GLOBAL CARTELS REDUX:

The Amino Acid Lysine Antitrust Litigation (1996)

John M. Connor[1]

---

[1] John M. Connor provided expert opinions for a law firm representing plaintiffs in the class action encaptioned as *Amino Acid Lysine Antitrust Litigation*, MDL No. 1083 (Northern District of Illinois 1996). He also wrote opinions as a consultant for the Antitrust Division of the U.S. Department of Justice during the sentencing phase of its criminal trial *U.S. v. Michael D. Andreas et al*., in which three officers of the Archer-Daniels-Midland Co. were prosecuted for lysine price fixing.

INTRODUCTION

In the evening of June 27, 1995, more than 70 FBI agents simultaneously raided the world

headquarters of Archer-Daniels-Midland Company (ADM) in Decatur, Illinois and interviewed a

number of ADM officers in their homes. Serving subpoenas authorized by a federal grand jury

sitting in Chicago, the agents collected documents related to ADM's lysine, citric acid, and corn-

sweeteners businesses. Within a day or two, investigators had also raided the offices of four

other companies that manufactured or imported lysine. These subpoenaed documents, together

with hundreds of secret tape recordings of the conspirators' meetings and conversations, built a

strong case that five companies had been illegally colluding on lysine prices around the world for

three years.

The FBI raids were widely reported in the mass media and unleashed a torrent of legal

actions, some of which were unresolved ten years later.[2] The antitrust actions were the result of

an undercover investigation by the U.S. Department of Justice (DOJ) that had begun in

November 1992 with the undercover cooperation of the ADM lysine-division president. Within

a year of the FBI raids, more than 40 civil antitrust suits were filed in federal district courts by

direct buyers of lysine. In early 1996, approximately 400 plaintiffs were certified as a single

federal class, and the case called *Amino Acid Lysine Antitrust Litigation* was assigned to a judge

of the U.S. District Court of Northern Illinois. Soon thereafter in April 1996, the three largest

defendants offered the federal class $45 million to settle the damages allegedly caused by their

price fixing. Final approval of the settlement occurred in July 1996.[3] Additional follow-up suits

---

[2] By the end of fiscal 1996 (June 30, 1996), ADM was a defendant in an antitrust suit or target of a government investigation in 79 cases, of which 21 related to lysine. In subsequent fiscal years, the number of active suits or investigations varied from 22 to 41 (ADM 2001). In 2002, ADM appealed its lysine-conspiracy fine levied by the European Commission, but the European Court of Justice ruled against ADM in 2006.

[3] The two other defendants settled for almost $5 million about a year later.

include about 15 actions filed by farmers, consumers and other indirect buyers of lysine in the courts of six states and two Canadian provinces.[4] The lysine cartelists incurred monetary penalties that would total $305 million, of which ADM paid $177 million. ADM was further distracted by derivative shareholders' suits charging mismanagement by the company's managers and board of directors.

A few months later, the DOJ sought and obtained guilty pleas for criminal price fixing by the five corporate lysine sellers. Although the corporate members of the cartel pleaded guilty and paid historic fines, not all of the executives who managed the conspiracy were willing to plead guilty. Therefore, the DOJ prosecuted four lysine executives in a highly publicized jury trial held in Chicago in the summer of 1998; three of the four were found guilty and heavily sentenced.[5] The five corporate conspirators were later investigated and fined by the antitrust authorities of Canada, Mexico, Brazil, and the European Union.[6]

The three federal lysine cases were important for at least four reasons. First, it was the U.S. Government's first completely successful conviction of a global cartel[7] in more than four decades.[8] Under the leadership of Attorney General Thurman Arnold, the DOJ had obtained convictions of scores of companies that had been members of international cartels that had operated between the two world wars (Wells 2002). These suits had been initiated in the late

---

[4] It is difficult to trace most settlements in indirect-purchaser suits, but I estimate that the payout was about $25 to 30 million. The Canadian private damages suit, one of the first such suits in Canada, covered both direct and indirect purchasers and settled for US$3.4 million.

[5] The transcript and exhibits of *U.S. v. Michael D. Andreas et al*. are a major source of primary information on the lysine cartel (Tr.); exhibits from this trial are labeled Tr. Ex. In late 1999, three top ADM officers were sentenced to long prison terms; Andreas got a 36-month sentence, the then maximum allowed by the Sherman Act (Kanne *et al*. 1999). One defendant, a managing director of Ajinomoto of Japan, remains a fugitive.

[6] Translated into U.S. dollars on the day the decisions were announced, the Canadian and EU fines were $11.5 and $110 million, respectively. Mexico does not reveal its fines. Brazil's fines were under appeal in 2007.

[7] Beginning in the late 1990s, the DOJ began for the first time to compile prosecutorial statistics on *international* cartels, which are defined as cartels with participants from two or more nations. I identify *global* cartels as international cartels that conspired across two or more continents (Connor 2007d, p.5).

[8] Although the Federal Trade Commission successfully prosecuted one international cartel (*Mylan Laboratories* 1998), nearly all naked cartel cases are handled by the DOJ because of the latter agency's unique authority to bring criminal cases.

1940s and had wrapped up by around 1950. During 1950-1995, the DOJ had attempted to prosecute only three international cartels. In all three cases, the DOJ failed to prevail at trial either because essential evidence located abroad could not be subpoenaed or because juries would not convict U.S. businessmen on the testimony of their foreign co-conspirators.[9] The criminal lysine convictions signaled to would-be price fixers that the DOJ could win convictions of international schemes at trial.

Second, the conviction of the lysine cartel was the first public manifestation of a sea-change in enforcement priorities by U.S. and overseas antitrust officials.[10] Prior to 1995, less than 1 percent of the price-fixing indictments by the DOJ involved at least one non-U.S.-based corporation or non-U.S. resident. By contrast, since 1998 more than half of all criminal price-fixing indictments have been brought against non U.S. conspirators (Connor 2007d, Figure 1.1). The investigation of the lysine cartel led directly to the discovery and successful prosecution of 30 multinational corporations that participated in global price fixing in the markets for lysine, citric acid, sodium gluconate, and ten bulk vitamins. Since 1996, nearly 200 international cartels have been uncovered and prosecuted by the DOJ, the Competition Policy Directorate of the European Commission (DG-COMP), and other antitrust authorities around the world (Connor and Helmers 2006). Cartel enforcement remains a high priority for the Antitrust Division of the DOJ, which is devoting about 30 percent of its resources to criminal price-fixing prosecution.[11]

---

[9] Prosecutions of the uranium cartel (1978) and industrial diamonds (1994) were hampered by the absence of witnesses and documents outside U.S. jurisdiction. The DOJ lost at trial when prosecuting one member of the thermal fax paper cartel in 1995. Finally, although the DOJ was victorious in a U.S.-Canada cartel that fixed the prices of plastic dinnerware (1996) that cartel was only tangentially international in scope. In contrast, the three ADM executives were sentenced to a collective total of 99 months in prison.

[10] Joshua (2006, p.16) argues that the European Commission had had its epiphany about the ubiquity and harmfulness of hard-core international cartels in the late 1980s.

[11] In Fiscal 2002, the Division planed on allocating 258 full-time equivalent positions (FTEs) to this activity (DOJ 2002). However, if one adds the resources of U.S. Attorney offices and the FBI, about 3000 FTEs were devoted by the U.S. Government to fighting cartels, at an annual cost of $440 million.

Third, the lysine-cartel case demonstrated the Government's intention to employ tough, "blue-collar" criminal investigative techniques to what had been formerly been treated as a gentle, "white-collar" misdemeanors. In the three-year investigation that preceded the FBI's 1995 raid, the DOJ showed that it was prepared to use all the tools of its profession that it habitually employs in gathering evidence against drug cartels and other forms of organized crime, including seeking the cooperation of foreign police organizations. During guilty-plea negotiations with targeted cartel conspirators, prosecutors have made deft use of a wide range of possible sanctions to instill cooperation, including threatening crippling fines, imposing significant prison sentences, and perpetually barring convicted felons from entering U.S. territory.

Finally, the lysine cases and those that followed soon thereafter showed that the sanctions for criminal price-fixing had escalated enormously. Congress raised the maximum corporate statutory fine for Sherman Act violations to $10 million in 1990 and to $100 in 2004. U.S. Sentencing Guidelines first promulgated in 1987 permit government fines up to 80% of a guilty company's affected sales or, alternatively, criminal penalties as high as "double the harm" caused by a cartel (Connor and Lande 2005). That is, corporations can be fined twice the monopoly overcharge generated by a cartel, an amount that often exceeds the statutory caps when percentage overcharges are high (Connor 2007d, pp.77-80). ADM, the leader of the lysine cartel, was fined $100 million for its role in two criminal price-fixing schemes – a record amount that was twice eclipsed in the late 1990s by leaders of highly injurious global cartels.[12] Since the

---

[12] ADM was the second firm to be fined above the $10-million statutory limit, but the first to be widely reported by the business press and popular media. In 1999 Hoffmann-La Roche paid $500 million for its participation in six global cartels for bulk vitamins.

lysine cartel was fined, worldwide antitrust penalties on international cartels have exceeded $25

billion (Connor and Helmers 2006).[13]

U.S. Government fines are mere paper cuts compared to the financial wounds that may be

inflicted by plaintiffs in civil actions. Direct buyers suing in federal courts, the principal focus of

this chapter, are entitled to seek treble damages. However, antitrust liability does not stop there.

More than 25 states allow their residents who are *indirect* purchasers to sue in state courts, most

of which permit treble damages. State attorneys general increasingly have banded together to

pursue antitrust claims in federal courts (*parens patriae* suits) to recover treble damages for their

state governments and for corporate and individual indirect buyers residing in their states.[14] Not

counting the losses associated with derivative shareholders' suits, legal fees, and reputational

effects, corporations accused of criminal price fixing now face maximum U.S. antitrust liabilities

that could range up to *seven times* the cartel's U.S. overcharges.[15] The fines and prison terms

meted out to cartel managers have also risen.[16]

The major role played by economic analysis in horizontal price-fixing cases is the

calculation of the *overcharge* on buyers in markets affected by a cartel.[17] The overcharge is the

value of purchases of a cartelized product actually made minus what the sales would have been

for the same volume of product absent the cartel. Accurate estimates of conspiracy-induced

overcharges are primarily of importance to determine recovery of civil damages, but also can be

---

[13] These are nominal U.S. dollars. Further details on global cartel sanctions are given in Connor (2004).

[14] In October 2000, the attorneys general of more than 40 states announced a settlement totaling $340 million to be paid by the six largest members of the vitamins cartels (Connor 2007d, p.409).

[15] This is a theoretical upper limit. In practice, cartels rarely incur penalties that exceed treble damages (Connor 2007a).

[16] The median individual fines are below $100,000 but a few have been high. The employer of one German CEO, the ringleader of the graphite-electrode cartel, paid a U.S. fine of $10 million to avoid a prison sentence of about 6 months. In 2002, the chairman art-auction house Sotheby's was fined $7.5 million for price fixing (Markon 2002).

[17] For a broad historical analysis of cartel overcharges, see Connor and Lande (2005).

the basis for the calculation of U.S. Government fines. In criminal price-fixing cases[18], the U.S. Sentencing Guidelines obligate federal prosecutors to seek corporate fines that are based on either a defendant's affected sales or its overcharges.[19] For individuals, base fines are either figured at 1% to 5% of the overcharge, or, under an alternative statute, fines up to $25 million are assessed from a sliding scale that also depends on the size of the overcharge. In summary, both corporate and personal penalties for price fixing are in principle closely related to cartel overcharges.

The primary purpose of this case study is to illustrate the computation of overcharges in a forensic setting with facts drawn from the lysine cartel of 1992-1995. Most of the issues regarding such calculations arose during preparations for the private federal class-action, *In re Amino Acid Lysine Antitrust Litigation* in the summer of 1996. However, as additional time and economic date became available, more refined estimates of the lysine-cartel overcharge became available for the sentencing phase of the criminal case, *U.S. v. Michael D. Andreas et al.* This study also illustrates the difficulties of corporate achieving monetary sanctions international criminal price fixing that are capable of optimally deterring cartel formation.

ECONOMICS AND LAW OF CARTELS

[18] By long-standing custom, the DOJ brings 90% or more of all horizontal price-fixing indictments as criminal matters, and only hard-core cartels as prosecuted criminally.

[19] The Guidelines were mandatory from 1987 to January 2005, at which time following the Supreme Court decision in *Brooker,* they became voluntary (Connor and Lande 2005). The Guidelines are complex in their details (see http://www.ussc.gov/guidelin.htm), but are intended to deter price fixing by imposing punitive penalties.
There are two approaches. If prosecutors believe that the overcharge is around 10% of affected sales, a base fine of 20% of sales is calculated, and the base fine is raised by a complex list of factors that yields a numerical culpability multiplier between 0.15 and 0.40. This method is intended to be a convenient proxy for an overcharge-based fine calculation. Alternatively, if prosecutors have evidence that the overcharge was significantly above 10% or want to impose a fine above the Sherman Act limit, then the maximum fine for criminal price fixing is double the cartel's overcharge. In practice, one of the two methods produces a proposed fine that becomes the staring point for DOJ-defendant plea bargaining; guilty-plea negotiations typically result in actual fines well below the starting point.
In rare publish versions of the details of an antitrust plea-bargaining episode, DOJ officials lowered the fine demanded of ADM in stages from as much as $400 (Lieber 2000:36) to $100 million (Eichenwald 2000:487, 507-511, 521-523). The number of ADM officers to be indicted also was reduced.

A hard-core cartel is an association of two or more legally independent businesses that explicitly agree to coordinate their prices or output for the purpose of increasing their collective profits. Some cartels are organized by state agencies or government-owned corporations; other cartels have been formed by multilateral treaties to attempt to smooth commodity price cycles. This chapter is concerned only with private business cartels that operate unprotected by the cloak of national sovereignty.

Economics views cartels as a special type of oligopoly, an extra-legal joint venture of businesses that are normally rivals in the same industry. The mission of a cartel is to increase the joint profits of its members to a level as close as possible to that of a monopolist would earn as possible; the strategy of a cartel is to implement one or more the "restrictive business practices" popularly known as price fixing. A key feature of private cartels is that the participants must forge a contract that is self-enforced. Cartels almost always explicitly contract to raise their list prices, to lower total production, or both; they may also reinforce this basic agreement by fixing market shares for each member, allocating specific customers, imposing uniform selling conditions, sharing sales information, monitoring price agreements, pooling and redistributing profits, adopting a method for punishing deviants, and hiding or destroying evidence. The time and management resources required to negotiate the formation of a cartel and to carry out the agreements can be substantial.

Economic models of cartels emphasize the necessity of high concentration and of product homogeneity in an industry (Stigler 1964, Dick 1998, Connor 2007d). Without small numbers of member-sellers and reasonably standardized products, the transactions costs of forming and maintaining a group consensus would become too high relative to the anticipated increase in profits. Moreover, because cartel agreements must be self-enforced and because there is always

a profit incentive for cartel members to cheat on the cartel's agreement (i.e., to sell more or at a lower price than that agreed upon), only small numbers and homogeneity will keep the information costs of detecting cheating within acceptable bounds. Other conditions that facilitate the formation and stability of cartels include large numbers of buyers, a small amount of noncartel production capacity, equality of production costs across firms, and relatively stable or predictable demand conditions. High barriers to entry into the industry will facilitate the formation and longevity of cartel agreements.

Section 1 of the 1890 Sherman Act deems cartels *per se* illegal. That is, an explicit agreement to fix prices is a "conspiracy in restraint of trade," irrespective of the agreement's actual impacts on market prices or output. Outside the United States, the competition laws of most industrialized nations judge the illegality of a cartel under the rule of reason.[20] In practice, however, non-U.S. competition-law agencies routinely prosecute all naked cartels that they discover. In the EU rare exceptions are made for cartels with significant benefits for consumers from technological innovation. Many countries, the United States included, permit registered cartels to coordinate exports.

Strict enforcement of laws against overt price fixing is a public policy widely supported by economists and legal scholars of all stripes. They may differ as to the causes giving rise to collusive behavior and as to the likelihood of long-term success, but they are unified in their evaluation of the negative economic effects of cartels. Effective cartels cause unrecoverable losses in production and consumption, transfer income from customers to the stakeholders of cartel members, and often engage in wasteful rent-seeking expenditures (Posner 2001, Ch. 1).

---

[20] Enforcement in Canada mimics the *per se* rule, and since the 1980s the EU has evolved toward and American-style, conspiracy-based theory of cartel enforcement (Joshua and Jordan 2004). Other cartel-like behavior, such as patent pooling or standards-setting, may be prosecuted as civil violations of the Sherman Act and be judged under the rule of reason.

INDUSTRY BACKGROUND

Lysine is an essential amino acid, a building block for proteins that speed the development of muscle tissue in humans and animals. Food derived from animal and marine sources normally provides humans with sufficient lysine to ensure healthy muscle development. Certain vegetables, soybeans in particular, are also good sources of amino acids; expensive pharmaceutical-grade or "natural" lysine is chemically extracted from vegetable matter.

In 1956, scientists in Japan discovered that amino acids can be produced as a byproduct of bacterial fermentation (Connor 1999). By 1960, two Japanese companies, Ajinomoto and Kyowa Hakko, were selling commercial quantities of lysine utilizing these new biotechnologies. From the beginning, lysine was produced by fermentation at a far lower cost than chemically extracted lysine; continuing improvements in production technologies have brought the cost of so-called synthetic lysine down to less than one-fifth that of pharmaceutical lysine. The lower prices of lysine in turn made it cost-effective to incorporate manufactured lysine into animal feeds. Today, well over 90% of the world's lysine supply is made by biotechnology and is used as a supplement in animal feeds, principally swine, poultry, and aquaculture.

Evolution of the Industry

At prices generally around $1 to $2 per pound, worldwide demand for lysine by animal-feed manufacturers soared from nothing in 1960 to almost 70 million pounds in 1980. In the 1980s, global consumption of lysine grew by 16% per year; in the 1990s, volume growth was still a heady 12% annually (Connor 2007d, Ch. 7). In the early 1990s, approximately two-thirds of the demand for lysine originated in North America and Western Europe, areas with the highest levels of meat consumption and with consumers most willing to pay for lean meats.

The Japanese duopoly initially satisfied global demand by exporting from its two domestic plants. Ajinomoto made the first move abroad by building a large plant in France in 1974. Kyowa Hakko opened its first overseas lysine plant in Mexico in 1980 and its second in Missouri in 1984. Ajinomoto, which had about twice the capacity of Kyowa Hakko, responded by opening its own U.S. lysine plant in Iowa in 1986. After they were up and running, the Japanese firms implemented significant capital expansions to their plants outside Japan every two or three years.

Lysine was a Japanese duopoly until 1980, when the South Korean conglomerate Sewon opened a new plant in its home country. Sewon never expanded through direct investment abroad, instead relentlessly expanding its sole plant and exporting most of its output to Asia and Europe. Sewon reached its goal of achieving a 20% world market share by the late 1990s, but at the cost of massive borrowing.

The lysine oligopoly colluded successfully at least three times prior to 1992 (Connor 2007d, pp.174-175). It fixed prices in Japan in the 1970s (Tr. 908-909) and 1980s (Tr. 1670-1894) and in Europe in the 1980s (Tr. 2197-2522). From 1986 to 1990, Ajinomoto and Kyowa Hakko fixed prices and divided the U.S. lysine market 55-45% (Tr. 1670-1894). The U.S. price of lysine at times reached just over $3 per pound in the late 1980s. In brief, when the lysine biotech industry consisted of two or three Asian producers, collusive behavior was more often the norm than uncooperative or classic competitive behavior.

Entry in the 1990s

Patents on high-yielding microbes and technological secrecy largely prevented new firms from enjoying the high growth and large profits being made in the lysine industry. Leading French

and German biotechnology firms attempted to form lysine joint ventures in the 1970s and 1980s, but were thwarted from doing so (Connor 2007d, pp.175-176). With two exceptions, only very small scale entry occurred in the 1990s (*ibid.*, pp. 180-182).

In early 1991, two newcomers turned the lysine industry into a five-firm oligopoly. ADM, according to a plan finalized in late 1989, opened the world's largest lysine-manufacturing plant at its headquarters in Decatur, Illinois in February 1991. Within 18 months, ADM's plant had expanded global production capacity by 25% above year-end 1990 levels, and by 1993 ADM's single plant accounted for one-third of global capacity (780 million pounds). ADM's strategic objective was to acquire a global market share equal to the industry leader, Ajinomoto. Ruthless price cutting by ADM and the sudden appearance of large excess capacity caused lysine prices to plunge 45% in the first 18 months of the Decatur plant's operation. Global oversupply was exacerbated by the simultaneous opening of a smaller plant in Indonesia controlled by the South Korean food firm Cheil Sugar Co. ADM's aggressive entry into the lysine industry was the precipitating event in the formation of a new lysine cartel in 1992.

Cartel Behavior 1992-1995[21]

Ajinomoto, Kyowa Hakko, and Sewon began meeting as early as April 1990 to try to forge a plan to cope with ADM's entry, but they were fatalistic about ADM's impending success. After ADM entered production, the Asian manufacturers repeatedly signaled their willingness to raise lysine prices, but ADM appeared to be steadfast in its drive toward sharing global dominance. By mid-1992, ADM had captured an impressive 80% of U.S. sales, and it was exporting more than half its production. Ajinomoto and Kyowa experienced large operating losses in late 1991

[21] Details may be found in Connor (2001d, Ch. 8) and Appendix A of Connor (2000). Many of these facts were corroborated by testimony or exhibits from the 1998 criminal trial (Tr.). For popular accounts of the cartel, see Eichenwald (2000) and Lieber (2000). The final legal decision is Kanne *et al*. (2000).

and early 1992. In June 1992, the U.S. transaction price bottomed out at $0.68 per pound, which

was $0.10 per pound below the long-run marginal cost of ADM (see discussion of costs below).

By early 1992, the Asian incumbents were considering asking ADM to join them in a

more cooperative arrangement. It must have seemed something of a godsend when in April 1992

the President of ADM's lysine division showed up in Tokyo with another more senior ADM

officer to propose the formation of a lysine "trade association."[22] Under the guise of establishing

such a trade group, Ajinomoto, Kyowa, and ADM officers met in Mexico City in June 1992.

This was the first of 25 multiparty price-fixing meetings among the five corporations that joined

the cartel; dozens of supplementary bilateral meetings by regional sales managers and hundreds

of telephone calls cemented agreements on prices in as many as 13 currencies. The price

agreements covered only dry feed-grade lysine.[23] In early 1993, a brief price war broke out

among the conspirators, mainly because of ADM's insistence that the participants had to agree to

global market shares. After a top-level meeting in October 1993 resolved the issue, the cartel

displayed a high level of harmony and consensus. Cheating was restrained in part by largely

accurate monthly reporting of each company's lysine sales volume to all the members of the

cartel.

The lysine cartel ended with the FBI raid on cartel offices in June 1995, almost exactly

three years after the first price-fixing meeting had occurred. During that time, the average U.S.

transaction price of lysine (manufacturers' delivered price) rose from $0.68 per pound when the

cartel began operating to a plateau of $0.98 (October-December 1992), fell again to $0.65 (May

1993), and rose quickly again to above $1.00 for most of the remainder of the conspiracy period

---

[22] A year or two later, the International Amino Acids Manufacturers' Association was formed and recognized as a "working party" of the Agriculture Directorate of the European Commission.
[23] In the U.S. market ADM sold a somewhat diluted aqueous version delivered in tanker trucks to nearby customers. On an active-ingredient basis, liquid lysine was less expensive but highly correlated in price movements to the powder form. Liquid lysine accounted for well under 5 percent of the U.S. market.

(Figure 1). Prices in the European Union closely tracked those in the United States, albeit at a level \$0.10 to \$0.25 higher.[24] Target prices were also higher than the U.S. target price in Latin America, Japan, Oceania, and most parts of Asia. However, for the rest of this chapter, only U.S. prices will be analyzed.

The Costs of Collusion

As mentioned above, there is considerable sentiment among some economists that the costs of forming and maintaining a collusive contract are so high that the incidence of cartels is low and their lives fleeting.[25] The history of the lysine cartel and related global cartels prosecuted in the late 1990s does not support this sanguine view.

Internal memoranda and extensive trial testimony by cartel participants confirm that the conspirators reasonably anticipated that the rewards from price fixing would far outweigh the costs of operating the cartel (Connor 2007d, Ch. 8). At a key meeting in late 1992, a top ADM official expressed the expectation that their recently concluded agreement would generate \$200 million in joint profits annually in a global market for lysine that generated from \$500 to \$700 million in annual sales. His prediction, from ADM's perspective, was spot on: ADM would earn just about \$200 million in profits from the cartel over three years with its one-third share of sales

---

[24] The correlation in prices is even higher when one compares the U.S. price in dollars to the EU price in Deutschmarks. That is, that U.S. \$/DM exchange rate, which is rather unpredictable, introduced more variability into the European price because the conspirators used the dollar to fix prices quarterly.

[25] An accessible treatment of the inherent instability of cartel agreements may be found in Posner (2001, pp. 60-69). Among the obstacles to agreement are an own-price elasticity of demand that is too high at the competitive price, uneven costs of production among potential cartel members, product heterogeneity, a steeply rising marginal cost curve, a large fringe of suppliers that will not join the cartel, lower costs of production by the fringe producers, and the difficulty of apportioning reductions in output among the cartelists. After the cartel is formed each member has an incentive to cheat by either cutting price or offering an improved product; cheating is difficult to detect; and virtually the only way to punish deviants is through expensive, self-destructive trigger mechanisms such as price wars.

in the worldwide lysine market. Direct operating costs of the cartel were modest.[26] During the four years of preliminary negotiations and actual cartel operation, each of the four (later five) companies sent two men to meetings held on average once every three months. Late in the conspiracy, regional sales managers became involved, but the total number of conspirators never exceeded 40 (Connor 2000, App. A). Counting the monthly production reports submitted by each firm and other communications, it appears that each corporate member of the cartel managed the conspiracy with an input of 15 to 25 man-days per year. Total labor costs for all corporate conspirators could not have exceeded $1 million for the entire conspiracy period.

It is certainly true that the cartel members squabbled frequently and that the two smallest members, both South Korean companies, were strongly inclined to cheat on the price and market-share agreements. Infighting led to one sharp price war for a few months in early 1993. However, a number of techniques adopted by the cartel and the impressive diplomatic skills of the cartel's dual leaders, ADM and Ajinomoto, kept the effects of cheating to tolerable levels.

Among the most important practices that cemented cartel harmony was the tonnage quotas agreed upon in late 1993. Combined with accurate monthly sales reports and politic concessions of additional quotas to the two Korean firms, the market-share agreements would be honored with impressive precision throughout 1994 and 1995. The formation of an amino acid trade association under European Commission sponsorship provided excellent cover for the group's illegal meetings in Europe and elsewhere. A compensation system was adopted to punish members that exceeded their quotas, but it was never necessary to implement the scheme.

---

[26] Neither is there any reference to cartel coordination of cost-saving production technologies or capital investments. What is known is that ADM's president was involved in illegal industrial espionage that stole lysine-production secrets from employee's of Ajinomoto's plant in Iowa (Connor 2007d, pp.212-213). Indeed, the technological leader in fermentation techniques, Ajinomoto, would later sue ADM for patent infringement concerning a genetically modified microbe that yielded more lysine per unit of dextrose. Moreover, the pell-mell expansions of Sewon's and Chiel's plants were a constant source of friction at cartel meetings (*ibid.,* p. 214). Nearly all empirical investigations of modern private cartels fail to find evidence of static cost efficiencies due to cartel coordination (Audretsch 1989).

ADM, with its new efficient plant and ample excess capacity, frequently reminded the cartel of its willingness to flood the market with lysine; its threats were credible because it had twice driven the world price of lysine to below its own average total cost of production, inflicting the others with operating losses. Moreover, ADM had taken the rare step of inviting its rivals in the lysine market to an intimate tour of its capacious production facilities. Finally, it should be recalled that the three largest Asian companies in the 1992-1995 cartel had had a great deal of experience in organizing price-fixing schemes for two decades. ADM too is a serial price fixer.[27]

MEASURING THE OVERCHARGE

The monopoly overcharge is the difference between what a buyer has paid for a cartelized product and what a buyer would have paid absent the cartel. Under the U.S. antitrust laws, a successful plaintiff is entitled to treble the dollar overcharge, which is then multiplied by the number of units purchased.[28] Two features of estimating cartel damages help simplify the analytical task. First, the market-definition problem so critical in monopolization and merger cases, is usually not an issue. For effective hard-core conspiracies, cartelists self-define the appropriate product and geographic market.[29] Second, the time period for *intended* cartel price effects is usually an admitted fact. Actual market price changes often will lag by several weeks the starting date and by several months the ending date. It is possible that the cartelists achieved

---

[27] Besides lysine, since 1990 ADM was penalized for conspiring to fix prices in eight other markets: carbon dioxide gas, sodium gluconate, citric acid, high fructose corn sweeteners, corn dextrose, corn glucose, monosodium gluconate, and other nucleotides (see Connor and Helmers 2006).

[28] Equivalently, one may compute the *percentage* increase in price for each time period during the conspiracy, and then multiply these percentages by the *value* purchased in each period.

[29] Under U.S. law prior criminal convictions are *prima facie* evidence for follow-on civil damages cases. An anonymous referee rightly pointed out that market definition could become a forensic issue if the alleged agreement must be proven from circumstantial rather than direct evidence. Market definition will also require analysis if the alleged cartel conduct was a facilitating practice rather than an overt agreement on price or output.

no pricing power in the market. However, in most cases the collusive period is treated as parametric information.[30]

Information on actual transaction prices and quantities sold is usually readily available from the parties in such cases, but the unobserved "but-for" price must be inferred using economic reasoning.[31] Enter the economists.

Methods of Calculation

There are five generally recognized methods of calculating an overcharge (Page 1996, Hovenkamp 1998). Proving an antitrust injury in U.S. courts depends on the preponderance of the evidence in the case, but the *amount* of damages is decided according to a lower standard, that of reasonableness. As I understand the term, reasonableness requires a "formula" (a precise method of calculation) that can be applied to data likely to be available to the analyst. Each of the five methods of computation below will meet the legal standard of reasonableness, and forensic economists often will examine more than one method to see if they are mutually supporting.

Three methods were applied to calculate the lysine cartel's overcharge in the U.S. market. One of them, the before-and-after method, was employed by economists acting as experts for the two sides in the civil treble-damages suit. Opinions and rebuttals were exchanged during May-July 1996 prior to a fairness hearing for the federal class of plaintiffs and after the defendants

---

[30] In the lysine case, the length of the time period of the affected period was an issue that divided experts for the two sides (Connor 2001). It is usually uncontroversial to use the conspiracy period for the affected sales period, but in the lysine case the defendants had not yet agreed to plead guilty. Consequently, the opt-out plaintiffs had to depend on press reports to define the affected period. Plaintiffs chose August 1992-December 1995 to be the affected sales period. In fact court testimony would later reveal that the lysine cartel had two episodes divided by a brief price war in the spring of 1993. Defendants' experts decided that only the second episode was effectively cartelized. (White 2001) refers to an "unusual and suspicious" pattern of "uncharacteristic stability" in lysine transaction prices from September or October 1993 to February or March 1995 (see Figure 1).

[31] Single damages under the law in most court circuits are precisely equivalent to the income transfer due to the exercise of market power. Single damages are slightly higher than the stream of monopoly profits accruing to the cartel members, because operating the cartel requires the expenditure of some management resources. In some circuits, the dead-weight loss may be permitted as an additional source of damages (Page 1996). Some legal theorists argue that a buyer's lost profits is a conceptually superior measure of damages (Hovenkamp 1998, p. 658).

provided their average monthly prices for 1991-1995. Two other methods of analysis, one using costs of production and the other a time-series econometric market model, were carried out in 1999 with the benefit of data from exhibits filed in the Chicago criminal trial.

The Before-and-After Method

This method has been used to calculate antitrust damages in U.S. civil cases since at least the 1920s (Hovenkamp 1998, p. 661). "Before-and-after" is something of a misnomer because the "before" period is really any nonconspiracy period -- whether before, after, or during an intermediate pause in price-fixing. It is important that the "before" period be one that is quite comparable to the conspiracy period with respect to demand and supply conditions. Shifts in buyer preferences, appearance or the disappearance of substitutes, or changes in the cost of production of the cartelized product during the affected period can cause overstatement or understatement of the overcharge.

Choosing the months to employ for the before price requires judgment. If real prices were fairly constant for one to three years before a cartel began, then averages of these one, two or three years' prices might serve well as benchmarks. One problem often encountered is that cartel formation frequently occurs after a recessionary period in the industry; if so, then the benchmark price might be understated and the damages overstated. Similarly, a predatory episode prior to cartel formation could result in an overestimate the overcharge, as happened in lysine. On the other hand, older pre-cartel prices could have been generated by a previous cartel episode unknown to plaintiffs. This seems to have been the case in the vitamins cartels in 1985-1989 (Bernheim 2002, Figure 8-2).

Similarly, post-cartel prices can yield equally problematic benchmarks. Ideally, conduct may be a reversion to noncooperative equilibrium. However, defendants may pursue a strategy of unsustainably low pricing to mollify their angry customers. Alternatively, the cartel experience may allow its participants to form more stable conjectures than were possible before the cartel existed, in which case even uncooperative conduct inflates post-cartel prices because a sort of carry-over effect of cartel behavior. Harrington (2004) developed a model in which former cartelists keep prices high in order to reduce their liabilities in follow-on civil suits.

This method lends itself to simple graphical treatments. Most commonly, the analyst fits either a straight line from the before price forward in time until the end of the cartel or a line backward from the after price to the beginning of collusion. A slightly more sophisticated approach is to draw a straight line from the before price to the after price. If it has an upward slope costs probably increased and vice-versa.[32] Bernheim (2002, Figure 12-1) illustrates this approach from a damages analysis prepared for the U.S. vitamin E cartel suit. Plaintiffs alleged that most of the vitamins cartels had organized cartels in 1985-1989, an allegation that complicated the calculation of damages. Bernheim (2002) judged that there was a brief period of pricing in late 1999 that would serve as a relatively noncooperative benchmark; also, he decided that collusive carry-over effects on prices dissipated after about 12 months.

In April 1996 ADM, Ajinomoto, and Kyowa offered the federal class of lysine direct purchasers (about 400 companies) $45 million to settle the suit. This offer came at a time when the DOJ's criminal investigation appeared stalled. Indeed, a rather unusual feature of the civil suit is that the settlement offer was made *four months before* the government obtained the first of its guilty pleas. In the majority of criminal cartel cases, treble-damages suits are follow-on

---

[32] If this line has a slope, this may be a rough way of accounting for changing costs, technological progress, or a secular shift in demand during the affected period.

actions that are settled out of court or go to trial well after guilty pleas are made in a government case, pleas that are by law *prima facie* evidence in following civil actions (Lande and Davis 2006). Moreover, civil plaintiffs can benefit from facts admitted in the pleas (e.g., conspiracy dates). In this case, through discovery plaintiffs were provided with two slim bits of information: average U.S. monthly selling prices of lysine for the years 1990-1995 and annual sales of the four largest sellers (Cheil Sugar did not participate in discovery). From public sources the only other potentially useful data were list prices of lysine, international trade in lysine (value and volume), and U.S. prices for corn and soybeans. Changes in corn prices drove most of the variability in the cost of manufacturing dextrose, the principal feedstock and largest input for making lysine.[33]

The decision faced by the judge in July 1996 was whether the $45-million proposed settlement was fair and reasonable (Connor 2007d, pp. 394-399). The proposed settlement had been hammered out behind the scenes in about three months by the lead class counsel and the law firms representing the lysine makers.[34] Many of the larger lysine plaintiffs were dismayed at the small size of the award and what they perceived to be unassertive legal representation. They had to weigh two options: (1) stay in the class and take a riskless 3 cents on the dollar or (2) opt out of the class and face the uncertainty of either a higher settlement or nothing at all. Naturally, it was in the interests of the potential opt-outs to persuade the judge to reject the proposed settlement.

---

[33] Dextrose was the foundation for fermentation in Ajinomoto's and ADM's U.S. plants; Kyowa Hakko's Missouri plant used sucrose. Dextrose accounted for 38% of variable costs of manufacturing lysine in ADM's plant and 32% of total manufacturing costs (Connor 2007d, p.229).

[34] In the interests of expediency, the judge had awarded the role of lead class counsel on the basis of a fixed-fee auction that provided the class counsel with ". . . little incentive to maximize the recovery for the class" (Coffee 1998, p. B6). The fee was capped at $3.5 million for any settlements above $25 million. The firm hired no economists to analyze the overcharge issue. The legal fees, at 7% of the settlement, were very low by historical standards; normally fees are 20 to 30% of recovery in class actions for price fixing.

The main issues with respect to calculating the overcharge were the length of the time period of the affected period and the but-for price. It is conventional to use the conspiracy period for the affected sales period, but recall that the defendants had not yet agreed to plead guilty. Consequently, the opt-out plaintiffs had to depend on press reports that the conspirators had first met in June 1992 and had continued colluding until the FBI raid in June 1995. Because there appeared to be lags between the time the cartel set a list price and the time the transaction price fully responded, August 1992-December 1995 was chosen to be the affected sales period.[35]

The hypothetical nonconspiracy benchmark price was the most contentious judgement that had to be made. Given the paucity of price observations (only 71 months), three periods seemed to be the leading candidates: (1) average prices prior to August 1992; (2) a nadir in prices in mid-1993 caused by a disciplinary price war; and (3) prices after June 1995. Ideally, but-for prices should be long-run equilibrium prices, averaged over fairly long periods of perhaps one to three years. However, prices from the February 1991-July 1992 period were affected by an earlier lysine cartel as well as ADM's massive entry. Not only was market structure shifting, but also costs were changing because of ADM's learning-by-doing. ADM's new plant suffered a number of contamination incidents during its first year, but very few thereafter. That is, most of the early pre-cartel period appeared to be in disequilibrium.

Like the summer of 1992, the summer of 1993 also seemed to be a return to a regime that exhibited highly competitive pricing conduct; journalistic sources, later confirmed by memoranda of the cartel's meetings around this time, reveal that bickering among cartel members resulted in a return to aggressive pricing behavior (Connor 2007d, pp. 213-216). When

---

[35] Lags were created by 30- to 45-day price protection clauses in most sales contracts, by delivery chains (particularly overseas deliveries), and information lags. In fact, the observed lags were mostly between 2 to 4 months except for minimal spot sales. The lags appeared to be asymmetric: longer when prices were declining and shorter when responding to upward changes in list prices by the sellers.

they later became available, ADM's production records would show a surge in output in early

1993 that probably triggered the crash in lysine prices (Tr. Ex. 60-67). In consideration of these

factors, the opt-out plaintiffs chose May-June 1992 and April-July 1993 as the but-for periods.

Perhaps accidentally, prices averaged $0.70 per pound in both periods.

However, the third candidate period did not appear to be useful for competitive

benchmarking. First, only six data points (months) were available for the post-cartel period, and

the effects of cartel behavior might well lag for several months after the cartel was exposed.

Second, the shadow price of lysine had forced the cartel to drop its prices in early 1995, but then,

just after the FBI raid, it climbed precipitously for the rest of 1995.[36] One might hazard that the

former cartel members had learned how to tacitly collude by following movements in the shadow

price, because other demand and supply factors did not seem to explain the late-1995 rise in

prices.

ADM's main line of defense was to criticize the simple before-and-after analysis (White

1996, 2001). The major flaws in the plaintiffs' method were alleged to be: (1) the benchmark

price would have been generated by noncooperative oligopolistic behavior rather than purely

competitive conduct; (2) the price increases observed after the summers of 1992 and 1993 could

have been seasonal rather than conspiratorial; and (3) the affected period chosen by the

plaintiffs' expert was too long. As a matter of legal strategy, it is worth noting that because the

lysine defendants had not yet admitted guilt, their experts would not be expected to present

alternative overcharge estimates to the judge. Thus, trying to demonstrate weaknesses in the

---

[36] The shadow price of lysine was governed by a technical rule-of-thumb followed by the animal-feed industry.
Three pounds of lysine and 97 pounds of corn were nutritionally equivalent to 100 pounds of soybean meal. Thus,
when the price of the complementary corn rose and the price of the substitute, soymeal, fell far enough, feed
manufacturers could stop buying manufactured lysine (Connor 2007d, pp.199-201).

plaintiffs' case was virtually the only option available to obtain a fairness ruling favorable to the defendants.

All three of these criticisms are logical possibilities. All of the economists working on the case agreed that the U.S. (and indeed global) lysine industry was a classic oligopoly. Sales concentration was high (Herfindahl index above 3,000), buyer concentration was low, the product is perfectly homogenous, and several barriers to entry were present. "In sum, the lysine industry had virtually all the characteristics of an industry in which *implicit* oligopolistic coordination of some kind would likely have arisen in the absence of the *explicit* conspiracy" (White 2001, p. 28). If true, the but-for equilibrium price would, according to most oligopoly theories, be above the competitive price, and the overcharge significantly lower.

However, a few features of lysine industry may have prevented the sellers from forming an oligopolistic consensus. Chief among them is the fact that two of the five sellers (ADM and Cheil) were brand new to the industry; in other words, the major players did not have a sufficiently long history of strategic interaction to form *conjectures* likely to yield a stable implicit agreement. Prior to its entry into the lysine industry, ADM had no overlapping markets with any of the three incumbents (Connor 2000, app. E). Moreover, we now know that the principal form of oligopolistic conduct among the incumbents prior to the 1992-1995 cartel was explicit price fixing. Finally, internal contemporaneous documents show that ADM fully intended to put at least one of the incumbents out of business in order to achieve its announced goal of market-share parity with Ajinomoto (Connor 2007d, Ch. 8). Predatory conduct by ADM, most likely to be effective in the U.S. market, could have driven the but-for price down to and even below the long run competitive price in 1992 and 1993. Had the Asian manufacturers not

agreed to join an ADM-dominated cartel, ADM might well have continued predatory pricing well beyond June 1992.

Seasonality of demand for lysine was well recognized by the managers of the cartel (Connor 2007d, pp.201-202). It arises from swine feeding practices of producers in the temperate zones. With less than six full years of price data for lysine and no price series for comparable feed ingredients, it is difficult to be precise about how strong seasonal effects are.[37] Taking the simple average of prices at the seasonal peak to prices at the seasonal trough (about 14 percent) would cause the calculated overcharge to decline by 10% from an estimate that ignores seasonality.

In most forensic settings, the affected period and conspiracy period are treated as identical. Both sides acknowledged that changes in transaction prices lagged changes in posted prices, the latter being the conspirators' direct price-fixing tool. In a retrospective evaluation of the cartel, a defendant's expert contends that a 17-to-19-month period is the appropriate affected period (White 2001). He bases his position on the "unusual and suspicious" pattern of "uncharacteristic stability" in transaction prices from September or October 1993 to February or March 1995 (see Figure 1). The plaintiff's expert, on the other hand, maintains that information revealed by the Chicago trial provides additional support for a 42-month affected period (Connor 2001b). Without the luxury of additional time for more formal analyses it is not possible to determine the affected period definitively.[38]

---

[37] Seasonal effects are symmetric. The autumn run-up in lysine prices was followed by a spring decline, except in 1994 when the cartel was at its most effective. Because most lysine was consumed by farms in the Northern Hemisphere, peak demand in December-March was only slightly negated by the winters in the Southern Hemisphere. There were no evident seasonal effects from late 2003 to late 2005.

[38] White's after-the-fact speculations do offer an insight into why the defendants offered a settlement consistent with a $15-million overcharge. Taking the 19-month affected period and the average prices for one year prior to September 1993 ($1.10 per pound) results in almost exactly a $15-million overcharge (Connor 2001d, p.269). Again recall that the defendants' legal strategy discouraged them from presenting even minimal overcharge calculations because that would have been tantamount to an admission of guilt.

The Cost-Based Approach[39]

This method and econometric modeling (discussed below) were not available to the economic

experts doing battle in the 1996 federal civil proceeding, but they do shed light on the accuracy

of the before-and-after method. The disparity between the two sides was an order of magnitude.

Plaintiffs considering opting out of the federal class had a $150-million overcharge calculation

before them, whereas the defendants' settlement offer of $45 million implicitly supposed a $15-

million overcharge by the lysine cartel.

During the 1998 criminal trial of three ADM executives for lysine price fixing,

prosecutors introduced the confidential production and sales records of ADM's lysine

department as exhibits (Tr. Ex. 60-67). These internal records (now public documents) provided

ADM managers with monthly plant output and several costs (labor, energy, dextrose, other

chemicals, overhead expenses, transportation, storage, and sales-office expenses) during the five

years 1991-1995. Figure 2 plots these costs of manufacturing and distribution against monthly

physical plant output using regression analysis.

The plot appears to show considerable "scale economies" for levels of output up to 10 or

11 million pounds per month. In fact, the diagram really captures strong learning-by-doing

effects, because all of the observations below 11 million pounds are drawn from the pre-cartel

period (February 1991-June 1992). Abundant testimony and the manufacturing records

themselves support the fact that nearly all of the high-cost months were ones with "yield

---

[39] The constant-margin method is a variant on the cost-based approach to calculating the monopoly gain that derives a but-for price by equating the competitive price to total variable costs plus a constant percentage mark-up. The mark-up is assumed to be the same during the cartel period as it was before or after.

failures" due to contamination of fermentors.[40] As ADM learned how to sanitize its plant's

fermentation reactors, contamination episodes ceased and the costs of spoiled-product disposals

disappeared.

The most important feature of the average-total-cost curve shown in Figure 2 is the

portion *above* 10 or 11 million pounds per month. During the conspiracy, plant output always

exceeded 10 million pounds. Statistically, this portion is completely flat. It is true that

manufacturing costs were affected by short run changes in the price of dextrose, which in turn

was closely related to the market price of corn. Nevertheless, total manufacturing costs hewed

quite closely to the average of $0.63 per pound whenever production exceeded 10 million

pounds. As plant output edged closer to the maximum 18-million-pounds level, unit fixed costs

dropped a bit. However, the decline in unit fixed costs was nearly perfectly balanced by higher

selling costs incurred as ADM shipped higher shares of its U.S. production to overseas

destinations. Thus, after June 1992 (the likely cartel period), average total accounting costs of

manufacturing and sales varied only within the $0.73 to $0.78 per pound range and were

statistically unrelated to the quantity produced. Adding a fairly generous return on investment of

6% of sales brings the average total *economic* costs to $0.77 to $0.83 per pound of lysine.[41]

Whether in competitive or monopolistic industries, profit-maximizing firms equate their

marginal revenues to their marginal costs. Normally, marginal costs are unobservable, but

because ADM's total costs were effectively constant during the cartel period, then average

variable costs are equal to marginal costs. It follows that the but-for competitive price would

[40]In every case when costs jumped above about $0.80 per pound, the lysine/dextrose yield ratio dropped below 30%.
Such episodes became rare after June 1992 or when monthly production was above 10 or 11 million pounds.
[41] This is generous because it is ADM's own rate of return during fiscal 1990-1995 when its profits were bloated by
several commodity cartels (Connor 2000: Appendix A). It is also well above the average return earned by publicly
traded companies in similar industries.

have been just about $0.80 during the affected period. This observation is reinforced by the fact that ADM's costs of production were equal to or lower than all four of its rivals in the lysine industry (Connor 2001: 217). The full-cost price of $0.80 seems like a defensible but-for price.

Econometric Modeling

With sufficient time and access to detailed price and cost information, statistical modeling is often the preferred analytical approach of forensic economists in estimating antitrust damages (see, e.g., Slottje 1999). When all the necessary data have been received from defendants during discovery and cross-checked for accuracy and completeness, the econometric analysis itself could take as little as six months or up to a year or more.

With a rigorous model that is shown to fit the market's actual performance over time, the legal goal of isolating the effects of a defendants' illegal conduct from all other market forces would appear to be achievable. Econometrics seems ideally suited to identifying ". . . the only casual factor accounting for the difference between plaintiff's actual experience in the damage period and its but-for period. . ." (Page 1996, p. 36). Law journals and handbooks for lawyers in the antitrust field frequently include material on regression analysis for damages calculations (e.g., Fisher 1980, Page 1996, and Hovenkamp 1999). Baker and Rubinfeld (1999) and Brander and Ross (2006) provide nice surveys of the method.

Econometric estimation employs reduced-form equations using multiple regression methods.[42] The structural model assumes that both the quantity demanded and the quantity supplied are dependent simultaneously on the market price. One of two econometric approaches

---

[42] NEIO methods could be used to measure price effects from a simultaneous equation system built upon Cournot or Bertrand pricing assumptions. The greatest advantage is the fact that data only from the cartel period would suffice. The main disadvantages are that it is more time-consuming, relies on accounting costs supplied by the defendants, is more difficult to explain to lay audiences, and is quite demanding with respect to data on market structure. Such models are unusual in forensic settings.

regresses market price on observations from collusive and noncollusive periods. The right-hand side of the equation contains variables representing variable input costs (wages, materials, energy, inventories, and possibly exchange rates[43]) and variables that will capture sources of demand (customer incomes, buyer output levels, seasonal dummies, and prices of substitutes). The key variable is a dummy variable taking a value of one for each period during which the cartel is assumed to have effectively raised prices. If the model has a good fit, even if the coefficient of the time dummy is not highly statistically significant, the coefficient is the unit mark-up overcharge. Such models are in essence elaborations of the before-and-after method, but they are better able to handle exogenous shifts in demand and supply.

If the analyst believes that price fixing may have influenced costs of production, then the dummy variable for time will underestimate the price effect of collusion. In this case the appropriate approach is to fit a reduced-form regression to only the pre-cartel period. The regression coefficients on all the independent variables are then used to *forecast* the but-for price during the cartel period. In this approach, all the demand and supply variables can vary during the cartel period. Alternatively, if insufficient numbers of observations are available in the pre-cartel era, one can fit a model to post-cartel data and *backcast*. Froeb *et al* (1993) illustrate this method for a U.S. bid-rigging scheme in frozen fish.

Morse and Hyde (2000) developed and tested an econometric model of the lysine industry using 1990-1995 monthly information. The model incorporates a fairly complete list of determinants of lysine demand: the number of hogs needed by U.S. slaughter houses, red meat and poultry export demand, the price of a complement and a substitute (the shadow price

---

[43] Bernheim (2002) makes the interesting point that overcharge estimation in the U.S. bulk vitamins market need not adjust for exchange rates even though imports account for the majority of supply. He asserts that the raw materials used to produce vitamins, many of them petroleum derivatives, are denominated in U.S. dollars.

discussed above), and seasonality of lysine demand. On the supply side, an equation related

ADM's U.S. production to the cost of three principal inputs: dextrose, other variable costs of

manufacture, and capital. Both of these equations fitted the five years of data quite well, and the

signs were the ones predicted by economic reasoning. An equation permited them to measure

the degree of competitiveness ("conjectural variations") between ADM and its four rivals.

Econometric modeling has become the world standard for proving cartel damages. Yet,

econometric estimation has some disadvantages compared to the other methods mentioned. It is

data-hungry; dozens of demand or cost variable may have to be collected, and less than 40 or 50

non-cartel observation periods may produce statistically fragile estimates. The mathematical

form of the equation is not specified by theory. The specification of independent variables and

the corrections of econometric flaws may become issues too abstruse for the fact-finders to

comprehend. Biased estimates may result if post-cartel pricing conduct does not return to pre-

cartel conduct. Best from a rhetorical stance is to apply statistical methods but supplement with

other approaches and hope that they are mutually consistent.

The Yardstick Method

The *yardstick* approach involves the identification of a market similar to the one in which prices

were fixed but where prices were unaffected by the conspiracy. A yardstick market should have

cost structures and demand characteristics highly comparable to the cartelized market, yet lie

outside the orbit of the cartel's influence. Typically, the yardstick method is most useful when

applied to cases of geographically localized price fixing or bid rigging. Markets with nonstorable

products, with high transportation costs relative to price, and for localized services are good

candidates for the yardstick method. The yardstick method has been used in markets for bread

(Mueller and Parker 1992), fluid milk (Porter and Zona 1999), and construction services. With global cartels like lysine and vitamins, the geographic yardstick method could not be applied.

In principle, yardsticks can be sought for analogous *product forms* sold in the same geographic market as the cartelized product. One might search for a good that is made using a similar major input, similar technology of production, and sold to customers with similar demand characteristics as the cartelized good.[44] There is, however, a logical problem with product-form yardsticks in cartel cases. Cartels can only work if they sell a well-defined product, and such products by definition have no close substitutes. A good product yardstick is likely to be a close substitute for the cartelized product over a wide range in observed prices.[45] Thus, it appears to be a nearly hopeless task to find a good product-form yardstick that has a price unaffected by the alleged conspiracy.

There are reasons to be skeptical about estimating overcharges from the yardstick method. Connor and Bolotova (2006, p. 1134) found that such estimates were systematically overstated. Choosing an analogous market requires judgment that is best informed by a deep study of the market and cartel practices. It is best justified by examining price movements in the affected market and the analogous market before and after the cartel period. If monthly prices for two or three years are highly correlated, then the analyst has some assurance that the analogous market was a proper choice. The overcharge is then calculated by the differences in prices between the affected market and the yardstick market.

---

[44] For lysine, methionine was the leading candidate. It is an amino acid demanded by feed manufacturers and made by fermentation. However, the EU determined that a secret, widespread methionine cartel had operated nearly simultaneously with the lysine cartel. Had methionine price movements been used as a but-for price, the lysine overcharge would have been seriously miscalculated.

[45] Of course, the Cellophane Fallacy demonstrates that above a certain price, any cartelized product will run into product substitutes. In the fermented-lysine cartel, the cartel's managers were well aware that when the price of soybean meal was low enough, its natural lysine content would become price-competitive with the fermented version.

Using Game Theory to Check Results

The defendants in the lysine cartel provided a rebuttal to the plaintiffs' before-and-after analysis. They asserted that a noncooperative form of collusion was more probable than perfect competition had the cartel not operated (Warren-Boulton 1995). Further, the defendants specified the homogenous Cournot model as the most appropriate one, because of its long-standing acceptance and widespread analytical use economics. Over certain ranges of market conditions, that model predicted equilibrium prices that fell within the range of actual market prices observed during the cartel period. That is, the Cournot model implied that the cartel had been ineffective raising prices by *explicit* collusion above prices generated by *implicit* (and legal) pricing coordination. Thus, the overcharge was zero.

Predictions from specific oligopoly models require structural parameters. In particular, the Cournot formula for calculating the profit-maximizing price needs three pieces of market information: the Herfindahl index of concentration, the own-price elasticity of demand, and the marginal cost of production. About the first item there was no disagreement; the Herfindahl index for three domestic manufacturers and two importers during the conspiracy was about 3,500.[46] The other parameters were borrowed from the plaintiffs' own opinion, namely that document's assertion that $0.70 was the marginal cost (or close to it) and that the elasticity was around –0.5 to –1.0 during the cartel period.[47]

One problem with the Cournot model is that the formula can, under some ranges of parameters, predict impossible prices. In layman's terms, the model can "blow up." For

---

[46] Implicitly this assumes that a global cartel was viewing the U.S. market as geographically distinct from others. Internal records of the cartel's pricing decisions and its efforts to prevent geographic arbitrage tend to support this view. Global concentration was about 2,500 in 1994 (Connor 2001a, tbl. 8.A.3).

[47] Connor (1996) opined that feeds were manufactured under fixed proportions, which implied poultry, swine, or meat elasticities of –0.10 to –0.50. These are retail-level elasticities calculated from precartel, more competitive periods; at the higher cartel-period prices, the elasticity will be higher in absolute value. This discussion took place in the context of his analysis of the dead-weight loss from cartel pricing.

example, given the high degree of market concentration, if the demand for lysine is highly

inelastic (less than –0.35), then Cournot oligopolists would be predicted to set negative prices, no

matter what the cost of production. Negative prices are rarely observed in natural markets,

because prices generally must be set above the variable costs of production, and these costs are

always nonnegative. Another problem with Cournot is that it is only one of many plausible

oligopoly models; its popularity with economists rests more with its mathematical tractability

than its consistency with the organization of natural markets. Given the lysine parameters just

discussed, other equally plausible models such as price leadership by ADM produce equally

untenable market price predictions. Moreover, the model that many economists would agree is

the second most popular, the homogeneous Bertrand model, predicts *competitive* prices when

there are two or more sellers.[48] Finally, although possibly allowable as evidence in antitrust

cases, the degree of econometric literacy required to comprehend formal oligopoly models

greatly restricts their use in forensic settings.

A Note on Simulation Modeling

Simulation is another way to create a but-for market scenario. The economist starts with a

structural model of oligopoly and calibrates key parameters in the model using observations from

the natural market of interest; frequently econometrics is employed to estimate parameters like

the own-price and cross-price elasticities of demand (Froeb and Werden 1996). When the analyst

makes relatively few strong assumptions about the market, the models can become

computationally quite complex (Froeb and Werden 2000). However, the effort may be

---

[48] A nonhomogeneous Bertrand oligopoly is consistent with elevated prices, but few cartels deal in differentiatied
products (Connor and Helmers 2006).

worthwhile when a policy analysis needs to go beyond unidirectional comparative-statics and weigh the net effects of multiple opposing forces.

An outgrowth of the assimilation of numerical methods into economics in the early 1990s, simulation has become an increasingly important tool of industrial economists in assessing questions of competition policy. "The first major use of simulation in applied industrial organization was, and the most important use still is, in predicting the effects of mergers" (*ibid.,* p. 134). Simulation affords the opportunity to judge the net effects on prices and efficiency of horizontal mergers. Werden (2000) summarizes a simulation of a proposed merger between two leading U.S. bread makers that was developed in 1995; had the case been litigated, it would have been the first time that a merger simulation was used in an antitrust case.[49]

I am not aware of simulation techniques being employed to estimate the size of damages in cartel litigation, perhaps because a comparative-static framework is not inappropriate. However, there are a few academic studies that may point to the potential for forensic applications. Raper *et al.* (2000) use simulation to determine the degree of monopsony power exercised by cigarette manufacturers in the U.S. market for leaf tobacco; they also determine the absence of countervailing monopoly power by sellers in that market.[50] De Roos (2004) provides an example of how well dynamic simulation can fit the facts of a cartel, in this case the global vitamin C conspiracy. This method holds promise for proving the fact of injury and might some day help in the calculation of damages, but because it is so novel in applications to cartels, it would probably face Daubert challenges in U.S. courts.

---

[49] The DOJ decided to challenge the merger in July 1995, but a consent decree involving divestiture of assets was finalized in January 1996 (Werden 2000:139). However, the simulation became public in 1999 when a party to the consent decree tried to reacquire the assets.

[50] In the early 2000s, cartel fines were imposed on buyers of leaf tobacco in Spain and Italy; in the United States, tobacco farmers won $1.2 billion in a civil price-fixing suit against cigarette makers (Connor and Helmers 2006).

CONCLUSION

One of the hallmarks of a rigorous scientific discipline is the ability to measure parameters of interest with precision. From this perspective, the highly variable estimates often presented of cartel overcharges could be interpreted as reflecting badly on empirical economics. For example, the lysine-cartel overcharge estimates varied by as much as ten-to-one when the first civil suit was being resolved. A more sanguine view that of progressive analyses often show a movement toward greater precision, a movement made possible by additional information and the time to apply more complex analytical methods. At the very least testimony by opposing experts may yield a range of damage estimates within which parties will settle or a fact-finder will choose a compromise.

Modern cartel enforcement is a paradox. The stated goal of antitrust laws of most nations is deterrence, and optimal deterrence requires that cartel penalties be based on multiples of economic injuries corrected for the probability of punishment. Yet antitrust authorities are typically reluctant to calculate fines on the basis of damages because of perceived analytical challenges (ICN 2005). In my experience rough but reasonable estimates can be quickly prepared using one of several methods delineated in this paper, especially when the analyst has sufficient appropriate economic data. More often than not, alternative estimates of cartel overcharges tend to be mutually supportive

In July 1996, the trial judge approved the $45-million offer as fair and reasonable. His decision seems to have been made for reasons unrelated to the economic evidence presented. Rather, he seemed most persuaded by the testimony of class counsel that this was a hard-fought deal that was unlikely to be improved. About 33 of 400 direct buyers in the class begged to

differ by opting out of the settlement. Most of the opt-outs were larger firms with the legal resources to continue hard negotiations with the defendants and with the patience to wait for their rewards. Although settlement terms are confidential, reports in the press suggested that the opt-out firms, with the benefit of criminal guilty pleas by the lysine cartel members, got at least double the amount per dollar of purchases than did the smaller buyers in the class (Connor 2007d, pp.397-398). This trend – opt-outs becoming a larger share of the buyers and obtaining better settlements – continued in subsequent cartel settlements throughout the late 1990s (*ibid.*, pp. 402 and 406).

With the benefit of hindsight and a great deal more information, it appears now that the initial $150-million estimate by the plaintiffs was too high. Considering seasonality would have reduced the overcharge amount by about 10% or so. More importantly, the two periods selected to determine the but-for price were most likely unrepresentative predatory-type episodes that could not have been sustained for the entire three years of the cartel's operation. That is, ADM was punishing its future cartel partners by unilaterally forcing prices down to the point where ADM was barely covering its variable costs.[51]   A $0.70 but-for price was not enough to cover full economic costs. In retrospect, a but-for price of $0.80 was closer to a long run competitive price, suggesting that the true U.S. overcharge was around $80 million.[52]

The federal lysine class and the opt-outs from the class eventually collected approximately $70 million from the cartel members; indirect purchasers of lysine obtained about $25 to $30 million in state courts where such buyers have standing to sue. Thus, U.S. lysine buyers recovered as a group slightly more than single damages; net of legal fees, buyers

---

[51] Note that the lowest prices observed were $0.64 in July 1992 and $0.62 in June 1993. A cost-of-production analysis showed that ADM's average variable costs were $0.63, a result that is perfectly consistent with economic theory. That is, as a rule the lowest rational price a firm will accept or charge in the short run is the one that equals its variable economic costs of production.

[52]   Morse and Hyde (2000) predict the same overcharge.

recovered less than single damages (*ibid*., tbl. 18.1). The lysine buyers' settlements were comparable to the settlements in two similar cartel cases that followed on the heels of the lysine case (*ibid*., p. 474). Direct buyers of citric acid and vitamins recovered 90% and 135%, respectively, of U.S. overcharges. These results reinforce Lande's (1993) conclusion that civil price-fixing awards are typically less than actual damages, never mind treble damages.

The *ex ante* perception of antitrust liability is a critical determinant of deterrence. If would-be price fixers expect that their monopoly profits will exceed the financial costs of antitrust fines and civil settlements, it is rational for them to form a cartel. In the Introduction above, it was noted that the potential antitrust liability in the United States is presently approximately eight times the U.S. overcharges, and overcharges are only slightly larger than the monopoly profits from collusion. One might argue that the best conjectures a company could have made about antitrust liability during 1988-1992 were much lower because of the changing legal landscape during the latter part of the 1990s. However, this is at best only a partial explanation for the spate of global cartels unmasked and punished after the lysine actions in 1996. In evaluating the deterrence capabilities of current antitrust sanctions, one must also consider three additional factors: the probability of an operating cartel being detected and prosecuted, actual rather than maximum antitrust penalties, and the geographic location of the monopoly profits generated by a cartel.

Limited evidence from the United States and Europe suggests that the probability that an established illegal cartel will be caught is somewhere between 10% and 30% (Connor 2007c, Table 1). Outside of North America and Western Europe the chances are negligible. Evidence from the three best-documented cartel cases of the late 1990s shows that U.S. criminal and civil penalties approached but never exceeded double the U.S. overcharges. In the EU, these same

cartels were made to pay fines about equal to single damages, and the prospect of civil damages suits in Europe is dim. In Asia, cartel fines are small or nonexistent. A striking feature of most global cartels discovered since 1996 is that their sales and profits were distributed almost equally across North America, Western Europe, and the rest of the world. Taking into account each of these three general features of modern cartels and contemporary anticartel enforcement practices, it logically follows that global-cartel deterrence requires actual monetary sanctions to exceed *three to ten times* worldwide overcharges, where the exact multiplier depends inversely on the probability of discovery. Treble damages in the United States alone will not deter global cartels.

The rationale of deterrence can be illustrated with financial information about ADM, the most heavily fined of the lysine conspirators. ADM's monopoly profits from fixing the U.S. price of lysine for three years were about $80 million. ADM paid a $70-million fine to the federal government, about $49 million to direct buyers of lysine, and $15 million to indirect buyers in state court cases. Not counting legal fees and other intangible costs, ADM's *ex post* U.S. costs of collusion somewhat exceeded its U.S. revenues from collusion. On the other hand, ADM garnered approximately $100 million from its non-U.S. sales of cartelized lysine. Non-U.S. fines left ADM with a positive return of $25 to $35 million on its non-U.S. price fixing. Crime did not pay for ADM in the United States, but it did pay abroad. More importantly, when one factors in the expectation that the chances of being caught were small, ADM's decision to form the lysine cartel was eminently rational.

REFERENCES

ADM. *Annual SEC Form 10-K Report for the Year Ending June 30*, 2001 and previous years.

Audretsch, David B. "Legalized Cartels in West Germany." *Antitrust Bulletin* 34 (Fall 1989): 579-600.

Baker, Jonathan B. and Daniel L. Rubinfeld. Empirical methods in Antitrust Litigation: Review and Critique. *American Law and Economics Review* 1 (1999): 368-435.

Bernheim, B. Douglas. *Expert Report of B. Douglas Bernheim, In Re Vitamins Antitrust Litigation, MDL No. 1285,* U.S. District Court for the District of Columbia (May 24, 2002).

Brander, James A. and Thomas W. Ross. Estimating Damages from Price Fixing. *Canadian Class Action Review* 3 (2006): 335-369.

Coffee, John C., Jr. "Securities Class Auctions." *The National Law Journal* (September 14, 1998): B6-10.

Connor, John M. *The Cost to U.S. Animal-feeds Manufacturers of an Alleged Price-Fixing Conspiracy by Lysine Manufacturers*, affidavit presented in the case *In re Amino Acid Lysine Antitrust Litigation*, 1996.

Connor, John M. *Lysine Production, Trade, and the Effects of International Price Fixing (Third Edition)*, Staff Paper 99-13. West Lafayette, IN: Department of Agricultural Economics, Purdue University (October 1999).

Connor, John M. *Archer Daniels Midland: Price-Fixer to the World (Fourth Edition)*, Staff Paper 00-11. West Lafayette, IN: Department of Agricultural Economics, Purdue University (December 2000). [http://agecon.lib.umn.edu/cgi-bin/pdf_viewpl?paperid=2871&ftype=.pdf].

Connor, John M. " 'Our Customers Are Our Enemies': The Lysine Cartel of 1992-1995." *Review of Industrial Organization* 18 (February 2001): 5-21.

Connor, John M. Global Antitrust Prosecutions of Modern International Cartels. *Journal of International Competition and Trade* 4 (September 2004): 239-267.

Connor, John M. *Global Price Fixing: 2nd Updated and Revised Edition: Studies in Industrial Organization No. 26.* Berlin and Heidelberg: Springer, 2007c.

Connor, John M. Optimal Deterrence and Private International Cartels, presented at the 4th International Industrial Organization Conference, Savannah, Georgia (April 2007e).

John M. Connor, "Forensic Economics Applied to Price-Fixing Overcharges." *Journal of Competition Law & Economics* (forthcoming 2007b).

John M. Connor, "Effectiveness of Sanctions on Modern International Cartels." *Journal of Industry, Competition, and Trade* 6 (forthcoming 2007a).

John M. Connor and C. Gustav Helmers. *Statistics on Modern Private International Cartels: Working Paper 07-01.* Washington, DC: American Antitrust Institute (January 2007). [http://www.antitrustinstitute.org/recent2/567.pdf]

Dick, Andrew R. "Cartels." *The New Palgrave Dictionary of Law and Economics*, edited by John Eatwell. London: Macmillan, 1998.

EC. "Commission Decision of 7 June 2000 (Case COMP/36.545/F3 – Amino Acids)." *Official Journal of the European Communities* (7 June 2001): L152/24-72.

EC. *Competition Policy Newsletter*. Brussels: Competition-Policy Directorate of the European Commission (February 2002): 29-43.

Eichenwald, Kurt. *The Informant: A True Story*. New York: Broadway Books, 2000.

Fisher, Franklin M. "Multiple Regression in Legal Proceedings." *Columbia Law Review* 80 (1980): 702.

Froeb, Luke M. and Gregory J. Werden. Simulating the Effects of Mergers among Noncooperative Oligopolists, in *Computational Economics and Finance: Modeling and Analysis with Mathematica*, Hal Varian (editor). New York: Springer (1996).

Hovenkamp, Herbert. *Federal Antitrust Policy: The Law of Competition and Its Practice, Second Edition*. St. Paul, MN: West Group, 1999.

Joshua, Julian. Supermodels, Geeks, and Gumshoes: Forensic Economics in EC Cartel Investigations, Amsterdam Center for law and Economics conference "Forensic Economics in Competition Law Enforcement," Amsterdam, March 17, 2006.

Joshua, Julian M. and Sarah Jordan. Combinations, Concerted Practices, and Cartels: Adopting the Concept of Conspiracy in European Community Competition Law. *Northwestern Journal of International Law and Business* 24 (2004): 647-681.

Kanne, Michael S., *et al*. *Opinion, U.S. Court of Appeals for the Seventh Circuit in U.S. v. Michael D. Andreas and Terrance Wilson* (2000 U.S. App. LEXIS 14572). Chicago, IL, June 26, 2000.

Katzman, C. J. *et al*. *Decision of the U.S. Court of Appeals for the Second Circuit in Kruman v. Christie's International PLC*. New York, March 25, 2002.

Lande, Robert H. Are Antitrust "Treble" Damages Really Single Damages? *Ohio State Law Journal* 54 (1993): 115-174.

Lande, Robert H. and Joshua P. Davis. An Evaluation of Private Antitrust Enforcement: 29 Case Studies, Interim Report submitted to the Antitrust Modernization Commission. (November 8, 2006) [http://www.antitrustinstitute.org/recent2/550b.pdf]

Lieber, James B. *Rats in the Grain: The Dirty Tricks of "Supermarket to the World*. New York: Four Walls Eight Windows, 2000.

Markon, Jerry. "Ex-Sotheby's Chairman Is Sentenced to a Year in Prison, Fined $7.5 Million." *Wall Street Journal Online*, April 23, 2002.

Morse, B. Adair and Jeffrey Hyde. *Estimation of Cartel Overcharges: The Case of Archer Daniels Midland and the Market for Lysine*, Staff Paper 08-00. West Lafayette, IN: Department of Agricultural Economics, Purdue University, October 2000.

Page, William H. (editor). *Proving Antitrust Damages: Legal and Economic Issues*. Chicago, IL: Section of Antitrust Law, American Bar Association, 1996.

Posner, Richard A. *Antitrust Law: Second Edition*. Chicago: University of Chicago Press, 2001.

Raper, Kellie Curry, H. Alan Love and C. Richard Shumway. Determining Market Power Exertion Between Buyers and Sellers. *Journal of Applied Econometrics* 15 (2000): 225-252.

de Roos, Nicolas. A Model of Collusion Timing. *International Journal of Industrial Organization*, 22 (2004): 351-387.

_____. Collusion with a Competitive fringe: An Application to Vitamin C. *International Journal of Industrial Organization* (forthcoming 2006). [http://www.mgmt.purdue.edu/centers/ijio/Accepted/2266.pdf]

Slottje, Daniel J. (editor). *The Role of the Academic Economist in Litigation Support*. Amsterdam: Elsevier, 1999.

Stigler, George J. "A Theory of Oligopoly." *Journal of Political Economy* 72 (1964): 44-61.

Tr. Transcript of *U.S. v. Michael D. Andreas et al.*, U.S. District Court, Northern District of Illinois, Eastern Division, No. 96 CR 762, July to September 1998.

Warren-Boulton, Frederick R. *An Evaluation of "The Cost to U.S. Animal Feeds Manufacturers of an Alleged Price-Fixing Conspiracy by Lysine Manufacturers, 1992-1995*," Master File 95-C-7679, U.S. District Court for Northern Illinois, Eastern Division, 1996.

Wells, Wyatt. *Antitrust and the Formation of the Postwar World.* New York: Columbia
University Press (2002).

Werden, Gregory J. Expert Report in United States v. Interstate Bakeries Corp. and Continental
Baking Co. *International Journal of the Economics of Business* 7 (2000): 139-148.

White, Lawrence J. *Declaration of Lawrence J. White, In re Amino Acid Lysine Antitrust
Litigation*, Master File 95-C-7679, U.S. District Court for Northern Illinois, Eastern
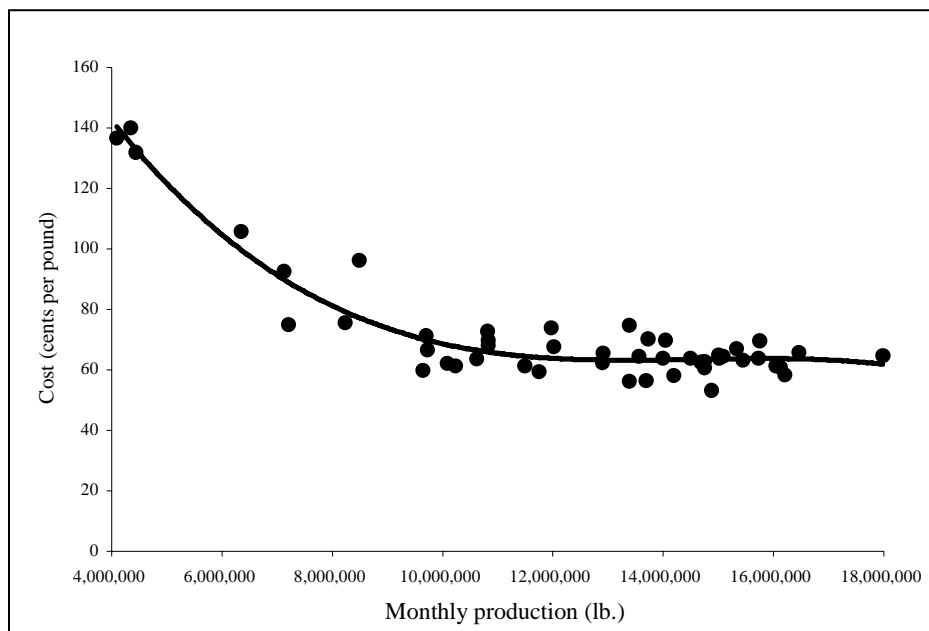Division, 1996.

White, Lawrence J. "Lysine and Price Fixing: How Long? How Severe?" *Review of Industrial
Organization* 18 (February 2001): 23-31.

Figure 1. Lysine Transaction Prices, U.S. and EU Markets, 1991-1996.
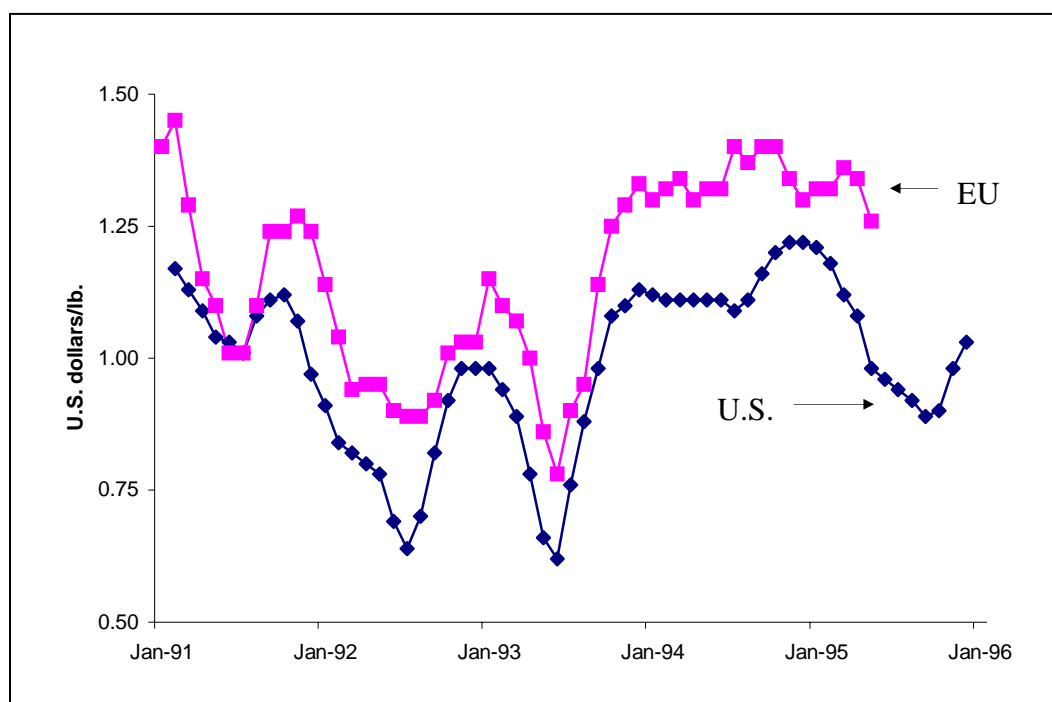
Note: U.S. prices from sales by the four largest manufacturers (see Appendix A of Connor (2000) for details). EU prices from a European Commission notice published on the *RAPID* web site in 2001, in euros, translated into U.S. dollars at the prevailing monthly interbank exchange rate.

Figure 2. ADM's Lysine Manufacturing Costs, 1991-1995.

Source: Tr. Ex. 60-67.