliable evidence of common impact and damages in antitrust class action cases. In many such cases, reliable economic models can be developed and used that do not require specification and data analysis of numerous characteristics of a but-for world that are both unnecessary (in the terms of counterfactual theories of causation) as well as impossible (in terms of the state-of-the-art in industrial organization economics). ■

- 1 Mark A. Allen, Robert E. Hall & Victoria A. Lazear, *Reference Guide on Estimation of Economic Damages*, in REFERENCE MANUAL ON SCIENTIFIC EVIDENCE (Federal Judicial Center, National Research Council of the National Academies 425, 432 (2011)).
- 2 David Hume, *An Inquiry Concerning Human Understanding*, Section VII (1748) (Pearson (1995)).
- 3 Important contributions include Trygve Haavelmo, *The Statistical Implications of a System of Simultaneous Equations*, 11 *ECONOMETRICA* 1 (1943); Jacob Marschak, *Economic Measurements for Policy and Prediction*, in *STUDIES IN ECONOMETRIC METHOD* 1 (W.C. Hood & T.C. Koopmans eds., 1953); David Lewis, *Counterfactuals*, OXFORD: BLACKWELL (1973); Donald Rubin, *Estimating Causal Effects of Treatments in Randomized And Non-Randomized Studies*, 66 *J. EDUC. PSYCHOL.* 688 (1974); Donald Rubin, *Assignment to a Treatment Group on the Basis of a Covariate*, 2 *J. EDUC. STAT.* 1 (1977); Paul Holland, *Statistics and Causal Inference*, 81 *J. AM. STAT. ASS'N* 945 (1986); Judea Pearl, *Causality*, CAMBRIDGE: CAMBRIDGE UNIVERSITY PRESS (2000); Christopher Hitchcock, *The Intransitivity of Causation Revealed in Equations and Graphs*, 98 *J. PHIL.* 273 (2001); and James Woodward, *Making Things Happen: A Theory of Causal Explanation*, OXFORD: OXFORD UNIVERSITY PRESS (2003). See generally Peter Menzies, *Counterfactual Theories of Causation*, *STANFORD ENCYCLOPEDIA OF PHILOSOPHY* (2014), <http://plato.stanford.edu/entries/causation-counterfactual/>.
- 4 James Heckman, *The Scientific Model of Causality*, 35 *SOCIOLOGICAL METHODOLOGY* 1, 1 (2005) (emphasis added). See also James Heckman & Edward Vytlacil, *Econometric Evaluation of Social Programs, Part I: Causal Models, Structural Models, and Econometric Policy Evaluation*, in 6B *HANDBOOK OF ECONOMETRICS*, ch. 70, at 4780 (2007); James Heckman, *Econometric Causality*, 76 *INT'L STAT. REV.* 1 (2008); James Heckman & Rodrigo Pinto, *Causal Analysis After Haavelmo*, 31 *ECONOMETRIC THEORY* 115 (2015).
- 5 Heckman, *The Scientific Model of Causality*, *supra* note 4, at 1.
- 6 Allen et al., *supra* note 1.
- 7 Jeffrey Church & Roger Ware, *Industrial Organization: A Strategic Approach*, IRWIN MCGRAW-HILL, 22 (2000).
- 8 Preston R. McAfee, Hugo Mialon & Michael A. Williams, *What Is a Barrier to Entry?*, 94 *AM. ECON. REV.* 461 (2004).
- 9 Of course, the presence of barriers to entry or exit can reduce the ability of firms to exploit profitable arbitrage opportunities.
- 10 Michael A. Williams, Grace Baek, Leslie Park & Wei Zhao, *Global Evidence on the Distribution of Economic Profit Rates*, 458 *PHYSICA A* 356 (2016).
- 11 The authors served, respectively, as testifying and consulting experts for the plaintiffs. The jury unanimously found for the plaintiffs, but the court overturned the jury verdict. The case is currently on appeal. See, e.g., Linda O'Brien, *Judge Sets Aside \$6.31M Jury Verdict in Cox Cable Box Tying Suit*, *ANTITRUST L. DAILY* (Nov. 12, 2015), http://www.dailyreportingsuite.com/antitrust/news/judge_sets_aside_6_31m_jury_verdict_in_cox_cable_box_tying_suit.
- 12 Memorandum Opinion and Order at 17, *Healy v. Cox Commc'ns, Inc.*, Case No. CIV-12-481-C (W.D. Okla. Dec. 28, 2011). See also the FCC's Notice of

- Proposed Rulemaking on set-top boxes: “FCC Chairman Proposal to Unlock the Set-Top Box: Creating Choice & Innovation. Ninety-nine percent of pay-TV subscribers are chained to their set-top boxes because cable and satellite operators have locked up the market. Lack of competition has meant few choices and high prices for consumers—on average, \$231 in rental fees annually for the average American household. Altogether, U.S. consumers spend \$20 billion a year to lease these devices. Since 1994, according to a recent analysis, the cost of cable set-top boxes has risen 185 percent while the cost of computers, televisions, and mobile phones has dropped by 90 percent. Congress recognized the importance of a competitive marketplace and directed the Commission to adopt rules that will ensure consumers will be able to use the device they prefer for accessing programming they’ve paid for.” https://apps.fcc.gov/edocs_public/attachmatch/DOC-337449A1.pdf.
- ¹³ The authors served, respectively, as testifying and consulting experts for the plaintiffs. The case settled in December 2015. Class Action Settlement Agreement, *Marchese v. Cablevision Sys. Corp.*, Civil Action No. 10-2190 (MCA) (MAH) (D.N.J. Dec. 7, 2015), <http://tcllaw.com/wp-content/uploads/2016/04/Settlement-Agreement.pdf>.
- ¹⁴ See, e.g., Patrick Bajari, C. Lanier Benkard & Jonathan Levin, *Estimating Dynamic Models of Imperfect Competition*, 75 *ECONOMETRICA* 1331 (2007).
- ¹⁵ The number of packages equals $2^{570} - 1$, which equals approximately 3×10^{171} . The number of atoms in the universe equals approximately 1×10^{80} . See *Number of Atoms in the Universe*, WOLFRAMALPHA, <http://www.wolframalpha.com/input/?i=number+of+atoms+in+the+universe>.
- ¹⁶ Justin McCrary & Daniel L. Rubinfeld, *Measuring Benchmark Damages in Antitrust Litigation*, 3 *J. ECONOMETRIC METHODS* 63 (2014).
- ¹⁷ ABA SECTION OF ANTITRUST LAW, *ECONOMETRICS: LEGAL, PRACTICAL, AND TECHNICAL ISSUES* 341 (2d ed. 2014) [hereinafter ABA, *ECONOMETRICS*]. With respect to damages, the “before-during approach identifies the effect of the alleged conduct by using data from a period before the alleged conduct in combination with data from the period when the alleged conduct occurred. Comparing the values of the dependent variable in the before period to the value it took on in the during period may serve to identify the effect of the alleged conduct.” *Id.* at 312 (citations omitted).
- ¹⁸ Halbert White, Robert Marshall & Pauline Kennedy, *The Measurement of Economic Damages in Antitrust Civil Litigation*, 6 *ECONOMICS COMMITTEE NEWSL.* (ABA Section of Antitrust Law) 17 (2006).
- ¹⁹ See, e.g., Kevin Caves & Hal Singer, *Econometric Tests for Detecting the Existence of Common Impact*, in *THE LAW AND ECONOMICS OF CLASS ACTIONS* 135–60 (James Langenfeld ed., 2013).
- ²⁰ *In re Fresh and Process Potatoes Antitrust Litig.*, Civil Case No. 4:10-md-02186 BLW (E.D. Idaho). The authors served, respectively, as consulting and testifying experts for the plaintiffs. The case settled before defendants filed expert rebuttal reports.
- ²¹ The actual and predicted prices are “close” in the sense that the coefficient of determination (R^2) equals 0.87.
- ²² The United Potato Growers of Idaho was formed in 2004, Second Amended Class Action Complaint ¶ 22, *In Re Fresh and Process Potatoes Antitrust Litigation*, Civil Case No. 4:10-md-02186 BLW (Jan. 31, 2012), while the United Potato Growers of America was created in March, 2005, Timothy W. Martin, *This Spud’s Not for You: Growing Co-Op of Farmers Seeks to Become OPEC of Potatoes by Controlling Supply*, *WALL ST. J.*, Sept. 26, 2006, at B1(2). We conservatively estimate the effect of collusion to begin on October 1, 2005. All of the data used in the regression shown in Figure 1 are publicly available.
- ²³ See, e.g., ABA, *ECONOMETRICS*, *supra* note 17.
- ²⁴ For example, the defendants’ potato prices were highly correlated with USDA nationwide prices.
- ²⁵ See, e.g., Ronald Babula, Timothy McCarty, Douglas Newman & Stephen Burket, *Econometric Examination of U.S. Potato-Related Market Relationships: Findings from a Recent U.S. Trade Investigation*, 9 *J. INT’L FOOD & AGRIBUSINESS MKTG.* 35 (1998). The authors use a vector autoregression model to estimate the demand elasticity for fresh potatoes.
- ²⁶ *Id.*
- ²⁷ United Potato Growers of Idaho, 1 *THE BULLETIN*, June 2006, at 7, 2.
- ²⁸ U.S. Dep’t of Agriculture, Nat’l Agricultural Stat. Serv., *Potatoes 2005 Summary* 4 (Sept. 2006), <http://usda.mannlib.cornell.edu/usda/nass/Pota//2000s/2006/Pota-09-21-2006.pdf>.
- ²⁹ Allen et al., *supra* note 1.