

# Econ **INSIDE** One

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## WHAT'S YOUR SIGN?



Everyday intuition can be misleading when using economic (or practical) significance to evaluate the reliability of regression analysis.

Economic experts often employ regression analysis to quantify the impact of factors affecting prices, market shares or other economic variables. For example, regression analysis can provide a means of isolating the price effect of an alleged conspiracy from the effects of other demand and supply factors on prices. Such a regression model would provide estimates for both the effect of the alleged conspiracy and of these other supply and demand factors. The reliability of the model and consequently, the reliability of its conspiracy effect, are often evaluated by examining the estimates of these additional factors. Two tools for assessing the reliability of such estimates produced by regression models (or more generally, by any statistical model) are examinations of their statistical<sup>1</sup> and economic significance. My focus here is evaluating the apparent economic significance of empirical results.

Examinations of economic significance have two aspects.<sup>2</sup> First, does an estimated effect have the right sign? Second, is the magnitude of the effect plausible? These issues are addressed first regarding the variable of interest--say, the conspiracy

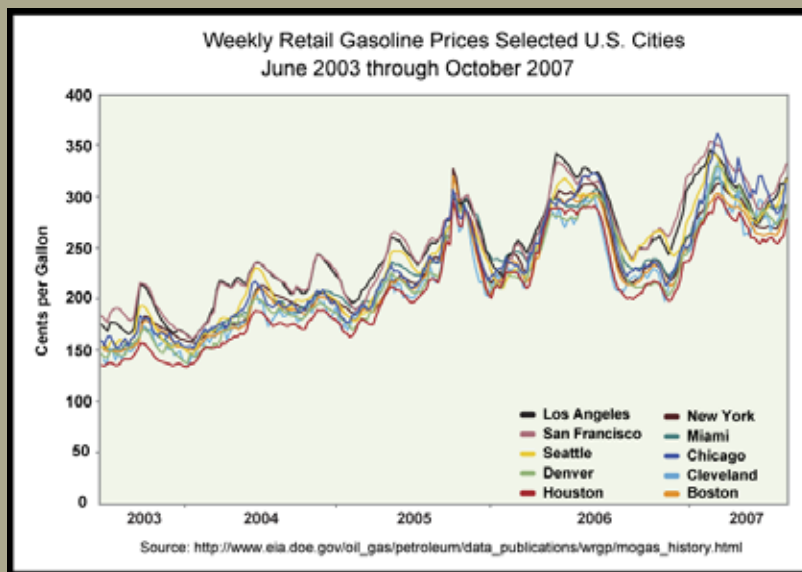
effect--then attention turns to the other factors in the model. Answers to both the correct sign and plausible magnitude questions depend on prior information regarding the relationship of interest. For example, in estimating whether an alleged conspiracy artificially raised prices in Los Angeles, the model would control for factors (other than the conspiracy) that would plausibly be thought to affect those same prices. Prices in areas not impacted by the conspiracy (e.g., San Francisco, Denver, Houston, New York) might capture some of the effects of non-conspiracy factors--be they changes in labor conditions, temporary supply chain variations, fortuitous product placement events, terms of foreign trade or the vagaries of fashion--that influence prices in Los Angeles. Such geographically varying prices can be particularly useful if direct data on the underlying supply and demand factors driving prices are difficult to obtain.<sup>3</sup>

When considering a model in which prices in Los Angeles are accounted for, in part, by prices in other cities, what prior information should you use to judge the economic significance of these factors? Consider the issue of the sign of each of these control cities. Intuition drawn from real-world experience would suggest that prices in these control cities tend to move together, and with prices in Los Angeles.

## WHAT'S YOUR SIGN? -CONTINUED

One might then conclude that the estimated relationship between each of these city's price on the price in Los Angeles would be positive. This conclusion however is likely to be incorrect.

Intuition may not be a reliable guide to establishing the signs of regression factors because regression models estimate the marginal or partial relationship between each city's price and the



Los Angeles price. These estimates are capturing the result of a hypothetical experiment in which other factors in the model, including prices at other locations, are constant and only the prices in Los Angeles and one other given city happen to vary (e.g., the relationship between Houston and Los Angeles prices is what we would observe if all other cities' prices were not changing).

Such conditions are unlikely to be observed in practice. Instead, prices across all of the cities tend to move together but not in lock-step. Therefore, our casual observations can mislead us regarding plausible signs for economic factors.

Simple regressions generally accord better with our day-to-day intuition, but cannot capture

the necessary relationships. These regressions model the effect of a single factor at a time. In the example above, simple regressions would capture the common movement of Houston prices with Los Angeles prices, and then San Francisco prices with Los Angeles prices, and so on. That exercise would generally agree with our prior experience, and reveal the positive relationships between prices in each city and Los Angeles that we would expect, but it would tell us little about the actual marginal relationships. These marginal relationships are what we need to

successfully control for factors beyond the alleged conspiracy.

As an example, the figure below plots average weekly retail gasoline prices in 10 cities. It is apparent that the gasoline prices across these cities tend to move together. Correlations of each of the other 9 city prices with the price in Los Angeles range from 94.8 percent to 98.2 percent.<sup>4</sup>

In contrast, within a fuller specification that includes prices in all 9 remaining cities as factors accounting for price variation in

Los Angeles, 5 out of 9 of these city prices have negative estimated relationships with Los Angeles.<sup>5</sup>

As the example above illustrates, one reason why the signs of marginal relationships (as measured by regression analysis) may be at odds with our intuition is that these effects may tend to move together in everyday experience. Such behavior has been pejoratively labeled as "collinear." Models that include such factors--like the example above--are sometimes castigated in economic literature as "suffering" from "collinearity" or more redundantly "multicollinearity." In fact, unexpected signs on estimated effects are sometimes held up as a "warning sign" of collinearity.<sup>6</sup> This criticism is usually

## WHAT'S YOUR SIGN? -CONTINUED

without merit. Collinearity can, at most, only be considered a relevant concern when the variable of interest (e.g., the conspiracy effect) is collinear with other effects.

Evidence that prices in other cities are collinear is largely immaterial, because identifying the precise relationship between each city's price and the price in Los Angeles is not the objective.<sup>7</sup> Rather, the objective is measuring the effect of the alleged conspiracy. Other cities' prices function as controls and collinearity among controls is generally not an issue.<sup>8</sup>

One response to counterintuitive signs, and to collinearity more generally, is to discard some of the collinear effects, as being redundant. This is often accomplished through model selection techniques that attempt to prioritize these variables so that the modeler can get rid of those with the least explanatory power.<sup>9</sup> In the present example, one would try to discard one or more of the other cities' prices from the model.

Such exercises are unwarranted when the variable of interest (e.g., the conspiracy effect) is not one of the factors affected by the collinearity. Even a high correlation between the conspiracy variable and other model factors provides no motivation for discarding variables if the conspiracy effect is statistically significant. The expected consequence of including prices for locations that do not bring with them significant additional information is to lower the overall statistical significance of estimated effects.<sup>10</sup> The argument that a conspiracy effect is statistically significant because a model is "overfit" lacks statistical foundations.

While the hypothetical above used prices in cities across the country as controls, pricing models

more often employ lagged prices. For example, Los Angeles gasoline prices might be modeled as depending on gasoline prices in Los Angeles in the preceding weeks. Similar comments regarding the interpretation of the signs and magnitudes of these lagged prices apply in this context as well. Prices and lagged prices tend to move together, so any intuition regarding the "correct" sign of lagged effects should be considered tentative at best.

To illustrate, while correlations between Los Angeles gas prices in a given week and those in prior weeks range from 91.9 percent (at 4 weeks prior) to 99.1 percent (at 1 week prior), a model of Los Angeles gasoline prices on the preceding 4 weeks reveals a strong negative partial effect at two weeks.<sup>11</sup>

I should comment on one notable difference between models that rely on lagged prices as controls and models that rely on factors outside the reach of the alleged conspiracy. In the former case, the controls cannot be expected to be independent of the conspiracy. Even so, collinearity between the conspiracy effect and lagged price effects will be strongest when the conspiracy's impact on price itself is strongest, and hence, when it is most clearly identified. Thus, here too, the potential collinearity of lagged price controls should not cast dispersions on the statistical significance of the conspiracy effect.

In summary, counterintuitive signs on controls are often not an indication of model misspecification, but rather simply an indication that the marginal relationships the analysis is identifying are not readily apparent through casual observation. Relationships for factors that tend to move together (i.e., that are collinear) will tend to be more at odds with simple intuition. The defect is in our intuition, not in the model. Common movement (i.e., collinearity) among controls is not usually a problem, and raising it as an issue does not constitute a valid attack on a statistically significant conspiracy effect.

## WHAT'S YOUR SIGN? -CONTINUED

<sup>1</sup> See Choi, William and Mark Dwyer, "Is a 'Statistically Significant' Result Significant?" Inside Econ One, Spring 2004 for a discussion of precautions related to statistical significance.

<sup>2</sup> See for example, Wooldridge, Jeffrey M. Introductory Econometrics: A Modern Approach, South-Western, 2000, pp. 131-134, 735-736.

<sup>3</sup> In this example, as often in practice, the available explanatory variables are proxies for economic fundamentals. This proxy nature of many model controls further weakens our ability to assess their economic significance. For an introduction to proxy variables see Wooldridge, op. cit., pp. 284-291.

<sup>4</sup> These high, positive correlations imply positive relationships in the single-city, simple regressions described above. These coefficients range from 0.874 to 1.013, again indicating that on average, gasoline prices across the country tend to be positively related to Los Angeles prices.

<sup>5</sup> In this model, prices in control cities are from the prior week. The price in Los Angeles from the prior week is also a control. This example is intended to capture some of the most salient features of such a specification for illustrative purposes.

<sup>6</sup> See for example, Greene, William H., Econometric Analysis, 4th ed., Prentice Hall, 2000, p. 256.

<sup>7</sup> In the Los Angeles price conspiracy example above, collinearity would only be a problem if prices in other cities only happened to shift significantly in tandem with the onset and the end of the hypothetical conspiracy. This would call into question the presumption that these cities were untainted by the conspiracy.

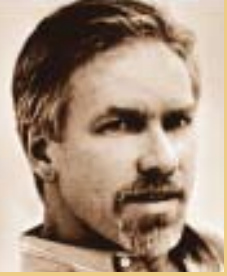
<sup>8</sup> See Wooldridge, op. cit., pp. 95-97.

<sup>9</sup> See for example Ramanathan, Ramu, Introductory Econometrics with Applications, 4th ed. Dryden, 1998, p. 238 as an advocate of such a process, or Greene, op. cit., pp. 341-342. For an introduction to model selection procedures, see Ramanathan op. cit., pp. 164-166.

<sup>10</sup> See, for example, Wooldridge, op. cit., p. 102, or Greene, op. cit. p. 338.

<sup>11</sup> As with the previous empirical example, this model aims to be illustrative rather than to represent a complete pricing specification.





*Trimble Navigation Limited v. RHS, Inc., CSI Wireless, Inc., and Satloc, Inc.*

The parties in this case are makers of agricultural GPS guidance products designed to aid in the accurate application of fertilizers, pesticides, and herbicides. Trimble sued for patent infringement, alleging that the defendants utilized technology for “adaptive curve” guidance (a method of providing guidance to farm equipment operators) that was owned by Trimble. Econ One was retained by defendants in this matter to analyze damages. Charles Mahla demonstrated that the plaintiff’s damage theory was based on a too broad interpretation of the patent at issue. Dr. Mahla’s analysis focused on the fact that Trimble’s patented technology was but one method of providing adaptive curve guidance and that the cost to defendants to redesign its products to perform that function in a non-infringing way was relatively low. After each side’s experts’ reports were filed and expert depositions were taken, the Court ruled in favor of defendants on summary judgment.

*Off-the-clock work allegations against major sporting goods retailer*

In this ongoing case, the plaintiffs (employees of a major sporting goods retailer) allege that they were not paid for all the time they worked due to improper automatic lunch deduction parameters programmed into the defendant’s time punch system. Econ One was retained to calculate the damages potentially due to the approximately 115,000 employees in the defendant’s stores located in 34 different states. This data intensive project, under the direction of Dwight Steward, required Econ One researchers to analyze the employees’ alleged damages under both the FLSA (Fair Labor Standards Act) and the applicable individual state statutes. At a recently concluded multi-day mediation, Stephanie Botello provided on-site consultation to the plaintiffs’ legal team.

*City of San Antonio et al versus Hotels.com et al*

This ongoing case involves alleged underpayment of hotel occupancy tax by some fifteen online travel companies in the State of Texas. The plaintiffs (a proposed class of 175 Texas cities including Austin, Dallas, Houston and San Antonio) allege that--contrary to the relevant tax statutes and ordinances--online travel companies have been remitting hotel occupancy tax to the plaintiffs based on the wholesale room price rather than the higher retail room price.

Econ One has been retained on behalf of the plaintiffs. Jeff Leitzinger has submitted two expert reports showing that damages can be calculated formulaically for the entire class. He has given deposition testimony as well as testimony at an evidentiary Class Certification hearing in San Antonio in May 2007.

*Meijer, Inc., et al. v. Warner Chilcott Holding Company III, LTD, et al.*

Plaintiffs are a class of direct purchasers of the brand name prescription drug Ovcon. They allege that defendants violated antitrust laws by improperly delaying the market entry of cheaper generic substitutes to Ovcon, an oral contraceptive. Econ One was retained by plaintiffs’ counsel to opine regarding class certification issues and the calculation of damages. Those issues include 1) the likely impact of a delay in generic competition on the class members, 2) the availability of economic methodologies and evidence--common to all class members--that will demonstrate impact in the form of overcharges, and 3) whether damages can be calculated on a class-wide, aggregate basis. Jeff Leitzinger has submitted two expert reports--one relating to class certification and the other relating to the calculation of damages. Dr. Leitzinger also has submitted a rebuttal report concerning his damages calculations.

## *Econ One in Brief -Continued*

### *Silvaco Data Systems v. Cypress Semiconductor Corp.*

The plaintiff is a maker of electronic design automation (EDA) software used to design integrated circuits (chips). The defendant is a manufacturer of chips used in a wide variety of devices, ranging from iPods to hotel door locks. In a previous matter filed by Silvaco, a court ruled that another EDA software company, CSI, had stolen Silvaco's software, incorporated the software into its own products, and had then sold those products to chip manufacturers such as Cypress. Cypress was given notice of the court's ruling and the settlement that gave Silvaco ownership of those CSI products. Such ownership meant that purchasers of CSI's products containing Silvaco's software had to obtain a license from Silvaco for continued use of those products. Silvaco alleges that Cypress has continued to use those CSI products without obtaining a license. Econ One was retained by counsel for Silvaco to evaluate Silvaco's actual loss and any unjust enrichment received by Cypress. Jeff Leitzinger recently provided deposition testimony and the case is scheduled for trial in 2008.

### *Columbus Drywall & Insulation, Inc., et al. v. Masco Corporation, et al.*

Plaintiffs are a class of residential insulation contractors who purchased fiberglass insulation direct from manufacturers. Plaintiffs alleged that these four manufacturers violated antitrust laws by entering into agreements amongst themselves and with Masco, a national consolidator of insulation contracting, to maintain an artificially elevated spread between the prices charged to Masco and the higher prices that they were charged. Econ One was retained by plaintiffs' counsel to opine regarding class-wide liability and other economic issues relating to liability. Jeff Leitzinger submitted expert reports and was deposed in this matter. The court subsequently gave preliminary approval to a settlement with the four

manufacturer defendants. Econ One has continued to advise plaintiffs' counsel, most recently in its response to expert reports filed on behalf of Masco, the sole remaining defendant.

### *Janet Skold and David Dossantos, et al. v. Intel Corporation and Hewlett-Packard Company*

In this case filed in California state court, plaintiffs are a nationwide class of consumers who purchased or leased a Pentium 4 microprocessor or a computer containing that microprocessor. Plaintiffs allege that defendants conspired to misrepresent various aspects of the performance of the Pentium 4 processor when it was introduced in late 2000. While the nature of the allegations involved technical aspects of computer hardware performance, a key issue in whether the class should be certified was whether it is possible to assess class-wide damages by comparing prices paid for the Pentium 4 with prices of other microprocessor/computers sold at the same time. Econ One was retained by counsel for plaintiffs to analyze class certification-related issues. Russell Lamb submitted an expert report in support of class certification which included economic models that showed it was possible to determine the extent by which prices of Pentium 4 prices were higher on a class-wide basis. Dr. Lamb also provided deposition testimony in this ongoing matter.

### *Merger review for the State of California*

Tesoro acquired Shell Oil's Los Angeles refinery (100,000 barrels per day) and 278 retail gasoline stations in Southern California for \$1.8 billion in the spring of 2007. Earlier in 2007, Tesoro also acquired USA Petroleum's 138 gasoline stations in California for \$273 million. These two acquisitions resulted in a large increase in Tesoro's refining capacity in California and also dramatically increased its presence in retail gasoline operation within the state. Econ One was retained by the California Attorney General to assist the State in its review of these acquisitions. Barry Pulliam and Tony Finizza analyzed potential competitive issues associated with these transactions.

By Daniel Flores, Economist, Econ One, Los Angeles, CA

## MARKET POWER: A TEXTBOOK EXAMPLE

It would happen several times each semester. I would be in my office at a liberal arts college in the Northeast, preparing a lesson or working on a research paper, when a jovial representative from one of the textbook publishers would show up at my door “just to say hello.” The representative appeared genuinely concerned that I was still using the textbook by Professors X and Y in my courses, when the new edition of Professor Y’s textbook--which happened to be published by his company--had a far superior treatment of this or that topic. If I needed any evaluation copies and ancillary materials, he’d be happy to send those to me.

I thought of these visits when reading recent reports that California legislators have introduced bills to try to reign in textbook prices. The price of a typical introductory economics textbook is now over \$100, and textbooks for advanced courses are even more expensive. Textbook prices have been increasing rapidly over the past few years, in an industry that is generally perceived to be very profitable.

Why are textbooks so expensive? Industry insiders often argue that textbooks are costly to produce--payments to authors, proofreaders, and other labor involved in creating the textbook quickly add up, not to speak of the cost of paper, ink, and other materials. However, come to think of it, these costs also go into the production of hardcovers and paperbacks, which retail at a fraction of the price of a textbook.

There is a crucial difference between books and textbooks.

Say a friend recommends two books to you equally--The Kite Runner and Middlesex. You go to your local bookstore and find that one of the books is selling for \$109 and the other for \$17.99. Chances are you will buy the cheaper one. Your choice, together with the choices of millions of other consumers across the U.S., will send a powerful signal to the publisher of the overpriced novel that it needs to lower its price or risk losing significant sales.

The example above illustrates what economists call “competitive market forces,” a central tenet of economic analysis. When numerous buyers have the choice to buy a product from numerous sellers, consumers will tend to buy from the cheaper sellers, and the more expensive sellers will either have to lower prices or be driven out of the market. The market will thus reach a competitive price.

Textbooks, though, are not similarly subject to these competitive market forces. Remember the jovial textbook representative at my office? He knew well that if he could convince me to adopt “his” textbook, the following semester scores of students would have to use it (hundreds if I had been teaching at a larger university). Currently, most introductory economics textbooks cover the same topics in similar ways,



## MARKET POWER: A TEXTBOOK EXAMPLE - CONTINUED

so arguably students would rather buy a cheaper textbook than a more expensive one. However, when I would say “tomorrow we’ll discuss section 10.2 of the textbook” students who had a different textbook would have to scramble to find which section in their textbook to look for. (Or they would come ask the professor after class. I suspect that’s why most syllabi state “required” instead of “suggested” textbook. Even decidedly pro-market professors tend to dislike spending their afternoons finding section equivalences between textbooks!)

Using economic terms, the dissociation of adoption choice (by the professor) and actual buying (by the students) of textbooks results in market power for textbook publishers. Alternative textbooks become very poor substitutes for the one the professor has chosen, so the students can no longer “vote with their wallets” in favor of cheaper textbooks. The demand

for textbooks becomes inelastic (i.e., unresponsive to changes in price). Interestingly, I don’t recall any of the representatives who used to visit me ever mentioning the retail price of their product. They would always focus on all the bells and whistles that the new edition of their textbook offered, but not on how it compared price-wise with its competitors.

The fact that textbook publishers may be enjoying high profits due to the way the market operates does not automatically raise antitrust concerns. However, the way in which publishers react to legitimate attempts to make the market more competitive may deserve better scrutiny. For example, it appears that publishers are releasing new editions of textbooks at shorter and shorter intervals. Are these new editions warranted by advances in the subject matter covered in the textbook, or are they simply a tool to prevent a competitor (i.e., the used textbook) from reaching price-sensitive students? Perhaps the California Legislature is onto something.

## ECON ONE ECONOMISTS TAKE OFFICES IN D.C.

(And no one had to kiss any babies) Econ One Washington, D.C. has moved to beautiful new permanent offices complete with a rooftop patio overlooking the National Mall. Drop by and let us shake your hand.

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## THE PREDOMINANCE REQUIREMENT FOR ANTITRUST CLASS ACTIONS

Jeff Leitzinger and Russell Lamb set out to find a solution to the lack of an evidentiary standard for evaluating the “predominance” issue that arises in the class certification phase in antitrust litigation. In order to do so they traced the roots of predominance and proof of antitrust injury, looked into how relevant markets serve as reliable indicators of injury, and demonstrated how relevant market analysis correctly reveals the absence of antitrust injury.

Their conclusion: We believe that relevant market analysis--along with its accepted analytical framework, modes of proof, and standards for evidence--may be the answer. In particular, there is compelling economic logic to suggest that

proof of the relevant market (combined with showing that the proposed class members were participants within that market) should

be sufficient to meet the predominance requirements as to proof of injury.

For the full article please go to [www.econone.com](http://www.econone.com)



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