

The deterrent effects of national anticartel laws: evidence from the international vitamins cartel

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I. Introduction

During the 1990s the European Commission and the United States Department of Justice between them prosecuted over 40 cartels that involved private firms and whose effects went beyond national borders. These private international cartels were found in a wide range of products—from citric acid, vitamins, newsprint, and fax paper to shipping and chemicals such as aluminium phosphide and

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sodium gluconate.¹ Furthermore, these cartels tended not to collapse under the weight of their own incentive problems, as 24 of them lasted at least 4 years. The latter fact suggests that market forces alone may be unable to quickly undermine attempts to fix prices, rig bids, allocate quotas and market shares; perhaps implying a potential role for national anticartel enforcement.

The large number of cartels being unearthed in the European Union (EU) and the United States has not gone unnoticed in the rest of the world and competent authorities in other jurisdictions are increasing their cartel enforcement efforts. For example, submissions to the Organization of Economic Cooperation and Development (OECD) provide details of recent anticartel enforcement actions by developing economies.² Moreover, many nations established competition authorities in the 1990s. The recent United Nations Conference on Trade and Development (UNCTAD)'s *Directory of Competition Authorities* now contains entries for 93 nations and three supranational entities (the Commonwealth of Independent States, the European Commission, and Union Economique et Monetaire Ouest Africaine).³ Given that anticartel laws tend to be one of the first competition measures to be enacted by national authorities, these figures suggest that there is substantial legislative support—if not necessarily the capacity—for cartel enforcement.

These observations prompt a number of research questions whose answers may have implications for policy makers. First, what is the impact of these international cartels on prices and quantities sold in different nations' markets and on international trade flows? Second, how large are the rents created by international cartels? Third, to what

¹ See S. J. Evenett et al., *International Cartel Enforcement: Lessons From the 1990s*, WORLD ECONOMY, Sept. 2001, at table 1.

² ORGANIZATION FOR ECONOMIC COOPERATION & DEVELOPMENT, REPORT ON THE NATURE AND IMPACT OF HARD CORE CARTELS AND SANCTIONS AGAINST CARTELS UNDER NATIONAL COMPETITION LAWS (2002).

³ UNITED NATIONS CONFERENCE ON TRADE & DEVELOPMENT, DIRECTORY OF COMPETITION AUTHORITIES (2002).

extent—if at all—do cartel members take into account the potential for future enforcement actions by national competition authorities when planning and executing their agreements to distort market outcomes? This latter question might shed light on the deterrent effects of national anticartel laws and on the potential impact of adopting such a law. This set of questions, which is not exhaustive, highlights the impact of international cartels and cartel enforcement on market outcomes; and should be distinguished from questions associated with the jurisprudence of anticartel laws and related legal matters. As will become clear, the focus of this article is on the quantitative impact of one major international cartel—that of vitamins—leaving others to tackle the complex legal issues raised by cartel enforcement.

The international vitamins cartel operated from 1989 to 1999 and involved producers located in Belgium, Canada, France, Germany, Japan, the Netherlands, Switzerland, and the United States. Using international trade data from 1985 to 1999, and after taking into account the other plausible determinants of trade in vitamins, this article examines whether the formation of this cartel had effects on international trade flows in vitamins that differed across distinct types of importing nations. This article is especially interested in evaluating the hypothesis that, while a cartel is in operation, the conspirators will tend to raise prices less in those destinations with active cartel enforcement regimes.

This hypothesis could be rationalized in the following manner: Cartel members will weigh the gains from a further increase in prices in a given nation's market with the increase in the probability that such a price increase will result in enforcement action that, in turn, could lead to financial and other penalties. In principle, an antitrust authority could notice high (or rising) prices of the cartelized product and begin an investigation. Another—perhaps more likely—channel is that buyers of the cartelized product are more likely to make a complaint to an antitrust authority the more the price of vitamins is raised above precartel levels. The constraint—if any—that a nation's cartel enforcement regime is likely to place on the pricing behavior of cartel members will depend on a number of factors including the ability of the antitrust authorities to collect the relevant evidence, the

incentives such an authority has to encourage private firms to come forward with evidence, the strength of any penalties for cartelization that the nation's law allows for and, where relevant, the likelihood that a nation's courts will convict cartel conspirators.

Another argument is relevant in the international context. In those nations where announcements about cartel investigations and prosecutions are closely watched by other nations' enforcement authorities, cartel members may well deliberately reduce their price increases or may well avoid cartelization altogether. Such cartel members may prefer to stay "under the radar screen" in jurisdictions with stronger cartel enforcement regimes so as to reduce the probability of triggering an investigation by another nation's antitrust authority; and quietly get on with raising prices in nations with weaker cartel enforcement regimes. For both reasons, one might expect the cartel's formation to result in price increases—and, if demand for the cartelized product is inelastic, the increase in the total value of cartelized exports—that are smaller in jurisdictions that have active cartel enforcement regimes.

This article presents evidence that, after the formation of the vitamins cartel, exports from countries where the cartel conspirators' headquarters were located to those nations in Asia, Western Europe, and Latin America that did not have active cartel enforcement regimes tended to rise in value more than in those nations that had such regimes. Given that industry studies suggest that the demand for vitamins is price inelastic, this finding is consistent with the hypothesis that the vitamins cartel raised prices more in nations without active cartel enforcement regimes. These findings also have implications for the cost-benefit analyses of anticartel laws. In nine economies in Western Europe and Latin America, where recent estimates of government outlays on competition policy enforcement were found, these expenditures were compared with the additional overcharges on vitamins imports that would have resulted if each of these nations did not have an active cartel enforcement regime. In seven of the nine economies the reduction in overcharges on this one international cartel *alone* exceeded a *quarter* of their government's spending on the entire competition policy enforcement regime.

The analysis in this article departs from the existing literature in a number of respects. Unlike First's article,⁴ which described the vitamins cartel in illuminating detail, this analysis is quantitative and not qualitative. The approach taken here focuses on the implications for international trade flows of international cartels, and so does not examine how within-border (domestic) transactions are affected by cartelization.⁵ Third, the approach employs econometric tools to identify what impact cartel laws have on the export decisions of cartel members. Fourth, unlike the paper by Levenstein and Suslow⁶ which calculates the effects of international cartelization at a point in time, this article estimates the impact of the vitamins cartel's formation on trade flows throughout the 1990s.

The remainder of this article is organized as follows. The next section summarizes the recent discussions on international cartels in leading international forums and highlights how economic research might shed light on a number of the issues being addressed there. The third section summarizes the main features of the international vitamins cartel. The fourth section presents an empirical analysis of the effects of the formation of the vitamins cartel on international trade flows and draws out some of the implications for assessing the costs and benefits of active cartel enforcement. Concluding remarks appear in the fifth section.

II. A selective overview of the ongoing discussions on international competition policy, especially as they relate to international cartels.

Understanding the effects of international cartels on market outcomes has some bearing on certain longstanding debates in international forums about the effects of large companies' operations

⁴ H. First, *The Vitamins Case: Cartel Prosecutions and the Coming of International Competition Law*, ANTITRUST L.J. 711 (2001).

⁵ See JOHN M. CONNOR, *GLOBAL PRICE FIXING: OUR CUSTOMERS ARE THE ENEMY* (2001). See also Lawrence J. White, *Lysine and Price Fixing: How Long? How Severe?*, REV. INT'L ORG. (2001).

⁶ M. C. LEVENSTEIN & V. SUSLOW, *PRIVATE INTERNATIONAL CARTELS AND THE EFFECT ON DEVELOPING COUNTRIES*, BACKGROUND PAPER FOR THE WORLD DEVELOPMENT REPORT (2001).

and about the merits of adopting international disciplines on competition policy. As is often pointed out, one can go back to the debates surrounding the Havana Charter in the 1940s to see concerns raised about the potential for the benefits of international trade reform to be eroded by anticompetitive practices. Moreover, concerns about "restrictive business practices" led the United Nations General Assembly to adopt on December 5, 1980 a Set of Multilaterally Agreed Equitable Principles and Rules for the Control of Restrictive Business Practices. This "Set" was renewed in 1985, 1990, 1995, and 2000; highlighting recurring concerns by some policy makers about the effects of restrictive business practices, of which cartels are a leading example. Many (notably U.S.-based) scholars and officials are, and have been, skeptical about the pervasiveness and effects of restrictive business practices in international commerce; a presumption that was easy to sustain when there was little available research on contemporary international cartels. It is, therefore, significant that there have been a number of recent attempts to quantify the effects of cartels that have had international effects⁷ and this article can be thought of as part of this recent research program.

In the 1990s the members of the OECD also gave growing attention to what are often referred to now as hard-core cartels.⁸ Discussions at the OECD covered a wide variety of aspects of anticartel enforcement and laws; including the severity of sanctions, role of leniency programs, and the nature and extent of current and potential future international cooperation in anticartel enforcement. These discussions, which now routinely include non-OECD members, have added greatly to the body of knowledge on cartel enforcement and have provided an opportunity for best practices to be discussed

⁷ *Id.*; CONNOR, *supra* note 5.

⁸ The definition of a hard-core cartel is "an anticompetitive agreement, anticompetitive concerted practice, or anticompetitive arrangement by competitors to fix prices, make rigged bids (collusive tenders), establish output restrictions or quotas, or share or divide markets by allocating customers, suppliers, territories, or lines of commerce." OECD, RECOMMENDATION CONCERNING EFFECTIVE ACTION AGAINST HARD CORE CARTELS, available at <http://www.oecd.org/daf/clp/Recommendations/Rec9com.htm> (last visited Jan. 9, 2003).

and ideas exchanged. Moreover, on March, 25, 1998, the OECD Council approved a Recommendation Concerning Effective Action Against Hard Core Cartels that:

calls upon countries to take two sorts of actions. First, countries are urged to ensure that their competition laws effectively halt and deter hard core cartel conduct. This requires that sanctions and investigatory powers are adequate and that exclusions and authorizations of what would otherwise be hard core cartels are both necessary and no broader than necessary to achieve their overriding policy objectives. Second, the recommendation urges countries to cooperate with one another in enforcing their laws against cartels. The Recommendation then sets forth several principles and practices that contribute to effective co-operation in the anti-cartel effort. The Recommendation . . . also invites non-Member countries to associate themselves with it.⁹

One potential payoff from this initiative is that it may strengthen the deterrent value of national cartel enforcement efforts that, in turn, may result in cartels raising prices less in jurisdictions where such efforts are perceived to be stronger.¹⁰ It is an interesting research question, therefore, whether cartels that were prosecuted in the 1990s did in fact discriminate across jurisdictions on the basis of the deterrent value of their anticartel laws. Furthermore, after a few more years have passed, it would be interesting to see if any pattern of discrimination by cartel members has changed as a result of national legislative changes that may well, in part, have resulted from consultations and discussions at the OECD.

Identifying the extent to which international cartels influence market outcomes is also important for assessing a number of proposals advanced by members of the World Trade Organization (WTO). The membership of the WTO, which is much broader than that of the OECD and includes many economies without competition laws, has to decide in September 2003 at its next Ministerial Meeting in Cancun, Mexico, whether and upon what terms negotiations can proceed on incorporating new disciplines on competition policy into

⁹ OECD, *HARD CORE CARTELS—A CONTRIBUTION BY THE OECD SECRETARIAT* 3 (2002).

¹⁰ This is in addition to the effect that greater deterrence may have on the incentive to form a cartel in the first place.

WTO agreements. Moreover, the WTO's Working Group on the Interaction between Trade and Competition Policy has held a number of discussions on international cartels and on the merits of adopting multilateral rules on these matters. Advocates of such rules, which include the European Union, point to the benefits of adopting effective anticartel laws. Opponents are concerned about the implementation costs of competition laws and wonder whether enforcement actions by OECD nations against their own firms who engage in cartelization abroad is a preferable alternative to making developing economies adopt their own anticartel laws.¹¹

It is, of course, an empirical question as to the extent to which the damage done by international cartels is reduced by the adoption of, or the strengthening of, national cartel enforcement regimes. Furthermore, even if such cartels were highly responsive to changes in cartel enforcement regimes, one would then want to compare the benefits that accrue from such steps with the associated implementation costs. As noted above, this article will present evidence that is pertinent to such a cost-benefit analysis for nine economies in Western Europe and Latin America.

III. A brief account of the international vitamins cartel

The purpose here is to provide a brief account of the vitamins cartel, and not to repeat the detailed renditions that can be found elsewhere.¹² This cartel has been described as "wheels within wheels" by Connor, principally because it comprised a series of interrelated conspiracies to manipulate the markets of at least eight vitamins and four other chemical compounds.

The cartel started in 1989 when two Swiss vitamins manufacturers—Roche and BASF—agreed to gradually increase the price of vitamins A and E and to a geographic division of the world's markets for these two substances.¹³ Roche and BASF controlled over

¹¹ B. M. HOEKMAN & P. MAVROIDIS, *ECONOMIC DEVELOPMENT, COMPETITION POLICY AND THE WTO* (World Bank 2002).

¹² See CONNOR, *supra* note 5; First *supra* note 4.

¹³ See CONNOR, *supra* note 5, at 305–06.

70% of sales in these markets and subsequently successfully co-opted their principal rivals, Rhone-Poulenc and Eisai. By 1991, these four companies essentially controlled the world price for vitamins A and E; a situation they were able to sustain until 1999 when the conspiracy was prosecuted by the U.S. antitrust authorities.

The conspirators' success encouraged them to further the scope of the cartel to include other vitamins and other producers. By the end of the 1990s, 22 manufacturers had at one time been a part of the 12 "wheels" (cartels) within the overall vitamins conspiracy.¹⁴ So extensive was the price fixing within these markets that the European Commission branded the entire vitamins industry a single conspiracy.¹⁵ Table 1 lists the duration of eight such "wheels." It is noteworthy that five of these conspiracies lasted until 1998, potentially distorting international markets throughout almost the entire 1990s. In contrast, the cartel in vitamins B₁, B₆, and folic acid fell apart in 1994, largely as a result of competition from Chinese exporters that were not members of the cartel.

In late 1998, Rhone-Poulenc sought leniency for its participation in the vitamins cartel. It has been argued that Rhone-Poulenc's decision to seek leniency was prompted by the earlier indictment by the U.S. authorities of Lonza for the latter's participation in the vitamins B₃ cartel. Another factor may well have been the U.S. authorities well-publicized investigation into the lysine and citric acid cartels, which included scrutiny of firms that also produced vitamins.¹⁶

Table 2 lists the names and location of the headquarters of the 16 firms that, according to U.S. federal indictments in 1999, participated in the vitamins conspiracy.¹⁷ This subsequent American enforcement action resulted in fines of \$10.5 million, \$5 million, \$500 million, \$225 million, \$72 million, \$40 million, \$25 million, \$13 million, and \$2 million for Lonza, Chinook, Hoffmann-La Roche, BASF, Takeda, Eisai, Daiichi, Degussa, and Reilly/Vitachem, respectively.

¹⁴ See CONNOR, *supra* note 5.

¹⁵ See EC Competition Policy Newsletter (2001).

¹⁶ See CONNOR, *supra* note 5, at 368–69.

¹⁷ See United States Department of Justice Press Releases (1999–2000).

Table 1
Conspirators Forming Eight Global Cartels to Fix Prices of Selected Compounds, 1990-1999

<i>Duration of cartel</i>	1990-1999	1990-1999	1991-1994	1991-1995	1991-1998	1991-1998	1989-1996
<i>Products</i>	A & E	B ₁₂	B ₁ , B ₆ & folic acid	C & B ₂	B ₅	beta-carotene	choline chloride
<i>Cartel members</i>	Roche BASF Rhône Eisai	Rhone Hoechst	Roche Takeda Daiichi	Roche BASF Takeda Merck	Roche BASF Daiichi	Roche BASF	Chinook Mitsui DuCoa BASF Akzo UCB

SOURCE: JOHN M. CONNOR, GLOBAL PRICE FIXING: OUR CUSTOMERS ARE THE ENEMY 307 (2001).

Table 2

Companies and Location of Their Headquarters Mentioned in U.S. federal indictments

<i>Company</i>	<i>Country</i>
Akzo	Netherlands
BASF	Germany
Chinook	Canada
Daiichi	Japan
Degussa	Germany
DuCoa	U.S.
Eisai	Japan
Hoechst	Germany
Lonza	Switzerland
Merck	Netherlands
Mitsui	Japan
Napera	U.S.
Rhone-Poulenc	France
Roche	Switzerland
Takeda	Japan
UCB	Belgium

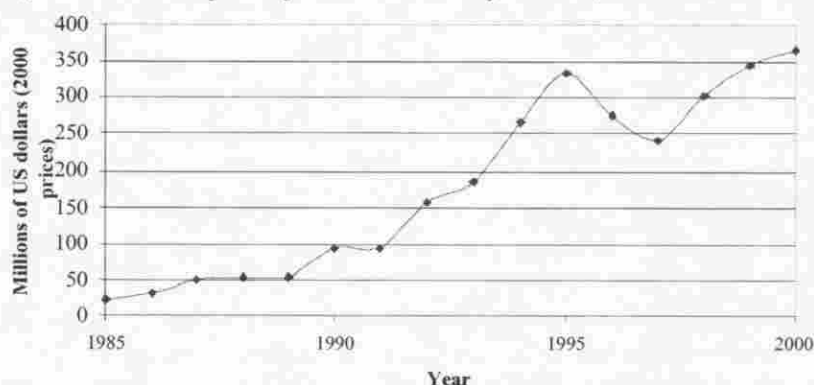
SOURCE: U.S. Department of Justice Press Releases (1999–2000).

The European Commission's (EC's) investigation into this cartel's activities revealed a slightly different set of cartel members and estimates of each wheel's duration (see table 3). Four additional companies were found to have participated in this cartel: Kongo Chemical Co. (headquartered in Japan), Solvay Pharmaceuticals (headquartered in the Netherlands), Sumitomo (headquartered in Japan), and Tanabe (headquartered in Japan). The EC enforcement action resulted in the following fines for nine firms: Hoffmann-La Roche (462 million euros), BASF (296.16 million euros), Takeda (37.06 million euros), Eisai (13.23 million euros), Daiichi (23.4 million euros), Merck (9.24

million euros), Aventis (5.04 million euros), Solvay Pharmaceuticals (9.1 million euros) and Takeda (37.06 million euros).¹⁸

This account would be incomplete without some mention of the role that Chinese exporters are said to have played in disrupting some of the wheels that made up the vitamins cartel.¹⁹ Chinese firms remained outside the cartel and their exports of vitamins and polyvitamins surged after 1991 (see the figure). These exports rose from just under \$100 million in 1990 to nearly \$350 million in 1995, before falling back to approximately \$250 million in 1997, and rising sharply to over \$350 million in 2000.²⁰ (All of these import values were measured in year 2000 U.S. dollars.) It has been claimed that Chinese exports were an important factor in the breakdown in 1994 of the cartel in vitamins B₁ and B₆ and in folic acid.²¹ As will become clear later, in estimating the effect of the vitamins cartel's formation on value of vitamins exported from countries where the conspirators maintained their headquarters, this article attempts to control for the effect of Chinese vitamins exports.

Figure Chinese Exports of Vitamins and Polyvitamins, 1985–2000



¹⁸ See the EC Competition Policy Newsletter (2001).

¹⁹ See CONNOR, *supra* note 5, at 306.

²⁰ STATISTICS CANADA, WORLD TRADE ANALYSER DATABASE, PRODUCT LINE NUMBER 5411 (refers to trade in vitamins and polyvitamins).

²¹ See CONNOR, *supra* note 5, at 306.

Table 3
Cartels Uncovered in the EC Investigation and Participants in Those Cartels

Vitamin	Participants	Duration*	
		From	To
Vitamin A	Roche, BASF, Rhone-Poulenc (Aventis)	September 1989	February 1999
Vitamin E	Roche, BASF, Rhone-Poulenc (Aventis), Eisai	September 1989	February 1999
Vitamin B ₁ (thiamine)	Roche, Takeda, BASF	January 1991	June 1994
Vitamin B ₂ (riboflavin)	Roche, BASF, Takeda	January 1991	September 1995
Vitamin B ₅ (calpan)	Roche, BASF, Daiichi	January 1991	February 1999
Vitamin B ₆	Roche, Takeda, Daiichi	January 1991	June 1994
Folic acid (B)	Roche, Takeda, Kongo, Sumika	January 1991	June 1994
Vitamin C	Roche, BASF, Takeda, Merck	January 1991	August 1995
Vitamin D ₃	Roche, BASF, Solvay Pharmaceuticals, Rhone-Poulenc (Aventis)	January 1994	June 1998
Vitamin H (biotin)	Roche, Merck, Lonza, Sumitomo, Tanabe, BASF	October 1991	April 1994
Beta-carotene	Roche, BASF	September 1992	December 1998
Carotinoids	Roche, BASF	May 1993	December 1998

* The duration of each company's participation in a cartel need not necessarily be the same.

SOURCE: EC Competition Newsletter (2001), at 32.

IV. Theoretical considerations and empirical implementation

In this section the theoretical rationale for the analysis of the vitamins cartel's effects on international trade flows and the manner in which the empirical analysis was implemented is described.

A. Effect of cartelization on prices and total revenues or sales

Theoretical analyses of cartel behavior invariably focus on these conspiracies' effects on the prices charged to buyers, rather than on the effects on total revenues (or total sales) of the cartel members.²² In our case this emphasis is unfortunate as international trade data on the price of vitamins is much more scarce than data on the total value of purchases by buyers located in an economy from firms located in another economy. With an assumption on the own-price elasticity of the good in question, one can draw out the implications of a cartel's decision to raise prices in a market for the value of total sales by cartel members in that market. In fact, if the demand for a good is price inelastic then an increase in price will generate an increase in total revenues.²³ What is more, as quantity demanded falls when price rises, one can also conclude that the percentage increase in total revenues that results from the formation of the cartel bounds from below the price increase that is caused by the conspiracy.

B. Establishing a benchmark for trade flows in the absence of cartelization

Subsection A. established how total sales in a market—be it domestic or foreign—are distorted by the creation of a cartel. This begs the question of what benchmark level of sales would have prevailed in the absence of the cartel. In the international trade

²² It is straightforward to show that the change in consumer surplus caused by the cartel's formation is (in magnitude) larger than the increase in total revenues of the cartel members. Therefore, any estimates of the changes in the total value of sales of the cartelized product in a given market will also provide a lower bound on the harm done by the cartel's formation to consumers in that market.

²³ See CONNOR, *supra* note 5 (for a discussion of the price inelasticity of the demand for vitamins).

context, such a benchmark is important as it establishes what the exports of one nation's firms to another nation's buyers would have been in the absence of the cartel. Fortunately, the study of such bilateral trade flows is well advanced in research in international trade and provides an empirically implementable benchmark.

One of the few—perhaps the only—robust empirical regularity in the analysis of international trade flows is known as the gravity equation. This equation relates the total value of one nation's imports from another nation positively to the levels of national income of both nations and negatively to the distance between them.²⁴ Over the last 25 years our understanding of the theoretical underpinning of the gravity equation has deepened²⁵ and empirical analyses of this equation have become more sophisticated.²⁶ What follows draws upon this substantial body of research into bilateral trade flows. Specifically, this article adopts a standard formulation of the gravity equation. Denote:

M_{ij}^v	As the total value of country i 's imports of vitamins (v) from country j .
y_j^v	As the total value of country j 's production of vitamins (v).
Y_i	As country i 's national income or gross domestic product.
Y_j	As country j 's national income or gross domestic product.
Y_W	As the world's total income or gross product.
M_{ij}	As the total value of all country i 's imports from nation j .

²⁴ The analogy to the determinants of the force between two masses in the physical sciences is deliberate.

²⁵ See James A. Anderson, *A Theoretical Foundation for the Gravity Equation*, 69 AM. ECON. REV. 106 (1979); E. HELPMAN & P. KRUGMAN, *MARKET STRUCTURE AND FOREIGN TRADE* (1985); A. V. Deardorff, *Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?*, in *THE REGIONALIZATION OF THE WORLD ECONOMY* (J.A. Frankel ed., 1998); J. EATON & S. KORTUM, *TECHNOLOGY, GEOGRAPHY, AND TRADE*, available at <http://econ.bu.edu/eaton/tgt501.pdf> (last visited Jan. 9, 2003).

²⁶ See D. Hummels & J. Levinsohn, *Monopolistic Competition and International Trade: Reconsidering the Evidence*, 110 Q. J. ECON. 799 (1995); S. J. Evenett & W. Keller, *On Theories Explaining the Success of the Gravity Equation*, 110 J. POL. ECON. 281 (2002).

Following Anderson's research,²⁷ the initial theoretical pioneer on the gravity equation, in the absence of barriers to international trade flows, with balanced trade in each nation, and each country's buyers have identical and homothetic preferences, one can derive the following two expressions for the gravity equation:

$$M_{ij}^v = \left(\frac{Y_i}{Y_w} \right) y_j^v \quad (1)$$

$$M_{ij} = \left(\frac{Y_i}{Y_w} \right) Y_j \quad (2)$$

Dividing (2) by (1) and rearranging yields

$$M_{ij}^v = M_{ij} \left(\frac{y_j^v}{Y_j} \right) \quad (3)$$

In this formulation, then, country i 's imports of vitamins from country j would rise one percent if the proportion of country j 's national output $\left(\frac{y_j^v}{Y_j} \right)$ that is devoted to vitamins production rose by one percent also. Furthermore, any factor that leads to a one percent reduction in the overall bilateral level of trade between nations i and j will, in this formulation, lead to i 's imports of vitamins from j falling by the same percentage. As these predictions were derived in the absence of a cartel, they can form the basis of a benchmark for vitamins trade.

Finally, taking logarithms of equation (3) yields

$$\ln(M_{ij}^v) = \ln(M_{ij}) + \ln(y_j^v) - \ln(Y_j) \quad (4)$$

which takes a convenient linear form amenable to econometric estimation.

²⁷ Anderson, *supra* note 25.

C. Econometric strategy

This econometric strategy has two goals. First, by using data on international trade in vitamins before and after the vitamins cartel was formed, one can examine whether there is a systematic deviation of the value of bilateral imports of vitamins from that predicted in equation (4) above. As argued earlier, so long as the demand for vitamins is price inelastic and the conspiracy resulted in higher prices, then if all else is equal the observed level of the value of vitamins imports (M_{ij}^v) should rise after the cartel's formation. In essence, the analysis uses the intertemporal variation of the trade data in vitamins to identify the effect of the cartel's formation.

Second, it is possible to examine whether the impact of the cartel's formation on the total value of a nation's vitamins imports (M_{ij}^v) depends on whether that nation's cartel enforcement regime is active. As will become clear below (when the data collection issues are discussed) some nations' enforcement agencies actively prosecuted cartels in the 1990s. Moreover, some nations only established (what turned out to be) active enforcement authorities after the cartel's formation, providing an opportunity to examine whether the imports of vitamins responded to the creation of an active enforcement authority. In the parlance of econometricians, the article uses both cross-sectional and intertemporal variation to identify the effects of cartel enforcement on the trade in cartelized vitamins.

A time subscript (denoted by t) to each of the variables in equation (4) is added to indicate the year that each (data) observation refers to. Furthermore, to take account of the effect on cartelized imports of competition from Chinese sources, another independent variable, denoted C_t , is added that represents the total exports of Chinese vitamins to all destinations in a given year t . This variable proxies for the marginal costs of production of vitamins in China, with the idea being that lower marginal costs of production in China would translate into—holding other factors constant—higher Chinese exports to all foreign markets.

Next, four parameters were formed to discriminate between the years before and since the cartel was formed, and between those nations with active (A) active cartel enforcement regimes and those

nonactive enforcement regimes (NA). In our case, the first wheel of the vitamins cartel was formed in 1989, implying that 1990 was the first complete year that vitamins trade was distorted by a cartel's formation; and so 1990 was taken as the threshold year in which the cartel's effects were first fully felt. One can, then, denote these four parameters by $A_{<1990}$, $A_{>1990}$, $NA_{<1990}$, and $NA_{>1990}$ respectively. These four parameters, along with variable C_t and a random error term ε_{ijt} , could be added to equation (4) to form the following estimating equation:

$$\ln(M_{ijt}^v) = I_{it}A_{<1990} + (1 - I_{it})NA_{<1990} + I_{it}^*A_{>1990} + (1 - I_{it}^*)NA_{>1990} + \beta_1 \ln(M_{ijt}) + \beta_2 \ln(y_{ijt}) + \beta_3 \ln(Y_{ijt}) + \beta_4 \ln(C_t) + \varepsilon_{ijt} \quad (5)$$

where $\beta_1, \beta_2, \beta_3$, and β_4 are other parameters to be estimated also, I_{it} takes a value of one if country i has an active enforcement regime in year t (where t is before 1990) and zero otherwise, and I_{it}^* takes a value of one if country i has an active enforcement regime in year t (where t is after 1989) and zero otherwise. In this formulation an economy that implements an active cartel enforcement program in 1993 will, for example, see I_{it} takes a value of zero throughout and I_{it}^* takes a value for years before 1993 and a value of one from 1993.

If equation (5) were confronted with data and estimates of the parameters $A_{<1990}$, $NA_{<1990}$, $A_{>1990}$, $NA_{>1990}$ recovered, then the estimated differences $(NA_{>1990} - NA_{<1990})$ and $(A_{>1990} - A_{<1990})$ would reveal whether the cartel's formation leads import values to rise faster in nations without active cartel enforcement regimes than nations that do. Before discussing the econometric estimation in some detail, certain matters relating to data collection are described below.

D. Data collection

In section C. above, the following eight economies where the headquarters of the members of the vitamins cartel are located were identified: Belgium, Canada, France, Germany, Japan, the Netherlands, Switzerland, and the United States. Each of these economies exported substantial amounts of vitamins over the years 1985–1999. The goal is to examine how these trade flows were

distorted—if at all—by the creation of the vitamins cartel. The vitamins exports of other nations that housed the overseas subsidiaries of the cartel members may also have been affected by the formation of this international conspiracy, but lacking detailed data on the location of such subsidiaries the analysis focused on the exports of vitamins by the eight economies listed above.

So as to avoid assuming that the quantitative impact of each determinant of vitamins imports is the same in each continent, five distinct samples were formed; for potential vitamins importers in Africa, in Asia, in Latin America and the Caribbean, in Europe, and in Oceania. Statistics Canada's *World Trade Analyzer*—which employs the United Nations classification of economies and customs territories—was used to identify all of the potential vitamins importers in each continent. Three further adjustments were made to the set of importers. First, taking each continental sample in turn, those economies that had in the year 2000 a population of less than 5 million people or a national income that was below U.S. \$5 billion were deleted.²⁸ The rationale for this step, which is often taken in studies using the gravity equation, was that such “smaller” economies—often island economies—tend to have unrepresentative trading patterns.

Second, from each sample any economy was deleted that was formed from the breakup of two or more other economies during the years 1985 to 2000. This excluded many of the formerly Communist states, in particular those nations that emerged after the fall of the Soviet Union. This second step is rationalized on the grounds that such newly formed states would not have a complete set of observations on vitamins imports since 1985.²⁹

Third, the eight vitamins exporters were excluded from the set of potential importers on the grounds that the conspiracy may have

²⁸ The World Bank's *World Development Indicators* database was used to discern whether an economy was too “small” on either criterion.

²⁹ Another argument in favor of excluding such states is that market forces are likely to play a less important role in these economies than in countries that have not previously experienced communism.

included special market-sharing provisions for sales in the "home" markets of the cartel members. These three adjustments resulted in the African, Asian, Latin American, European, and Oceania samples comprising 31, 20, 23, 15, and 3 importers respectively. The importer composition of each sample is given in table 4.

Each continental sample contains annual observations from 1985 to 1999 on the total value of vitamins imports by each importer from each of the eight vitamins exporters identified earlier. The value of each importer's total purchases of vitamins can be downloaded from the *World Trade Analyzer* database, which is perhaps the most widely employed database on international trade flows used by empirical researchers into international trade. The 4-digit code for the product line that corresponds to trade in "vitamins and polyvitamins" is 5411. No other product line at this level of disaggregation that included the word "vitamins" in the title or descriptor was found. Moreover, further disaggregation of trade in vitamins was not possible with this database. All of the recorded import values in this database are reported in current U.S. dollars and, consequently, each observation was converted into a common base year, specifically year 2000 U.S. dollars. This was accomplished by using the U.S. price deflator for gross domestic product (the so-called U.S. GDP price deflator), which is downloadable from the World Bank's *World Development Indicators*.

Data on each importing economies' total purchases of all goods from a given exporter—that is, the observations on M_{ijt} —were also obtained from the *World Trade Analyzer* database. The absence of production data for vitamins in the eight exporting economies necessitated the construction of a proxy variable for y_{jt}^v . As total sales of vitamins by firms located within a given nation j equals the sum of its total sales within nation j and its total sales abroad, the observed level of total vitamins exports by economy j was used as a proxy for y_{jt}^v . Furthermore, for each nation i , one netted out economy i 's total imports of vitamins from j 's total annual exports of vitamins; so creating a proxy for y_{jt}^v that is denoted by $y_{-i,jt}^v$.³⁰ The final piece of

³⁰ This adjustment is needed because the dependent variable in our econometric analysis—the value of nation i 's imports of vitamins from nation j in a given year t —is obviously a component of the total exports of vitamins by nation j to all destinations, y_{jt}^v .

Table 4

Importing Economies in Each Continental Sample

<i>Continental sample</i>				
<i>Africa</i>	<i>Latin America</i>	<i>Asia</i>	<i>Europe</i>	<i>Oceania</i>
Algeria	Argentina	Bangladesh	Austria	Australia
Angola	Bolivia	Cambodia	Bulgaria	New Zealand
Benin	Brazil	China	Denmark	Papua New Guinea
Burkina Faso	Chile	Hong Kong	Finland	
Cameroon	Colombia	India	Greece	
Chad	Costa Rica	Indonesia	Hungary	
Congo	Dominican Republic	Iran	Ireland	
Cote D'Ivoire	Ecuador	Israel	Italy	
Egypt	El Salvador	Jordan	Norway	
Ethiopia	Guatemala		Poland	
Gabon	Haiti	Laos	Portugal	
Ghana	Honduras	Lebanon	Romania	
Guinea	Jamaica	Malaysia	Spain	
Kenya	Mexico	Nepal	Sweden	
Madagascar	Nicaragua	Pakistan	United Kingdom	
Malawi	Panama	Philippines		
Mali	Paraguay	Saudi Arabia		
Mauritius	Peru	Singapore		
Morocco	Trinidad	South Korea		
	Tobago	Syria		
Mozambique	Venezuela	Thailand		
Niger		Turkey		
Nigeria		Vietnam		
Rwanda		Yemen		
Senegal				
South Africa				
Tanzania				
Togo				
Tunisia				
Uganda				
Zambia				
Zimbabwe				

international trade data collected was annual data on the total value of Chinese exports of vitamins, again obtained from the *World Trade Analyzer* database.

Data on the gross domestic product (GDP) of each exporter was taken from the *World Development Indicators* database. A full set of such GDP data was available for each vitamins exporter except Germany, where GDP data were only available after 1992. The *Penn World Tables* database was the source of the German GDP data before 1992 and, before reunification, only GDP data on West Germany was used.³¹

The last step in data collection was to identify those economies where there was some evidence of active cartel enforcement. For each importer listed in table 4, the extensive number of submissions to the OECD's 2001 and 2002 Global Forums on Competition were examined to see if there were any reported cases of cartel enforcement activity that resulted in fines or some other form of sanction being imposed, or in an order to cartel members to cease their conspiracy.³² If there was such evidence then the importer is classified as having an active cartel enforcement regime in the years since 1985 or the year its anticartel law came into force, whichever is later. More specifically, three cases can be distinguished. First, in an economy where such enforcement activity was reported in OECD

³¹ This widely used cross-country dataset can be accessed at <http://datacentre2.chass.utoronto.ca/pwt> (last visited Jan. 9, 2003).

³² See http://www1.oecd.org/daf/clp/Annual_reports/1999-00.htm (last visited Jan. 9, 2003) (for recent annual reports of the national competition authorities to the OECD's Committee on Competition Law and Policy, which provide evidence of cartel enforcement activity); http://www1.oecd.org/daf/clp/GFC_October2001/ (last visited Jan. 9, 2003) (for documentation of the 2001 OECD Global Forum on Competition); <http://www.oecd.org/oecd/pages/home/displaygeneral/0,3380,EN-document-0-nodirectorate-no-20-24303-0,00.html#title0> (last visited Jan. 9, 2003) (for documentation of the 2002 OECD Global Forum on Competition). Technically, China does not have a competition law. However, measures to defraud the state—through bid rigging and the like—are illegal. To the extent that any vitamins imports were purchased by state or quasi-state bodies, then the activities of the international vitamins cartel may well constitute defrauding the state.

documentation and where the economy's anticartel legislation came into force before 1990, the indicator variable I_{it} switches from its default value of zero to one for every year since that legislation came into force and the indicator variable I_{it}^* takes a value of one for every year in the 1990s. Second, in an economy where evidence of cartel enforcement activity was found and where the economy's anticartel legislation came into force during or since 1990, the indicator variable I_{it} takes a value of zero throughout and the indicator variable I_{it}^* switches from its default value of zero to one for every year since the legislation came into force. The third case, where there is no evidence of cartel enforcement by an economy's authorities, both indicator variables I_{it} and I_{it}^* take a value of zero in every year.

An example may clarify matters. According to OECD documentation, Romania completed at least two cartel enforcement actions during the years 1997 to 2000. Given Romania passed her competition law in 1996 and that that law came into force on January 1, 1997, the algorithm above would set indicator variable I_{it} to zero throughout and indicator variable I_{it}^* to one in the year 1997 and for each year thereafter.

There is one additional wrinkle. Those importers that are members of the EU—or its predecessor the European Economic Community (EEC)—are treated slightly differently. Given Brussels increasingly tough line on cartel enforcement, a nation is said to fall under an active cartel enforcement regime in the year that it joined the EU or EEC. For those importers that joined the EC before 1990, the indicator variable I_{it} is set to one at the year of accession³³ and in every subsequent year until 1989. Furthermore, in this case, the indicator variable I_{it}^* takes a value of one for 1990 and for each year after. For those importers that joined the EU or EEC (as appropriate) during or after 1990, the indicator variable I_{it} is set to zero for each year before 1990 and the indicator variable I_{it}^* switches from its default value of zero to one in the year of EEC/EU accession and for every year thereafter. Given that several European economies joined the EEC and the EU during the years 1985 to 1999, the amount of

³³ Or in 1985, whichever is later. Recall each dataset begins in 1985 well after many nations had already joined the EEC.

commerce in vitamins that fell within the purview of Brussels-based antitrust officials is likely to have expanded over time. This intertemporal variation will be useful in identifying the effects of active cartel enforcement on the value of vitamins imports into European nations.

Following the procedure outlined above, recent OECD documentation provides evidence that the following potential vitamins importers had engaged in cartel enforcement actions or had commerce that fell within the ambit of EC competition enforcement: Australia, Austria, Brazil, Bulgaria, Chile, China, Denmark, Finland, Greece, Hungary, Ireland, Italy, Mexico, New Zealand, Norway, Peru, Poland, Portugal, Romania, South Africa, South Korea, Spain, Sweden, the United Kingdom, and Zambia. For these importers, then, the values of the indicator variables I_{it} and I_{it}^* took non-zero values at some point during the years 1985 to 1999.

This investigation-based measure of the presence of an active cartel enforcement regime is not without its drawbacks. For instance, the binary nature of the indicator does not take into account the differences in the intensity of cartel enforcement efforts between those nations that do have active enforcement regimes. Probably the best defense of the indicators employed here is that they do discriminate between nations on the basis of whether any cartel enforcement activity is reported at all to the international antitrust community that attends or follows meetings at the OECD. Arguably, a national cartel enforcement regime is unlikely to have a strong deterrent effect if members of this community—some of whom advise corporations—do not know of a regime's record in tackling price-fixing conspiracies and alike.

E. Estimation procedure

In subsection D., five continental subsamples were created, each comprising the bilateral exports of vitamins of the eight nations in which the headquarters of at least one cartel member was located. It might be tempting to confront equation (5) with data from each sample and use standard ordinary least squares techniques to recover the relevant parameters. However, this would ignore several important econometric issues.

First, many of the observed levels of vitamins imports (M_{ijt}^v) equal zero—especially in the poorest importing nations. As the logarithm of zero is undefined, this would pose a considerable problem. Often, this problem is—to put it politely—sidestepped by assuming that a dollar's worth of imports actually occurred, which yields a defined value of the dependent variable—namely the logarithm of one (which equals zero). However, there is something very unsatisfactory about assuming that a positive level of bilateral trade exists when the measured data reveal that it does not. Consequently, this article takes another tack, preferring to eliminate those observations with zero trade from the sample; arguing that the theory predicts positive levels of vitamins trade and that it is most likely—if ever—to fit the data in a setting where positive amounts of trade exist. This step—that of eliminating the zero trade observations—reduces the size of each continental sample considerably.

The second econometric problem is that since vitamins imports (M_{ijt}^v) are an element of total bilateral imports (M_{ijt}), there must be a contemporaneous correlation between the error term ε_{ijt} and M_{ijt} ; implying that ordinary least squares procedures will generate inconsistent estimates. To break this contemporaneous correlation the variable M_{ijt} is lagged by 1 year, essentially creating the variable M_{ijt-1} .³⁴ A similar but slightly different concern related to the variable C_t . Here a reduction in the formal or informal trade barriers to vitamins might result in both an increase in country i 's vitamins imports from nation j and from China. This would induce a positive correlation between ε_{ijt} and C_t , again potentially resulting in inconsistent estimates from ordinary least squares. To break this contemporaneous correlation, C_t is lagged by 1 year, using data on last year's total Chinese exports of vitamins to all export destinations, C_{t-1} .

As noted in subsection D., our proxy for country j 's production of vitamins (y_{jt}^v) is—in the absence of direct data on the production of vitamins—country j 's total export of vitamins in year t (net of its vitamins) exports to country i . This variable too could be

³⁴ Furthermore, the value of the dependent variable in year $(t-1)$ was subtracted from M_{ijt-1} . Thus the variable M_{ijt-1} is the lagged value of all nonvitamins imports by nation i from nation j .

contemporaneously correlated with the error term, and so $y_{i,jt}^v$ is lagged by 1 year also. This is the third adjustment to equation (5).

A final econometric concern is that the estimation results may be sensitive to outliers. This issue has been systematically explored in another gravity-equation-related context³⁵—which also made extensive use of dummy variables—and it was found that the inclusion of outliers substantially affected the estimated parameters of interest. In that study only when the 10% of the sample that had the largest (in absolute value) residuals were deleted was a semblance of parameter stability restored. The sample concern was explored here by trimming 1%, 5%, and 10% (and more) of each continental sample, and examining how stable the parameter estimates were as more and more outliers were removed. Only when the largest 10% of each sample's outliers were trimmed were the parameter estimates found to settle down. For this reason, the regression results presented below are from each continental sample after the data points that were in the top ten percentile of residuals (as measured in absolute value) were eliminated. In sum, each continental sample included observations on vitamins imports from 1986 to 2000. The African, Asian, European, Latin American, and Oceania samples included 1011, 1662, 1333, 1288, and 176 observations respectively.

In the light of the foregoing remarks the econometric specification taken to each sample is:

$$\ln(M_{ijt}^v) = I_{it}A_{<1990} + (1 - I_{it})NA_{<1990} + I_{it}^*A_{>1990} + (1 - I_{it}^*)NA_{>1990} + \beta_1 \ln(M_{ijt-1}) + \beta_2 \ln(y_{i,jt-1}^v) + \beta_3 \ln(Y_{jt}) + \beta_4 \ln(C_{t-1}) + \varepsilon_{ijt}. \quad (6)$$

This specification does not include a direct role for the distance between countries i and j , which the traditional proxy for international transportation costs in gravity equation studies. However, it should be pointed out that higher levels of such costs would reduce total bilateral imports, so reducing M_{ijt-1} . More generally, many time-invariant and time-varying determinants of bilateral imports of

³⁵ S. J. Evenett, *The Impact of Economic Sanctions on South African Exports*, 49 SCOTTISH J. POL. ECON. 557 (Nov. 2002).

vitamins (such as bilateral exchange rates and distance) will also affect total bilateral imports; and so the latter variable (i.e. M_{ijt-1}) can act as a control for a number of potentially important determinants of vitamins imports.

The econometric parameters for each continent are reported in table 5. With the exception of the African sample, in which no country had an active cartel enforcement regime in the 1980s, a full set of parameters were estimated. It is noticeable that all three of the gravity-inspired control variables have the correct sign and are statistically significant. Moreover, the effect of Chinese vitamins exports on the value of sales of cartelized imports is uniformly negative. In Africa, a 1% increase in Chinese exports resulted in a 0.16% reduction in African imports of vitamins from each cartel member. The strength of the "discipline" imposed by Chinese exports on the vitamins cartel varies considerably across continental samples: in Oceania it is four times as strong as it is in Africa. This may reflect the fact that trade barriers are lower in Oceania than in Africa.

The parameter estimates for the European sample was found to be sensitive to the inclusion of the four Eastern European countries in the sample; namely, Bulgaria, Hungary, Poland, and Romania. Arguably the role that market forces played in determining imports of all goods—not just vitamins—may be less in Eastern European economies than in Western Europe, in which case pooling Eastern and Western European import data into the same sample may not be appropriate. For this reason the estimation results for a Western European sample (labeled Europe (West only)) and the full European sample (labeled Europe (West and East)) were reported. In discussing the econometric results for European nations, this article refers to the Western European sample.

F. Principal empirical findings

The estimated parameters on the impact of the cartel's formation on the total value of imports vary considerably across continents and within continents; the latter in systematic ways. To facilitate interpretation, for each continent the implied percentage increase in the total value of vitamins imports that occurs in an economy that did not have an active

Table 5
Parameter Estimates by Continental Sample

Parameter	Predicted sign of parameter estimate	Africa	Continental sample: parameter estimate (t statistic)				Latin America	Oceania
			Asia	Europe (West and East)	Europe (West only)	Europe (West only)		
Constants for pre-1990	Enforcer Nonenforcer	n.e. 2.1203 (1.4130)	-4.3739 (-3.9041) -5.1017 (-4.6546)	-1.6375 (-1.4204) -1.6496 (-1.4351)	-2.2260 (-1.7467) -2.9372 (-2.3066)	5.1366 (4.5902) 4.6582 (4.1744)	1.0646 (0.4257) 0.6614 (0.2499)	
Constants for post-1990	Enforcer Nonenforcer	3.5174 (2.1632) 2.5477 (1.5886)	-4.5234 (-3.829) -4.7613 (-4.0652)	-1.5374 (-1.2241) -1.7888 (-1.4864)	-2.066 (-1.5133) -2.5172 (-1.8945)	5.4591 (4.5900) 5.0836 (4.2642)	1.6876 (0.6356) 0.1981 (0.0699)	
Last year's total imports from exporter	+	0.8448 (30.5812)	0.6664 (33.7044)	0.6920 (33.9013)	0.8616 (32.1887)	0.9236 (40.8392)	1.0912 (16.5695)	
Exporter's national income	-	-0.4716 (-1.0261)	-0.2478 (-8.5971)	-0.3261 (-13.5715)	-0.3884 (-14.5647)	-0.8556 (-26.7847)	-0.4801 (-6.1209)	
Proxy for exporter's total vitamins production	+	0.4690 (14.5036)	0.7836 (34.1105)	0.8263 (37.5782)	0.8558 (35.0157)	1.0273 (38.3862)	0.7767 (17.0237)	
Last year's total vitamins exports from China	-	-0.1639 (-2.2588)	-0.2051 (-3.7587)	-0.3230 (-5.6170)	-0.4392 (-6.9414)	-0.3110 (-5.6505)	-0.6329 (-5.5073)	
Number of observations (without outliers)		1011	1662	1333	1030	1288	176	
R-squared		0.5472	0.6315	0.7004	0.7377	0.7385	0.8334	

NOTE: n.e. implies that the relevant parameter could not be estimated in the sample.

cartel enforcement regime before 1990 and since 1990 is reported in table 6. The comparable increase for those economies with active cartel enforcement regimes is also reported in table 6. In the Asian, Western European, and Latin American samples a distinct pattern emerges: the formation of the vitamins cartel is associated with a greater increase in the value of total imports in those economies that do not have active cartel enforcement regimes. In the case of Latin America, those economies without such regimes saw the value of their vitamins imports rise by over 50% after the cartel was formed. In contrast, those Latin American economies with active cartel enforcement regimes found the total value of their vitamins exports rise by less than 40%. More generally, assuming the price inelasticity of demand for vitamins is comparable in both types of Latin American economy, then the empirical results presented here support the proposition that the vitamins cartel raised prices more in those Asian, Western European, and Latin American economies that do not have active cartel enforcement regimes.

Table 6

Implied Growth Rates of Total Imports after the Cartel's Formation,
by Continental Sample

<i>Implied estimated percentage growth in the total value of imports of an economy that ...</i>	<i>Continental sample</i>				
	<i>Africa</i>	<i>Asia</i>	<i>Europe (West only)</i>	<i>Latin America</i>	<i>Oceania</i>
did not have a cartel law before or after 1990	53.3	40.1	52.1	53.0	-38.1
did have a cartel law before and after 1990	n.e.	-13.9	17.4	38.1	86.4

NOTES: 1. As none of the African economies whose cartel enforcement was reported to the OECD had a cartel law before 1990 the implied change in imports that is associated with the formation of the vitamins cartel cannot be calculated from the estimated parameters.

2. The large reduction in vitamins imports after 1990 that is found in Oceania in economies without a cartel law is computed from parameter estimates that were themselves identified with two data points (out of a sample of 176 data points). Prudence suggests that this finding be ignored.

Oceania is the only sample where having an active cartel enforcement regime was found to have raised the total value of an economy's imports of vitamins more than not having such a regime. This sample is much smaller than the others (with 176 observations compared to 1011 observations in the African sample, the next smallest dataset) and contains data on the importing patterns of only three economies: Australia, New Zealand, and Papua New Guinea. Moreover, the estimated parameters for nonactive cartel enforcement regimes were identified from only four observations; all from one importer, Papua New Guinea. It is quite likely that some other factor—such as political instability in this one country in the 1990s—may have reduced imports and has influenced these parameter estimates. Consequently, it is doubtful that this finding is representative of the determinants of importing patterns in countries other than Papua New Guinea. In sum, in the three continental samples with a sizeable number of importing economies and where comparisons between those economies that had active cartel enforcement regimes and those that did not were possible, it is possible to find that the formation of the vitamins cartel was associated with a greater increase in imports above a commonly used empirical benchmark for bilateral trade flows.

Overall, these empirical findings provide support for the contention that strong cartel enforcement regimes have a deterrent value. Of course, such regimes may reduce the probability of a cartel being formed in the first place. That is not the effect being considered here. Rather, once a cartel is formed, the presence of a strong enforcement regime limits the damage that a cartel is willing to wreak. Overcharges tend to be lower in such regimes—even if the cartel is never actually prosecuted. The question is how much lower, but first estimates of the overcharges paid by each economy on their vitamins imports are presented.

Table 7 reports in year 2000 U.S. dollars the overcharges paid by 90 importing economies during the years 1990 to 1999. The overcharges were calculated using the estimated impacts of the cartel's formation on the value of imports that were reported in table 5 and take into account the fact that some economies may have only

begun to actively enforce anticartel measures during the 1990s.³⁶ Since countries differ considerably in the amount of vitamins that they imported throughout the 1990s, it should not be surprising that the estimated overcharges vary across economies. Having said that, in eight economies the estimated overcharges exceeded one hundred million U.S. dollars. What is more, in 35 more jurisdictions the estimated overcharges exceeded ten million U.S. dollars. In total, the estimated overcharges on vitamins paid by buyers in these 90 economies equaled 2709.87 million U.S. dollars; that is, just under two and three-quarter billion U.S. dollars. Such overcharges represent a sizeable transfer of rent between constituents of the world economy.

The next step was to estimate how much larger an economy's overcharges would have been if it did not have an active cartel enforcement regime. This provides an estimate of one of the savings that accrue to economies with such regimes. This calculation was performed for the Western European economies in the sample and for four Latin American economies (Brazil, Chile, Mexico, and Peru) where there was some evidence—in OECD documentation—of active cartel enforcement in the 1990s. The additional overcharges that would have resulted if these economies did not have an active cartel enforcement regime are reported in table 8. The annual estimated increase in overcharges on vitamins is reported in the third column and varies from \$700,000 in Peru to over \$30 million in Italy. For as many economies listed in this table as possible, data on the central government's annual outlays on its competition enforcement agency was collected; a figure that

³⁶ For those Asian economies with active enforcement regimes in the 1980s and the 1990s, the parameter estimates in table 5 suggest that the formation of the vitamins cartel would have been associated with a fall in the total value of vitamins imports. In principle there is nothing anomalous with this finding especially if the punishments for cartelization are very severe. However, so that the estimates of overcharges do not depend in any way on this particular econometric finding, the overcharges were calculated for these Asian economies assuming the formation of the vitamins cartel had no effect on the total value of vitamins imports into those economies. This essentially sets to zero the estimated overcharges in South Korea, which is therefore omitted from table 7.

Table 7

Estimated Overcharges From the International Vitamins Cartel, 1990-1999
in Year 2000 U.S. Dollars, by:

<i>Importing economy</i>	<i>Millions of U.S. dollars</i>		
	<i>Overcharges paid on vitamins imports during the conspiracy</i>	<i>Total value of imports during years when importer did not have cartel law</i>	<i>Total value of imports during years when importer did have a cartel law</i>
<i>Economies with evidence of cartel prosecutions in OECD documents</i>			
Brazil	183.37	0.00	665.19
Australia	154.70	0.00	333.63
Italy	153.78	0.00	1040.09
Mexico	151.98	111.33	411.38
U.K.	147.64	0.00	998.57
Denmark	138.49	0.00	936.62
South Africa	99.93	173.56	39.57
Spain	91.89	0.00	621.47
China	77.61	72.35	566.73
Austria	44.22	88.34	94.16
Chile	38.43	0.00	139.41
Poland	31.50	0.00	213.07
New Zealand	29.26	0.00	63.11
Hungary	24.71	48.73	54.11
Sweden	23.47	36.10	75.03
Norway	19.27	34.85	49.47
Romania	18.99	48.36	16.29
Peru	18.91	3.32	64.43
Ireland	17.76	0.00	120.10
Finland	16.44	28.06	46.08
Greece	13.73	0.00	92.83
Portugal	12.77	0.00	86.39
Bulgaria	5.04	2.87	27.47
Zambia	0.06	0.14	0.01
<i>Economies with no evidence of cartel prosecutions in OECD documents</i>			
Singapore	245.22	849.93	0.00
Hong Kong	178.48	618.61	0.00
Turkey	82.89	287.31	0.00
Thailand	78.45	271.91	0.00
Argentina	73.83	213.08	0.00
Colombia	54.95	158.60	0.00
Indonesia	48.72	168.85	0.00
Venezuela	45.32	130.81	0.00
Iran	44.25	153.35	0.00
Egypt	38.49	110.66	0.00
Pakistan	36.82	127.62	0.00
Israel	32.30	111.97	0.00
Philippines	29.58	102.53	0.00
Honduras	25.87	74.65	0.00
India	25.71	89.12	0.00
Malaysia	22.94	79.50	0.00
Ecuador	14.82	42.78	0.00
Saudi Arabia	13.11	45.43	0.00
Morocco	12.44	35.77	0.00
Algeria	11.09	31.88	0.00

Millions of U.S. dollars

<i>Importing economy</i>	<i>Overcharges paid on vitamins imports during the conspiracy</i>	<i>Total value of imports during years when importer did not have cartel law</i>	<i>Total value of imports during years when importer did have a cartel law</i>
<i>Economies with no evidence of cartel prosecutions in OECD documents</i>			
<i>(continued)</i>			
Guatemala	10.41	30.05	0.00
Nigeria	7.00	20.14	0.00
Bangladesh	6.42	22.26	0.00
Syria	5.79	20.08	0.00
Paraguay	4.57	13.18	0.00
Tunisia	4.45	12.80	0.00
Vietnam	4.38	15.19	0.00
Costa Rica	3.82	11.03	0.00
Bolivia	3.45	9.97	0.00
Zimbabwe	3.41	9.80	0.00
Lebanon	3.11	10.77	0.00
Dominican Republic	3.07	8.86	0.00
El Salvador	2.70	7.80	0.00
Jordan	2.54	8.82	0.00
Jamaica	2.11	6.09	0.00
Kenya	1.79	5.16	0.00
Ghana	1.32	3.81	0.00
Nepal	1.21	4.21	0.00
Nicaragua	1.20	3.46	0.00
Cote D'Ivoire	0.88	2.53	0.00
Senegal	0.82	2.36	0.00
Trinidad Tobago	0.81	2.33	0.00
Panama	0.68	1.96	0.00
Madagascar	0.60	1.73	0.00
Ethiopia	0.59	1.69	0.00
Yemen	0.58	2.02	0.00
Mali	0.49	1.41	0.00
Mauritius	0.46	1.33	0.00
Cameroon	0.39	1.12	0.00
Cambodia	0.28	0.98	0.00
Benin	0.22	0.63	0.00
Togo	0.19	0.53	0.00
Tanzania	0.16	0.46	0.00
Haiti	0.11	0.33	0.00
Angola	0.11	0.33	0.00
Gabon	0.09	0.27	0.00
Niger	0.07	0.19	0.00
Congo	0.06	0.19	0.00
Burkina Faso	0.06	0.17	0.00
Malawi	0.05	0.13	0.00
Rwanda	0.04	0.12	0.00
Uganda	0.03	0.10	0.00
Guinea	0.03	0.09	0.00
Laos	0.03	0.10	0.00
Chad	0.01	0.04	0.00
Mozambique	0.00	0.01	0.00

NOTES: 1. Total value of overcharges for imports into these 90 economies is 2709.87 million U.S. dollars.

2. This table does not include overcharges for Papua New Guinea or for Korea.

can include spending activities other than cartel enforcement also.³⁷ Such data were found for nine economies and is reported in the fourth column of table 8. Comparing columns three and four one can calculate *on average* how many cents of savings (from lower overcharges on this single cartel) resulted from each dollar of government spending on competition enforcement: a calculation that is reported in the fifth column of table 8. The savings-per-dollar-spent varied considerably across economies, from 7 cents per dollar spent in Peru to over 320 cents per dollar in Denmark. Even in an intermediate case, such as Mexico, each dollar spent on its competition enforcement agency resulted in a 46 cent saving on overcharges from the vitamins cartel alone.

The results in table 8 for the members of the European Union must be interpreted with care as the bulk of enforcement actions against international cartels comes from EC-led initiatives and not from national capitals. For each of the European economies listed in table 8 (above the line labeled "memorandum"), the estimated additional overcharges was compared with the annual cost of the country's national competition authority or authorities. To provide a larger Europe-wide perspective, the total additional overcharges paid by the 10 European Union members listed in table 8 was calculated. The additional overcharges that would have been paid in the absence of the prevailing cartel enforcement regimes totaled 1270.78 million U.S. dollars; a figure that is reported in the bottom row of table 8. These savings were compared to the sum of available data on these 10 economies' own governmental outlays on their national competition authorities plus the cost of running the competition enforcement agency in Brussels. This sum amounted to 127.5 million U.S. dollars at the end of the 1990s. Consequently, the annual savings-per-dollar spent on such European competition enforcement was 96

³⁷ It was not possible to find the government outlays on anticartel enforcement activities alone. The principal source for these outlays were the governments' own reports to the OECD's Committee on Competition Law and Policy, as analyzed in R.W. Hahn & A. Layne-Farrar, *Federalism in Antitrust* (2001) (mimeo, AEI-Brookings Joint Center on Regulation, at table 2. In the cases of Brazil and Peru the data on government outlays was taken from the Web pages of the relevant competition authority.

Table 8
Estimating the Average Savings-per-Dollar Spent on Competition

<i>Economy</i>	<i>Additional overcharges in the absence of a cartel law (millions of U.S. dollars)</i>	<i>Annual average during 1990-1999</i>	<i>Annual Cost of competition authority (1999-2000)</i>	<i>Return on each dollar spent; ratio of previous columns</i>	<i>Overcharges actually paid (millions of U.S. dollars)</i>
	<i>Total throughout the conspiracy</i>				
Austria	27.96	2.80			44.22
Brazil	72.09	7.21	0.15	48.06	183.37
Chile	15.11	1.51			38.43
Denmark	278.11	27.81	8.70	3.20	138.49
Finland	13.68	1.37	3.40	0.40	16.44
Greece	27.56	2.76			13.73
Ireland	35.66	3.57	1.60	2.23	17.76
Italy	308.83	30.88			153.78
Mexico	44.59	4.46	9.70	0.46	151.98
Norway	14.69	1.47	7.70	0.19	19.27
Peru	6.98	0.70	10.05	0.07	18.91
Portugal	25.65	2.57			12.77
Spain	184.53	18.45			91.89
Sweden	22.28	2.23	7.30	0.31	23.47
U.K.	296.51	29.65	46.60	0.64	147.64

Memorandum:

Sum of entries for	
EU members above	1220.78
	122.08
	127.50
	660.19
	0.96

NOTE: The cost of the European Commission's competition enforcement authority was added to the line "EU members above."

cents.³⁸ That is, the strength of the deterrent of European cartel enforcement in the 1990s was such that the reduction in overcharges by a single cartel alone would have "paid" for a substantial proportion of state outlays on competition policy enforcement in Europe.

It is worth noting that the above average savings-per-dollar spent calculations clearly do not represent a full cost-benefit analysis of the effects of robust cartel enforcement. The above calculation takes into account all government outlays on national competition policy enforcement, not just on anticartel activities. Moreover, our calculation of the savings only includes those from one (admittedly particularly large) cartel. These factors skew the calculation toward finding lower societal benefits from cartel enforcement than is actually the case. Furthermore, a full cost-benefit analysis would take into account the benefits to society of deterring the formation of cartels in the first place. Working in the other direction are the costs to society of any unwarranted harassment—or even outright corruption—that may result from activities by officials that purport to be cartel enforcement. It is not the contention of this article that these costs are substantial or that harassment and corruption are rife, merely that such effects are not part of the calculus developed here.³⁹ Overall,

³⁸ In interpreting this finding two additional points should be borne in mind. First, the total additional overcharges were calculated with data for only 10 out of the 15 EU members. (Four of the other five EU members had at least one cartel member headquartered inside their borders and so are the exporters of vitamins in our empirical analysis. Plus, Belgium and Luxembourg's international trade data are reported together and so Luxembourg was effectively treated as an exporter in our empirical analysis.) Arguably, the inclusion of additional overcharges by vitamins buyers in these five other EU economies would have raised the total savings to European purchasers from strong cartel enforcement. Second, and working in the opposite direction, the calculation of the total government outlays on competition enforcement at the national and supranational level does not include outlays on the Austrian, Greek, Italian, Portuguese, or Spanish national competition authorities. We could not find data on the latter outlays.

³⁹ In this respect it is interesting to note that number of current and former World Bank officials who claim that one of the reasons why developing economies should not enact anticartel legislation or enforce such legislation is that it opens the possibility of corruption by officials and harassment of the private sector.

then, in economies where corruption and harassment are not issues, the calculus presented here will almost certainly constitute an underestimate of the benefits of strong cartel enforcement regimes.

V. Concluding remarks

In the last 15 years many nations enacted competition laws for the first time or sought to revive moribund competition enforcement agencies. As these agencies begin to tackle perceived anticompetitive practices in the private sector, it is reasonable to expect that there will be greater scrutiny of the costs and benefits of competition policy enforcement. The recent enforcement actions against the international vitamins cartel provides one lens through which to assess the magnitude of the potential benefits of cartel enforcement, one important component of national competition laws.

An econometric evaluation—continent by continent—of the determinants of international trade in vitamins before and after this cartel's formation supports the contention that this cartel inflicted greater harm—in the form of overcharges—on those economies without active cartel enforcement regimes. What is more, in seven out of nine economies considered here—in particular, in Europe—the reduction in overcharges brought about by the presence of an active cartel enforcement regime was large enough that it covered a substantial proportion of the entire cost of competition policy enforcement. For example, the estimates presented here suggest that the annual reduction in overcharges in several European nations during the 1990s was equivalent to 96% of the total cost of enforcing competition policy in those nations (including the costs of running Brussels-based competition policy). Without suggesting that such calculations constitute a full cost-benefit analysis of competition policy, they do suggest that one important element of the latter has paid substantial dividends during the 1990s.

The overcharges on vitamins imports by 90 economies during the years 1990 to 1999 was found to be U.S. \$2709.87 million; that is, just under two and three-quarter billion U.S. dollars. This amount is almost certainly an underestimate of the total overcharges on all vitamins transactions during the cartel's duration for two reasons.

First, only overcharges on imports were considered here—not overcharges on purely intranational transactions. Second, the calculations presented here do not include any overcharges that might have occurred in the eight economies where the headquarters of the cartel members were located. Since these eight economies included the world's three largest economies—the United States, Germany, and Japan—it would be surprising if the estimated overcharges presented here are a fraction of the worldwide total overcharges.

This article's empirical findings are particularly relevant to the debate as to whether WTO members should adopt cartel laws as part of a potential multilateral agreement on competition policy as it implies that nations—both developing and industrial—without well-functioning cartel enforcement bodies are likely to be especially harmed by private international cartels. It is worth bearing in mind that these cartels take advantage of the very moves toward open borders that multilateral trade reforms seek to encourage. This article's findings suggest that the deterrent value of a nation's rigorous cartel enforcement regime may go a long way to paying for itself by reducing the overcharges that existing and future cartels are likely to charge buyers within the nation's borders. These reductions in overcharges are in addition to any benefits that accrue from deterring the formation of cartels in the first place. Since the estimated benefits from rigorous national cartel enforcement are—on the basis of this analysis of just one international cartel—substantial, it would seem that the often-raised concern about the costs of implementing a multilateral commitment to enact and enforce a national cartel law may well be misplaced.

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