The Impact of
Private International Cartels on
Developing Countries

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Abstract: Private international cartels are conspiracies among firms from multiple
countries to reduce market competition in an agreed upon industry and may have
considerable welfare implications for both consumers and producers worldwide. This
study investigates the impact of such cartels on developing countries by estimating the
welfare loss felt by developing countries’ consumers. Consumer welfare loss is composed
of two parts – an overcharge and a deadweight loss. In addition to estimating the
overcharge of six recent international cartels, the study uses regression models to derive
the total welfare loss of one – the seamless steel tubes cartel. Findings show that the total
welfare loss felt by developing countries’ consumers from the seamless steel tubes cartel
amounted to $1.4 billion. Upon coupling the empirical results with analysis of antitrust
policies, this paper concludes that the deterrence power embedded in existing antitrust
policies is insufficient in combating international cartels that hurt developing countries.
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For most people, international cartels bring to mind collusion in drug, oil and diamond, certainly not in vitamins or bromine, or seamless steel tubes. The topic of this paper often takes some explaining because the relevant industries are so foreign to the public ear. But its relative obscurity is what makes it so interesting. Harm is greatest when it goes unnoticed, and so little is known about cartels that are located in the north of world. Only recently have antitrust authorities in the industrialized countries recognized the graveness of the consequent market distortions in their domestic markets, and international organizations recognized their effects on the developing world. The world has started to take some steps in the right direction. Are they enough? As always, the sufferings of developing countries tend to be marginalized. This paper looks at the effect of private international cartels on developing countries in hopes of encouraging initiatives to combat such cartels on their behalf.

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Rapid global economic integration has created invaluable opportunities for developing countries to grow, through gaining foreign technology, participating in global production networks, and not least through increasing domestic market competition by opening the countries’ borders to foreign goods and services. The growth of trade in goods and services, however, has also made developing countries more vulnerable to foreign sources of anti-competitive behavior. Private collusion is one significant source of foreign competitive behavior. In recent years, various multilateral organizations and competition authorities, including the OECD, the U.S. Department of Justice, and the European Commission, have become increasingly concerned with international market distortions that result from the price and market rigging of large private cartels formed by firms across industrialized countries that stifle competition in the markets of both industrialized and developing countries.

While the anticompetitive behaviors of private cartels may affect numerous markets, their prosecution is national and specific to the damage they have done to the relevant domestic market. Industrialized countries have strong competition authorities to prosecute these crimes, such as the European Commission acting for the European Community and the Department of Justice acting for the United States. In contrast, only a
handful of developing countries have competition authorities, and even fewer have competent competition authorities. As such, the activities of cartels that affect the developing markets often continue unprotected.\(^1\)

From a purely economic efficiency standpoint, the world as a whole would be better off if private cartels were banned.\(^2\) From a pro-development perspective, it is especially important to prosecute cartels that hurt developing country consumers and hamper the development of the countries’ potentially important export sectors. This paper examines the impact of international cartels on developing countries and evaluates some options of fighting them.

The paper is organized as follows: Chapter 1 sketches cartel theory and discusses existing research in this field, Chapter 2 uses regression models to estimate the strength and welfare effects of the seamless steel tubes cartel, and Chapter 3 considers existing antitrust policies and possibilities for their improvement.

\(^{1}\) Even after a cartel is busted and its members fined by competition authorities of industrialized countries, cartelization of developing country markets may continue.

\(^{2}\) Exemptions may be put into place for cartels that help small producers export who could otherwise not do so.
Chapter One
Private International Cartels – In Theory and Practice

International cartels are agreements among firms of multiple economies to limit market competition…

Cartels come in many shapes and colors. This paper focuses on what has been made known as “hard core” cartels – explicit price fixing or market division agreements among private producers from multiple economies. These international cartels are created to limit competition within specific industries. By increasing price and restricting output, the cartel members enjoy extra profits that they could not in a more competitive marketplace.

The welfare effects of collusion are illustrated in the following figure. A cartel operating at its peak is like a monopoly, and chooses to produce and price at where marginal revenue equals marginal cost. Assuming constant marginal revenue, the monopoly profit takes the shape of the rectangle designated by MP and outlined by Pm, Pc and Qm in the following figure. As the monopoly profit is a welfare transfer from the consumers to the producers, it is also referred to as the consumer overcharge. The triangle designated by DWL is the consumer deadweight loss resulting from collusion. The magnitudes of the overcharge and dead weight loss are, to a large extent, determined by the properties of the demand curve. For example, a steeper demand curve is associated with a larger dead weight loss, given a monopoly quantity.

Figure 1.1 The Welfare Effects of Collusion
Collusion may also hurt producers, but that effect cannot be readily captured graphically.

Two conditions contribute to the sustainability of collusion: 1) a sufficiently high level of collusion profit and 2) punishment for defection. The members’ estimation of the potential extra profits from collusion determines their motivation to collude - the level extra profits is a function of the price elasticity of demand, the discount rate used by the would be cartel members, and the variability of demand for the would be cartel product. The lower the elasticity of demand, the lower the discount rate, the lower the variability of demand, the larger the profit increase from collusion. A sustainable collusion is represented by the following conditions:

\[ E(\text{defecting today}) + E(S(\text{following defection})^d) < E(S(\text{colluding forever})^d) \]

Punishment for defection are enforced by cartel members, often in the form of forcing the defector to compensate the other members in monetary terms that significantly reduces the defector’s profits.

The potential impacts of internal cartel activities on developing countries are large…

Many international cartels have been known to hurt both consumers and producers of developing countries - consumers suffer from the price increase and producers are barred from exporting to the markets of the cartel members.

The most current trade data available dates from 1997 (as will be explained, trade data provides the best proxy of the cartel’s impact on developing country consumers), in which the amount of imports by developing countries from a sub-sample of 19 industries that experienced collusion during the 1990s stood at $54.7 billion. That represents 5.2% of developing countries’ total imports and 1.2% of their total GDP. Resulting price increase range from 10%, in the case of thermal fax paper cartel, to 100%, in the case of
stainless steel cartel. Even taking the conservative estimate of 10% would produce an overcharge estimation of an astounding level. (A cartel is intended to raise the price of a good across the board, regardless of whether the producer of the good is a cartel member. In calculating the overcharge, the relevant figures would therefore be the total imports to developing countries and the price increase.) Consumers may further suffer from a more limited array of differentiated products.

Methods that cartel members have used to thwart entry by developing country producers include tariff barriers and anti-dumping duties against countries of potential entrants. Sometimes it is hard to determine whether barriers to entry exist because public records from the antitrust authorities have not discussed the issue at length. This is true in particular for cartels prosecuted by the DOJ, which holds price fixing *per se* illegal. But while their existence is not necessary for the formation of collusion, theory and anecdotal evidence suggest that barriers to entry are crucial in maintaining the profitability of collusion. As such, it is safe to speculate that many of the known international cartels must have attempted to establish some level of barriers to entry against potential competitors, and that some of these potential competitors would have originated from developing countries. One clue pointing to this conclusion is the emergence of joint ventures between previous cartel members and incoming developing country producers in the aftermath of the cartel. Joint ventures allow experienced producers from the developed world to limit the sales of their counterparts in the developing countries. While it is certainly true that joint ventures may also benefit developing country consumers through technology transfer or capital support, they drastically reduce competition between developing country and industrialized country producers.

It is important to note that international cartels may also benefit producers of developing countries. A cartel sets an industry price umbrella. It is possible that a limited number of developing country producers, who do not belong to the cartel, are allowed to sell at or slightly below the cartel price. Any benefits that may accrue to developing country producers, however, should be carefully weighed against the costs of reduced market competition.
Measuring the true impact of international cartels on developing countries is difficult…

The difficulty of estimating the impact of international cartels on developing countries lies in the unquantifiable nature of many factors. For example, it is often not possible to quantify the loss suffered by developing country producers. Economists are forced to confine their analysis to consumer loss. In estimating consumer loss, they have focused mainly on the overcharge to consumers due to difficulties in deriving the dead weight loss.

The U.S. Department of Justice and the European Union’s European Commission have together busted over forty international cartels in the 1990s, but legal formalities prevent the antitrust authorities from fully disclosing information they obtained during their investigations to the public. Economists therefore proxy company sales using international trade data, where imports of goods by developing countries from countries that hosted the cartel producers are used to estimate the cartels’ sales to developing countries. Specifically, the imports of a cartel good to developing countries, from the world, are taken as the basis for calculating the overcharges to developing countries’ consumers. This estimation suffers from several shortcomings. The import data used for the estimation is documented by individual developing countries using the Standard International Trade Code (SITC). While trade authorities in these countries have an incentive to do a good job at documenting import figures for the purpose of tariff and tax collection, lack of funding and resources, among other factors, may result in unreliable documentations. Furthermore, the SITC is not a highly product sensitive classification system, so the import figures it provide may encompass transactions of goods that do not belong in the cartel. Fortunately, the errors could cancel each other out to some degree - the former flaw results in an underestimation of cartel imports to developing countries while the latter an overestimation.

I minimize the overestimation from SITC calculations by using instead import data based on the Harmonized System (HS), a more product sensitive trade classification. In the case of the vitamins cartel, for example, HS database provides trade levels of the specific vitamins cartelized instead of a simple aggregate for the whole industry. The
overcharge estimates derived from HS trade data is presented in the following table for six cartels – the vitamins cartel (1990-1999), the citric acid cartel (1991-1995), the bromine cartel (1995-1998), the seamless steel tubes cartel (1990-1995), the graphite electrodes cartel (1992-1997), and the lysine cartel (1992-1995). Overcharge is calculated as imports / (1+price increase) * price increase, and the price increase is estimated from the observed price drop subsequent to the cartel’s demise. The results indicate that the overcharges to developing countries generated by collusion are large - U.S. $1.71 billion, $67 million, $8 million, $1.19 billion, $975 million and $43 million from collusions in the vitamins, citric acid, bromine, seamless steel tubes, graphite electrodes and lysine industries, respectively.
### Table 1.1

#### Estimate of Cartel Sales and Overcharge

<table>
<thead>
<tr>
<th>Product</th>
<th>Years of Cartel</th>
<th>Number of Firms</th>
<th>Country of Origin of Indicted Firms</th>
<th>Cartel Sales</th>
<th>Imports to Developing Countries</th>
<th>Price Increase</th>
<th>Possible Overcharge to Developing Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamins (SITC-5411; HS-293621, 293623, 293624, 293625, 293627, 293628)</td>
<td>90-99</td>
<td></td>
<td>U.S., Japan, Canada, Switzerland, Germany</td>
<td>$26.43 billion</td>
<td>$10.75 billion</td>
<td>$11.78 billion</td>
<td>$6.61 billion</td>
</tr>
<tr>
<td>Citric Acid (SITC-5139; HS-291814)</td>
<td>91-95</td>
<td>11</td>
<td>U.S., Germany, Switzerland, Netherlands, Austria, France</td>
<td>$9.86 billion</td>
<td>$447 million</td>
<td>$2.41 billion</td>
<td>$400 million</td>
</tr>
<tr>
<td>Bromine (SITC-52214; HS-280130)</td>
<td>95-98</td>
<td>2</td>
<td>Israel, U.S.</td>
<td>$598 million</td>
<td>$409 million</td>
<td>$356 million</td>
<td>$59 million</td>
</tr>
<tr>
<td>Seamless Steel Tubes (SITC-6782; HS-7304)</td>
<td>90-95</td>
<td>8</td>
<td>France, Germany, Italy, Japan, UK</td>
<td>$26.63 billion</td>
<td>$21.66 billion</td>
<td>$17.97 billion</td>
<td>$13.07 billion</td>
</tr>
<tr>
<td>Graphite Electrodes (SITC-77887; HS-854511, 854519)</td>
<td>92-97</td>
<td>8</td>
<td>Germany, U.S., Japan</td>
<td>$8.97 billion</td>
<td>$7.00 billion</td>
<td>$4.34 billion</td>
<td>$3.14 billion</td>
</tr>
<tr>
<td>Lysine (SITC-5146; HS-292241)</td>
<td>92-95</td>
<td>5</td>
<td>U.S., Japan, South Korea</td>
<td>$4.80 billion</td>
<td>$913 million</td>
<td>$3.23 billion</td>
<td>$470 million</td>
</tr>
</tbody>
</table>

Note – Cartel sales are approximated using export statistics from countries of origin of indicted firms. If participating firms are multinationals and the locations of their subsidiaries are known, sales is calculated by taking into account the exports of subsidiaries countries. When that information is unavailable and production is understood to be global, sales is calculated using exports of all countries producing the cartel product. Because the vitamins cartel ended in February 1999, sales and overcharge estimates are aggregated from 1990 to 1998.
The following pages briefly summarize the activities of each cartel and relevant industry information.

**Vitamins**

The vitamins cartel operated from 1990 to 1999. (Because the cartel ended in February, 1999, imports are aggregated from 1990 to 1998.) The cartel consisted of a series of conspiracies in the vitamin A, B2, B3, B4, B5, B6, Beta-carotene, C, E, and vitamin premixes sub-markets. Arrangements among cartel members were conspiracy specific, but they also shared the following elements: price fixing and market division, information sharing among members to enforce the cartel agreement, and in some cases bids rigging for contracts to supply vitamins. The U.S. Department of Justice, the Canadian Competition Bureau, and the European Commission, have each investigated and prosecuted the cartel for its effect on their respective domestic markets. The U.S. and Canadian authorities fined the cartel approximately $1 billion, the EC Euro 855 million, respectively.

The main members of the cartel were headquartered in Japan, the U.S., Canada, Switzerland, Germany, but they owned production plants worldwide. Annual global sales averaged $1.34 billions during the conspiracy.

The prices for vitamins in the U.S. rose in the early 1990s, particularly in 1992, and dropped significantly after the breakup of the cartel. Prices in Europe differed slightly from prices in the U.S., and it is unclear how developing countries’ prices relate to those in the industrialized countries. Connor (2001) estimated the price increase generated by the cartel to be 35%, which is the figure used for the overcharge calculation. Developing countries imported approximately $6.6 billion of vitamins over the course of 1990-1999. The value of vitamin imports is small in comparison to developing countries’ imports of seamless steel tubes and pipelines. But the impact of the vitamin cartel on developing countries may also have been felt by consumers importing vitamin-enriched foods for human and animal consumption because their prices would have been raised by the vitamins cartel. As such, the overcharge of $1.7 billion calculated here is probably an underestimate of the welfare loss from collusion in the vitamins industry.
**Citric Acid**

The citric acid cartel was established in 1991 and ended in 1995 upon prosecution by the U.S. Department of Justice, Canadian Competition Bureau, and the European Commission. Producers from the U.S., Germany, Switzerland, Netherlands, Austria, and France agreed to fix prices and allocate sales in the global citric acid market. The firms created an elaborate and vigilant system to police the behaviors of the cartel members, sharing monthly sales figures and measuring each firm’s production against its quota down to a tenth of a decimal point.

The cartel accounted for 75%-85% of sales in North America and Western Europe. There is no accurate estimate of the scope of cartel operations outside these two regions. EU Competition Commission Mario Monti claimed that the cartel raised prices by 50% in the European markets, but the figure may not accurately reflect the price increase felt in developing countries. It is suspected that the cited price increase may also have been contributed in part by the rise of prices in raw materials or in demand for citric acid. Connor (2001) estimates the price increase in the U.S., resulting solely from the cartel, to be 21% to 24%. Developing countries imported a total of $400 million worth of citric acid over the five years of conspiracy. Taking a conservative estimate of a 20% prices increase, the resulting overcharge totals $67 million.

The locus of citric acid production has remained in the U.S., Europe, and China. If any benefits arose from the cartel to developing producers, they would have accrued to Chinese citric acid producers. These benefits, however, could also have been offset by the barriers to entry into the industry established by the cartel members - data shows that following the cartel breakup, Chinese imports of citric acid to the U.S. rose dramatically from $22 million/year to $61 million/year, indicating existence of barriers to the U.S. market during cartel years. In 1995, while the cartel was intact, the U.S. producers also lobbied to impose anti-dumping duties on Chinese imports of citric acid to the U.S. in 1995. Fortunately, the sanctions were stalled at the last minute.

**Bromine**

The bromine cartel was established between Great Lakes Chemical of U.S. and Dead Sea Bromine of Israel. The two producers colluded to fix the prices of TBBA,
DECA, and 100% methyl bromide between 1995 and 1998. The cartel was prosecuted by the U.S. Department of Justice for price fixing behaviors in the U.S. market. But as the cartel is currently under investigation by the European Commission and the two firms have a joint venture in the Middle East, it is assumed that the cartel and its effects were international in scope.

Bromine is only produced in regions that have, either in their water supply or underground, sufficient concentrations of bromine to make its extraction profitable. Israel and the U.S. are the main sites of production. Netherlands also exports bromine from a production plant set up by the Israeli firm.

Annual global sales of bromine totaled $800 million in the late 1990s, two-thirds of which was by members of the cartel. Over the four years of the conspiracy, developing countries imported approximately $59 million of bromine. HS trade statistics indicate that developing countries were not big consumers of bromine. Prices fell immediately after the conspiracy was made public, and the drop was observed to be between 15% and 20%. Taking the conservative figure of 15%, the overcharge to developing countries is approximately $8 million over the four years.

**Seamless Steel Tubes**

Seamless steel tubes and line pipes are often referred to in trade literature as Oil Country Tubular Goods (OCTG) and are used in oil and gas prospecting and transportation. The cartel was busted by the European Commission in December 1999, and fined $99 million for its illegal actions between 1990 and 1995. It comprised of eight steel producers, four European and four Japanese. The members operated under the title of “European-Japanese Club” and reached an agreement to refrain from selling in the home markets of other members of the cartel, for the purpose of reducing competition in their respective domestic markets. In instances where a number of producers shared a domestic market, the allocation of sales was designated by the entire group. The cartel agreement also encompassed operations in third markets, but charges made by the European Commission were directed to the cartel’s operations in the European markets the Commission did not find third market operations to have greatly hurt the European
It is unclear precisely what share of the global OCTG market was controlled by the cartel. We know, however, that during the period of the conspiracy approximately 40% of worldwide steel tubes exports was accounted for by exports from countries of origin of the cartel members. This figure rose slightly towards the end of the conspiracy. This figure may includes sales of firms who did not participate in the cartel, and it may excludes sales by production plants affiliated with cartel firms located in other regions of the world. For example, several of the cartel members own production facilities in developing countries, including Brazil, Mexico, and Argentina. The former would result in an overestimation while the latter in an underestimation of actual sales.

Demand for OCTG can be highly variable, depending on the volume of drilling taking place, which in turn is determined by the price of oil and gas. Sharp fluctuations in demand can thus result in fluctuations in the prices of OCTG, making the estimation of the price effect of the cartel difficult. The OECD estimated a 10% through observation of the fall in prices upon the breakup of the cartel. Over the period of the conspiracy, 1990-1995, imports of seamless steel tubes and line pipes to developing countries totaled $13.08 billion. Assuming the price charged to developing country consumers was 10% higher than the competitive price, the overcharge equals $1.19 billion.

**Graphite Electrodes**

The graphite electrodes cartel to fix prices and allocate market shares worldwide was established in 1992 and busted in 1997. The cartel was investigated by a number of competition authorities and prosecuted in the U.S. and Canada. The effect of the cartel is expected to have been felt worldwide.

Main members of the cartel were headquartered in the U.S., Japan, and Germany, but production was global. The U.S. firm UCAR, for example, owned production plants in U.S., Mexico, Canada, Brazil, France, Italy, South Africa, Russia, Germany, and Spain. As I had some information regarding the location of the cartel members’ overseas subsidiaries, I calculated sales by aggregating the exports of graphite electrodes from the
producing countries. Global sales over the entire period of the conspiracy totaled $7 billion.

Price increase resulting from the cartel is expected to be large. From 1992 to 1997, prices in the U.S. rose over 50%. In Canada, prices rose by more than 90%. There is some evidence that developing countries were able to purchase graphite electrodes below the cartel price. In a civil suit filed in the U.S., developing country producers alleged that the cartel raised prices by 45%. This estimate provides the only information available of the magnitude of price increase in developing countries. Developing countries imported $3.14 billion of graphite electrodes during the period of conspiracy. Overcharge to developing country purchasers of graphite electrodes based on a 45% price increase is $975 million.

**Lysine**

The lysine cartel began in 1992 and ended in 1995. Five producers from the U.S., Japan, and Korea agreed to fix prices, allocate sales worldwide, and monitor agreed upon quota. The cartel was prosecuted by the U.S. Department of Justice and the European Commission for its effects on their respective markets, but its effects is expected to have been felt worldwide.

Global sales by the cartel is calculated by aggregating exports from U.S., Japan, Korea, and Brazil (which hosts a production plant for one of the cartel members). Global sales totaled $913 million over the four years of the cartel, and 95% of the market was estimated to have been controlled by the five cartel members (Conner, 2001).

Developing countries imported a substantial $470 million of lysine over the period of the conspiracy. In 1994, the price of lysine reached $1.20 per pound, $.50 higher than its competitive price. The price increase, however, was observed to be lower in developing countries than in developed. The OECD estimates a 10% price increase. Using this estimate, overcharge to developing countries amount to $43 million.

By practicing price discrimination across regions, the cartel blocked entry by potential developing country producers. As two of the cartel’s members were Korean producers, developing countries also gained as conspirators. Except in very few
instances, the lysine market was closed to other potential developing country producers until the demise of the cartel in 1995. China has emerged as a locus for new ventures.

**But it is possible to improve upon previous estimates of welfare loss...**

Growing interest in the impact of private international cartels on developing countries has produced a number of important works in the field by the OECD, Levenstein and Suslow, and Connor. This chapter discussed some of their findings and method of deriving the consumer welfare loss. It also replicated that method to investigate the welfare effects of six cartels using alternative sets of trade observations. With the exception Connor’s work in 2001 on collusion in the lysine, citric acid and vitamins industries, existing studies have focused solely on the consumer overcharge in deriving consumer welfare losses, as was done in this chapter. But the consumer overcharge is only one of two types of consumer welfare losses from collusion, the other being the dead weight loss, and both should be estimated to measure the true impact of collusion.

The objective of the next chapter is to derive the total welfare loss – the overcharge and the dead weight loss - from the seamless steel tubes cartel. In calculating the consumer overcharge, it improves on previous studies by employing econometric models in place of the human eye to estimate the cartel’s price setting abilities. The estimate from the price model is then coupled with the elasticity of demand for the product, produced from another regression model, to derive the dead weight loss. A combination of cartel theory and industry research a story of what took place when eight producers from the developed world decided to monopolize the world market in seamless steel tubes.
Chapter Two
The Seamless Steel Tubes Cartel

Choice of Cartel

Given the time and resource constraints, it is not possible to examine in depth all six cartels discussed in the last chapter, so here I focus on one and hope that the insights provided by this study may be generalized to some extent for the others. In choosing which one out of the six to make the subject of this chapter, I considered both the economic significance of each cartel and the availability of data necessary for a detailed examination of its impact on developing countries. By these criterion the seamless steel tubes cartel stood out as the winner.

As seamless steel tubes are equipments for oil and gas exploration and transportation, the seamless steel tubes industry is intimately connected to the energy industry. Movements in one are expected to have strong impacts on the other. The significance of the energy industry cannot be overstated, especially in the early 1990s when this cartel was active, and as such distortions in the tubing market could have been magnified in the downstream oil and gas markets. What makes the seamless steel tubes cartel even more interesting is that the main energy producers/exporters for the world are developing countries, many of whom and some almost entirely dependent on energy production and export. If the cartel did substantially distort the market for seamless steel tubes, these countries would have suffered substantial losses in the form of welfare transfers from the purchasers to the sellers of the tubes and deadweight loss.

Because the world energy industry is so much in the limelight, information on it is plentiful and easily accessible to the public. Various sources provide reliable and accurate data on energy prices and productions that are useful in testing the correlation between movements in the seamless steel tubes and energy industries.
The OCTG Industry

The Product

Seamless steel tubes and line pipes belong to what is known as Oil Country Tubular Goods or OCTG and are used for exploration and transportation of oil and natural gas. OCTG products are produced in various weights, sizes, and finishes that are generally classified into two grades – carbon and alloy. Carbon grades of OCTG, made in strength levels of 75,000 pounds per square inch or less, serve oil and natural gas wells drilled to depths of roughly 8,000 to 11,000 feet. Alloy grades of OCTG are made in strength levels of 75,000 pounds per square inch or more to serve wells drilled in excess of 11,000 feet.

Both grades of OCTG products include production tubing, production casing, and surface casing. Production tubing is used to bring oil and natural gas to the surface of a well, production casing used to line wells during construction, and surface casing used to protect water-bearing formations during drilling. Whereas tubing can be replaced periodically throughout the life of a well, casing is permanent. Drill pipes are another kind of OCTG products, although they comprise only 5% of all OCTG products. Casing and tubing comprise approximately 60% and 35%, respectively. Once oil and gas are brought to the surface, they are transported and distributed by line pipes.

Production and Costs

OCTG products are available from both electric resistance weld (ERW) producers and seamless producers. The ERW method processes flat rolled steel into stripes that are then cold formed, welded, heat treated or seam-annealed, and end-finished with threads and couplings. Seamless producers individually heat and pierce solid steel billets into pipe. Seamless products are usually the pricier of the two kinds because the seamless production process is more costly.

Statistics provided by U.S. producers suggest that steel comprises roughly 3/4 of OCTG production costs. For example, purchased steel represented approximately 70% of
the U.S. producer Maverick Tube’s costs of goods sold in fiscal year 1996. Labor costs for Maverick represented another 9%. Overall production costs may vary from company to company depending on whether they “end-finish” their products at their main facilities or do so at different locations, the latter of which incurs additional freight and handling costs. (The end-finish process consists of upsetting, beveling, pressure testing, and the application of couplings to prepare products for direct installation in wells.) Different steel and labor costs also contribute to variations in prices across companies, especially across companies of different countries.

**Market Movements**

Demand for OCTG products is determined by the amount of drilling taking place, inventory levels maintained by end-users, and energy and trade policies. Drilling activity, the amount of which is positively correlated with OCTG demand, is the most important determinant and responds to energy producers’ anticipation of oil and gas prices. Energy price fluctuations can therefore cause significant fluctuations in OCTG demand. So can attitude changes towards the energy industry, be they supported or not by actual prices. When uncertainty rises about future energy prices and long-term prospects in the energy sector, energy producers may defer drilling projects, which would then adversely affect the demand for OCTG products.

Inventory levels held by end-users may also notably affect demand for OCTG products. The more the end-users draw on existing inventory, the greater the downward pressure on demand for new purchases. Conversely, demand rises when end-users build inventory. Maverick Tube estimated that inventory liquidation in 1994 ate away 6% of U.S. market demand, in 1995 0.1%, and inventory buildup contributed 5% to OCTG demand in the first nine months of 1996.

**Competition**

There is strong competition in the OCTG industry. Customers base their purchase decision on four main factors - quality, price, availability, and service - motivating

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3 Maverick Tubes produce welded products, but assuming that production material for both welded and seamless products are comparable, costs would also be comparable.
producers to be highly conscious of minimizing their production costs while providing top rate products and services. Because the cost of transporting OCTG products from one country to another is low relative to the total costs of gas and oil production, competition can be worldwide in scope. Distributors also present a source of competition in the OCTG market. While they add a middleman cost to the product prices, they have done well because buyers continue to go to them out of habit.

National subsidies may undermine competition to some extent, in that it reduces the number of competitors for the domestic producers. But where subsidies do not exist, or the effect of which is not strong, market competition gives strong leverage to consumers in negotiating the price of OCTG products. Transactions are initiated when buyers put a tender in the market to elicit bids from all interested OCTG producers. A period of intense haggling follows until the buyer finds the lowest price. And finally the purchase takes place. Between the tender and the purchase, the price will have moved a great deal, so that public prices never mimic the true price of transactions.

Given the above, it is not surprising that producers have sometimes expressed frustration towards their inability to count on passing rising production costs, such as that from steel, to consumers. In the short run, therefore, producers may be forced to internalize losses. In the long run, of course, those that stay in the industry should break even if not do much better.

But competition in the OCTG market does not necessarily imply competition in the seamless steel tubes market. Seamless goods comprise only one category of all OCTG products, the other being welded goods. The market for welded goods is much larger than that for seamless goods. The U.S., for example, purchased a total of 1.7 million metric ton of OCTG products in 1995, out of which only 180,000 were in the seamless category. As such, there are many more welded producers than seamless producers. The seamless segment of the world OCTG industry is controlled primary by four producers from Japan, a few from Europe, and a few from North and South America. The U.S. producers sell primarily to the North American market. The rest of the producers sell worldwide.
Substitutes

In certain cases, ERW products may be substituted for seamless products. ERW products have gained recognition in the carbon grade OCTG market beginning in the mid 1970s, and in the early 1990s accounted for an estimated 48% of the tonnage of OCTG products consumed annually in the U.S. Seamless products, however, have retained dominance in the carbon grade OCTG market. (Further penetration of ERW products depends upon technological advances in the materials and equipments used in the ERW manufacturing process.) Some claim that stainless steel tubes may also be substituted for seamless tubes.

According to industry experts, there is no close substitute for seamless products. The reason is that many countries have developed regulations towards what can be used in the energy industry. The American Petroleum Institute (API), for example, specifies the necessary properties of oil and gas exploration/transportation equipments. By the API standards, most welded and stainless products simply don’t measure up to their seamless counterparts. While standards are of greater importance in the industrialized world than they are in the developing countries, many energy producers of U.S. or European nationality in developing countries also observe the standards of their origin countries.

The Cartel

The European Commission busted the cartel in December 1999, and fined its members a total of $99 million for their anticompetitive activities between 1990 and 1995. The cartel comprised of eight steel producers, four European and four Japanese. British Steel, now known as Corus, and Mannesman of Germany were the two primary members, accompanied by Vallourec of France, Italy’s Dalmine, and Japan's Sumitomo Metal Industries, Nippon Steel, Kawasaki Steel and NKK. The members operated under the title of “European-Japanese Club” and reached an agreement to refrain from selling in the home markets of other members of the cartel for the purpose of reducing competition in their respective domestic markets. In instances where a number of producers shared a domestic market, the allocation of sales was designated by the entire group. The cartel agreement also encompassed operations in third markets, but charges made by the European Commission were directed to the cartel’s operations in the European markets.
because the Commission did not find third market operations to have greatly hurt the European market). For this reason, findings by the EC regarding damages in third markets, possibly developing markets, will likely never be made public.

Notice that the cartel included most of the world’s seamless producers, and all the big producers of Europe and Japan. We know that during the period of the conspiracy, approximately 40% of worldwide steel tubes exports were accounted for by exports from the cartel host countries, and this figure rose slightly towards the end of the conspiracy. This is a reasonable estimate of exports by the cartel members as the cartel comprised of the major producers from these countries, but it may includes sales of some marginal firms who did not participate in the cartel, and it may excludes sales by production plants affiliated with cartel firms located in other regions of the world. For example, several of the cartel members own production facilities in developing countries, including Brazil, Mexico, and Argentina.

Over the period of the conspiracy, exports of seamless steel tubes and line pipes from the cartel host countries to all developing countries totaled $13.07 billion. Prices of these exports are shown in Figure 2.1. Prices rose in unison in the late 1980s, reached a peak in 1990, dipped in 1994 and again in 1997, but in both cases recovered immediately. The mid 1990s marked the beginning of increasing price volatility, and Britain and France stood out conspicuously as the two countries that set the price trend and the bounds of price movements.

Corresponding prices of oil and gas are shown in Figure 2.2. One can make three observations about the illustrated energy prices: 1) the prices of oil and gas traveled together, 2) both, but in particular oil prices, seem to have traveled in the same direction as the export prices of seamless steel tubes, with the exception of 1985, and 3) they were less volatile than the export prices of seamless steel tubes, with the exception of 1985. The data also supports the expectation that the direction of price influence is from the energy industry to the seamless steel tubes industry – that is, energy prices set the trend for the prices of seamless steel tubes. For example, oil prices peaked in the beginning of 1990 and the export prices of seamless steel tubes peaked in the middle of the year, and oil and gas prices peaked again in 1996 and 1997 followed by a rise in the price of seamless steel tubes in 1997 and 1998. The patterns the figures illustrate confirm the
positive relationship between energy prices and seamless steel tube prices, but they also 
show that while both sets of prices fell during the period of collusion, energy prices fell 
by a greater percentage. Oil and gas prices dropped 36% and 32% respectively while 
seamless steel tubes prices fell by only 26%. That the prices of seamless steel tubes did 
not fall more may be indicative of market distortions.

**Figure 2.1**

*Price of Seamless Steel Tubes Exports, 1985-1999*

Figure 2.2

Energy Prices, 1985-1999

Source: British Petroleum databases and EIA databases.
The classical cartel is an organization of firms acting like a monopolist. It intends
to capture a large enough share of the market to be able to produce and price at where
marginal revenue equals marginal cost. A few cartels succeed in doing just that, some
fail, and many more fall somewhere in between these two extremes, acquiring significant
but limited price setting abilities.

How is the level of market power held by a cartel determined? One can begin by
looking at the Lerner index.

Consider the null hypothesis of a monopolized market where production is
determined by the cartel’s profit maximization condition of MR=MC. Marginal revenue
can be expressed as the following:

\[ MR = p(1+1/\varepsilon) \]

where \( \varepsilon \) is the elasticity of demand

According to this relationship, marginal revenue is positive when the demand curve is
elastic (\( \varepsilon < -1 \)) and negative when the demand curve is inelastic (-1 < \( \varepsilon < 0 \)). By
substituting the above relationship into the marginal revenue and marginal cost equality,
we arrive at another expression of the monopolist condition:

\[ (p-MC)/p = -1/ \varepsilon \]

The markup that will be charged at the monopolist’s optimum, on the left hand side of the
equation and referred to as the Lerner index, is shown to depend only on the elasticity of
demand the monopolist faces. The two are inversely related, such that when the elasticity
of demand is high the markup is low, and when the elasticity of demand is low the
markup is high. The lower the elasticity of demand, therefore, the further away is the
monopoly price from the competitive level.

In the case of a perfect monopoly, empirical findings of the elasticity of demand
for the product and the markup should satisfy the MR =MC condition. In the case of a
less than perfect monopoly, however, the MR=MC condition does not hold. Production
would occur at a point where MC is greater than MR and the markup is less than
predicted by the above relationship, given a specific elasticity of demand. The Lerner
index is thus a useful tool in investigating the market power of a cartel.
The OECD estimated that the price of OCTG products during collusion to be on average 10% higher than the pre-cartel price. If the pre-cartel price can be considered competitive, the markup would be simply 10% and the elasticity of demand as predicted by the monopolist condition roughly around \(-10\). For every 1% increase in price, an elasticity of \(-10\) implies that buyers reduced their purchases by 10%. This is an extremely high elasticity for such an important group of products and could have been explained only by the existence of close substitutes or intertemporal substitution-- which is the ability of consumers to discern the artificiality of the price increase and defer purchases until a later date. The lack of evidence for either of the two conditions suggests that the actual elasticity of demand was lower than \(-10\), and consequently implies that either the cartel did not have the power to raise prices to the monopoly level or that the observed 10% price increase was lower than the actual.

Is 10% a reasonable measure of the price increase? The level of markup consistent with profit-maximization is a function of the elasticity of demand for the product faced by the producer. If the elasticity of demand were extremely high, it would not be in the monopolist’s interest to raise the price considerably because lost sales would begin to reduce its profits. From the point of view of the seamless steel tubes cartel members, the decision to collude is determined by the net income from costs and profits of collusion, where the profits is a welfare transfer from the buyers to the producers, equal to the overcharge paid by the buyers. The estimated overcharge of seamless steel tubes cartel, derived using 10% as the price increase, was $1.19 billion over the course of six years during which the cartel operated. The profits are great, and even though we don’t know the costs of collusion, we can reasonably assume that the costs were lower than $1.19 billion. This line of reasoning does not rule out the possibility that the price increase was higher than 10%. Given that the cartel consisted of all major seamless product producers from Europe and Japan, that the U.S. producers sell primarily to the North America market, and the lack of close substitutes and intertemporal substitution, we have the necessary conditions for a close to perfect monopoly in the relevant seamless steel tubes market and a price increase of more than 10%.

To systematically investigate this hypothesis, I develop an econometric model that tests the impact of cartel presence on the price of these purchases, using a cartel
dummy variable. I also model the elasticity of demand for seamless steel tube exports using observations of purchases made by select developing countries from cartel host countries. The results of these two models will determine whether the cartel was operating at its peak, as specified in the monopolist condition, \( \frac{p-MC}{p} = -1/\varepsilon \): a perfect cartel would satisfy the condition, a less than perfect one would exhibit a markup less than predicted by the condition, given a specific elasticity of demand.

**Modeling the Determinants of Seamless Steel Tube Price**

The price of a commodity can be broken into two components: the marginal cost of production and the markup. In the case of seamless steel tubes, marginal cost primarily consists of the material cost of steel and the cost of labor. Depending on the elasticity of demand faced by the producers and competition in the industry, fluctuations in production costs may or may not change the price of the final good. For example, if the seamless steel tubes industry is one in which consumers are very sensitive to price changes and competition is strong, producers may choose to internalize rising steel costs by cutting operation costs and taking in a smaller profit, instead of raising the price of seamless steel tubes. The second component of price, the markup, also depends on the elasticity of demand and competition in the industry. Producers cannot directly affect the elasticity of demand, but they can affect the level of competition in the industry. The purpose of a cartel is precisely to minimize competition so that producers can charge a higher markup.

In modeling the price of seamless steel tubes, I must account for both supply and demand side factors. Supply side factors include production costs and the markup, and will be captured in the model by the cost of steel, from the previous year, and the presence of collusion. Demand is approximated by OCTG consumption – in the energy industry, the amount of drilling taking place is measured by “rig count”.

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4 It may also depend on the presence of import quota against the selling firm, but import quotas and tariffs are not accounted for in the model due to unavailability of data.
Modeling the Determinants of Seamless Steel Tube Demand

Developing countries’ demand for seamless steel tubes imports is a function of both world supply, and domestic demand. Domestic supply is negligible because there are no competitive producers of the product in the developing countries examined by this study (the following section on data explains the selection of developing countries). The prices of substitutes, another set of variables often added to demand models, are also unnecessary in the case of seamless steel tubes. Assuming no shifts in the demand curve during the sample period, world supply may be expressed through world prices of the product. Each developing country’s demand for seamless steel tubes is a function of two factors: 1) the number of oil and gas wells being drilled, as measured by rig count, and 2) the level of end-user inventories.

World prices and data on rig count can be collected from public and institutional sources, but inventory levels are not readily observable by the public. The lack of information on inventory levels makes it impossible to estimate a structural model of the demand for seamless steel tubes. A reduced-form model is estimated instead, which expresses import demand as a function world prices and rig count.

Data and Empirical Preliminaries

Although purchases made by developing countries from cartel members cannot be observed directly, we can infer from trade data the relationship between purchases and price fluctuations. This study takes exports of seamless steel tubes by countries that hosted the cartel members as proxies of cartel sales to a select few developing countries.

I look at six developing countries as the buyers of seamless steel tubes: Algeria, Nigeria, Libya, China, Indonesia, and Venezuela. All are OPEC members with the exception of China. In selecting them, I considered two criterion 1) the stage of the country’s economic development and 2) the degree to which its economy depended on
energy production. While there are many more energy producing countries who imported the cartelized product, this study seeks to estimate the harm done to the poorest and least developed, as they are presumably the ones who had the most to lose from setbacks in economic production. Table 2.1 presents some useful statistics.

Table 2.1

<table>
<thead>
<tr>
<th>The Importance of Fuel in Select Developing Countries, 2001</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GNI per capita² (in US$)</td>
</tr>
<tr>
<td>All developing countries</td>
<td>1,160</td>
</tr>
<tr>
<td>Algeria</td>
<td>1,580</td>
</tr>
<tr>
<td>Libya</td>
<td>5,730</td>
</tr>
<tr>
<td>Nigeria</td>
<td>260</td>
</tr>
<tr>
<td>China</td>
<td>840</td>
</tr>
<tr>
<td>Indonesia</td>
<td>570</td>
</tr>
<tr>
<td>Venezuela</td>
<td>4,310</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>7,230</td>
</tr>
<tr>
<td>Kuwait</td>
<td>18,030</td>
</tr>
<tr>
<td>UAE</td>
<td>18,060</td>
</tr>
</tbody>
</table>

Source: World Bank

With the exception of China and Indonesia, data shows that the export sectors of the selected developing countries are dominated by exports of fuels. Not surprisingly, trading in oil and natural gas brings in the bulk of the countries’ export revenues, and in some cases, the bulk of state revenues. Algeria, for example, is the world’s 16th largest oil producer and 6th largest gas producers. Its oil export of US$ 11.5 billion in 1999 accounted for more than 95% of its total export revenues. Libya is Africa’s top oil producer, and its oil exports account for an estimated 75% - 90% of total state revenues, and 95% of total export revenues.

The exporting countries are France, Germany, Britain, Italy and Japan – the five where the cartel members were headquartered⁷. Exports to the selected developing countries represent over 63% of exports from the cartel host countries to all developing countries.

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⁵ GNI per capita (formerly GNP per capita) is the gross national income, converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population. GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad.

⁶ Fuels comprise SITC section 3 (mineral fuels).

⁷ Cartel production from subsidiaries in other countries is not accounted for because trade aggregates from those countries may be too misleading an indicator of subsidiaries’ production levels.
The export values from 1985-1999 are retrieved from the World Bank’s World Integrated Trade Statistics (WITS) database. WITS provide two general categories of trade classifications - the Harmonized System (HS) and Standard International Trade Classification (SITC). The HS is more product sensitive and would have been the ideal source of data for calculating the DWL, but unfortunately HS does not provide the disaggregated bilateral trade observations needed for this study. SITC is used instead. From the SITC database I downloaded two sets of observations, one on the annual level of exports from each cartel host country to all developing countries, and another on the annual level of exports from each cartel host country to the selected developing countries. The first set of observations gives the necessary information to calculate the price per unit of seamless steel tubes, as the unit information is suppressed in the bilateral trade dataset. The price is then used in conjunction with the second set of observations to derive the units of exports. Figure 2.3 illustrates the consumption patterns of developing countries for seamless steel tubes over the sample period, where demand for seamless steel tubes in each country is equated to its aggregate purchases from the cartel host countries.

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8 Export data is used here because the import data is incomplete for the countries and time period in question. In the following sections, export data will sometimes be equated to the “imports” to the developing countries for conceptual purposes.
Figure 2.3

Import Demand for Seamless Steel Tubes, 1985-1999


The period of interest to this study is the first half of the 1990s. In 1990, imports to each country averaged at 23450.44 metric ton, which fell to 15466.39 in 1995 but bounced back to 23639.17 in the following year. China imported the most over the course of the sample period, and interestingly also exhibited a very different demand pattern from that of the other five countries. It purchased more than the combined total of all the others in 1985, but by the second half of the 1990s was purchasing levels comparable to the others’. China’s demand fell by over 70%. In comparison, the other countries exhibited stable and similar purchasing patterns. It may be tempting to omit China from the sample, but because a primary objective of the study is to estimate the dead weight loss suffered by the purchasing countries, all significant purchasers should be accounted for. China is especially important because it purchased much more than the other countries. The uniqueness of China’s demand pattern does pose an interesting economic question and
suggests that market conditions there were different in some way. This issue will be addressed more extensively in later sections.

Rig count levels from various regions of the world are obtained from Baker Hughes databases. Figure 2.4 illustrates the trends for the three regions examined by the study – Africa, Asia, Latin America – and the Middle East over the sample period. Notice that rig count in Asia falls consistently from 1990 to 1995, and rig count in Latin America falls precipitously from mid 1990 to 1993, but bounces back to the initial 1990 level by 1995. In comparison, drilling activities in Africa and the Middle East were the most stable. The dip of Middle East and rise of Africa in 1991 may be interpreted as results of shifting OPEC production allocations during the Gulf War.

Figure 2.4


The study uses the prices of steel produced in the U.S., compiled by the U.S. Geological Survey, because world prices are not readily available. U.S. prices should
mirror world prices to a certain degree. (It is possible, however, that the correlation may be weakened by the effect of tariffs.) The prices are shown in the Figure 2.5.

**Figure 2.5**

![Price of Steel, 1985-1999](image)

Source: Historical data of Iron and Steel, USGS

All raw data was retrieved in nominal value, which I then normalized to 1999 values using the World Bank’s GDP deflator inflation index.

**Data Descriptions:**

- **TUBEPRICE_{it}**: The average price of seamless steel tube exports, in thousands of US$, from each cartel country to the world, derived using total export value and units to the world.
- **TUBEUNITS_{it}**: The units of seamless steel tube, in metric ton, exported from each cartel country to each developing country, derived using export value to individual developing countries and TUBEPRICE_{it}.
- **OILPRICE_{t}**: The price of crude oil.
- **GASPRICE_{t}**: The price of natural gas.
- **RIGCOUNT_{it}**: Rig count of the relevant region.
- **STEELPRICE_{t}**: The price of steel produced in the U.S.
- **TIME**: Trend variable that takes on the values 0-14 from 1985 to 1999.
Where \( x \) = for cartel countries
\( i \) = for developing countries
\( t \) = for time of data sample, 85-99

In addition to the above variables, the estimation also included dummies for the cartel, each year in the sample period, each of the developing countries, and each of the cartel host countries. The dummy variables are designated as follows:

\[
\text{CARTEL} = 1 \text{ for years between 90-95 (except in the case of Britain, whose cartel company discontinued production and withdrew from cartel in 1993), 0 otherwise.}
\]
\[
\text{YEAR}86...\text{YEAR}99 = 1 \text{ if data is associated with the specified year, 0 otherwise.}
\]
\[
\text{ALGERIA, NIGERIA, LIBYA, CHINA and INDONESIA} = 1 \text{ if data is associated with the specified country. 0 otherwise. Venezuela is the reference country.}
\]
\[
\text{GERMANY, FRANCE, BRITAIN, JAPAN} = 1 \text{ if data is associated with the specified country, 0 otherwise. Italy is the reference country.}
\]

**Models:**

With the above sets of data, I estimate a price model and a demand model. It is a common practice to run a panel regression when dealing with cross-section and time series datasets that are small, from which it is not possible produce sharp inferences about the coefficients. If the specification is correct, pooling the data, by increasing the degrees of freedom, provides more efficient estimation and inference. The limited sample of this study therefore made a good case for running a single regression with panel data.

Consider first the price model. The expected price per unit of tubes charged by each exporter \( x \) in time \( t \), \( \text{TUBEPRICE}_{xt} \), can be modeled as a function of the presence of collusion, steel price from the previous year, rig count in the region where the country is located, and ongoing oil and gas prices:

\[
\mathbb{E}(\text{TUBEPRICE}_{xt}) = f(\text{CARTEL}_t, \text{STEELPRICE}_{t-1}, \text{RIGCOUNT}_{it})
\]

Where cartel is a dummy set to 1 in the years of collusion, 1990-1995, and 0 in other years. Because there may be variations in price across the exporters, due to varying costs of production /classes of tubes exported, dummies for exporters are added to the reduced
model. One exporter is left out to avoid singularity, and the fixed effects are to be interpreted as differentials from the reference country in the regression constant, Italy. I also add interaction terms, between each of the exporter dummies and the cartel dummy, to entertain the possibility that the markup charged upon collusion may vary from country to country. To obtain the elasticity of seamless steel tube price with respect to steel price and rig count, I estimate the logged model:

\[
\log(\text{TUBEPRICE}_{xt}) = \beta_0 + \beta_1 \text{CARTEL}_t + \beta_2 \log(\text{STEELPRICE}_{t-1}) + \beta_3 \log(\text{RIGCOUNT}_{it}) + \\
\beta_4 \text{FRANCE}_t + \beta_5 \text{GERMANY}_t + \beta_6 \text{JAPAN}_t + \beta_7 \text{BRITAIN}_t + \\
\beta_8 \text{CARTEL}_t \times \text{FRANCE}_t + \beta_9 \text{CARTEL}_t \times \text{GERMANY}_t + \beta_{10} \text{CARTEL}_t \times \text{JAPAN}_t + \\
\beta_{11} \text{CARTEL}_t \times \text{BRITAIN}_t + \beta_{12} \text{TIME}_t
\]

where the explanatory variables are as defined in the previous section.

Rig count is used to approximate consumption of seamless steel tubes, which is determined by perceived prospects in the energy industry.

Consider now the determination of imports. Unit of tubes purchased by a developing country from exporter \( x \) in time \( t \), \( \text{TUBEPRICE}_{xt} \), is expressed in a reduced-form model as a function of the price of tubes charged by the exporter \( x \) in time \( t \), \( \text{TUBEPRICE}_{xt} \), and rig count of the relevant geographical region, \( i \), (i.e. Africa, Latin America, Asia), at time \( t \), \( \text{RIGCOUNT}_{it} \).

\[
E(\text{TUBEUNITS}_{xt}) = f(\text{TUBEUNITS}_{xt}, \text{RIGCOUNT}_{it})
\]

To account for possible variations in the demand schedules of the importers, perhaps from OPEC participation, I add a dummy for each but one importer to the model. (The reference country is Venezuela.) Because serial correlation is often a concern when working with time series data, I also create year dummies or a time trend to control for exogenous factors that affect demand and supply of the product over time. (Year 1985 is the reference country when time dummies are used.) These two remedies both have pluses and minuses – while time dummies provide more flexibility to the model by allowing each year a different intercept, they make it impossible to include other time based dummies to the model. (More on this technicality in the next section.) The reduced elasticity of demand model using a time trend is:

\[
\log(\text{TUBEUNITS}_{xt}) = \beta_0 + \beta_1 \log(\text{TUBEPRICE}_{xt}) + \beta_2 \log(\text{RIGCOUNT}_{it}) + \beta_3 \text{ALGERIA}_t + \\
\beta_4 \text{LIBYA}_t + \beta_5 \text{NIGERIA}_t + \beta_6 \text{CHINA}_t + \beta_7 \text{INDONESIA}_t + \beta_8 \text{TIME}_t
\]
When time dummies are used in place of the time trend, the model is:

\[ \log(\text{TUBEUNITS}_{xt}) = \beta_0 + \beta_1 \log(\text{TUBEPRICE}_{xt}) + \beta_2 \log(\text{RIGCOUNT}_{it}) + \beta_3 \text{ALGERIA}_t + \beta_4 \text{LIBYA}_t + \beta_5 \text{NIGERIA}_t + \beta_6 \text{CHINA}_t + \beta_7 \text{INDONESIA}_t + \beta_8 \text{YEAR}86 + \ldots + \beta_{21} \text{YEAR}99 \]

**Choice of estimator**

The price model is estimated by the ordinary least squares (OLS) method. In the preliminary stages of the study, I will also use OLS to estimate the elasticity of demand model. But because the quantity of imports is a function of both supply and demand, \( \text{TUBEPRICE} \) in the OLS estimation is an endogenous variable. That is, some component in the error term that shifts either the supply and demand curve can change the values of both \( \text{TUBEUNITS} \) and \( \text{TUBEPRICE} \). In the presence of endogeneity, OLS estimators are biased and inconsistent, the estimated variance is incorrect, and hypothesis testing leads to misleading conclusions. Simultaneity can be remedied by replacing \( \text{TUBEPRICE} \) with an instrumental variable using two-stage least squared (2SLS) estimation, which "purifies" \( \text{TUBEPRICE} \) of its correlation with the error term in the original model.

**Choice of appropriate instrumental variables**

I assume that the presence of cartel is exogenous to the units of seamless steel tubes exported to the developing countries. (Exogeneity in this case means that the presence of the cartel is correlated with \( \text{TUBEUNITS} \) but not with the error term in demand model estimated by OLS.) There certainly is the possibility that the cartel was formed in response to falling prices in the OCTG market, but this study is not equipped to test that hypothesis. Given available information, I assume that the OCTG industry was experiencing ordinary market conditions in the late 1980s and early 1990s, and use the cartel dummy as an instrument variable for \( \text{TUBEPRICE} \). Dummies for the exporting countries are also expected to be exogenous and useful in determining the level of exports to the respective developing countries. As such, I add this set of dummies as instruments for \( \text{TUBEPRICE} \).
Results

The results confirm the hypothesis: the cartel sent prices higher, not very far from the monopoly level. The following sections interpret the respective results of the price and demand models – in reading them, it is important to keep in mind that this study estimated reduced rather than structural models.

Determination of Price

In the model:

$$\log(TUBEPRICE_{it}) = \beta_0 + \beta_1 CARTEL_t + \beta_2 \log(STEELPRICE_{it-1}) + \beta_3 \log(RIGCOUNT_{it}) + \beta_4 FRANCE_t + \beta_5 GERMANY_t + \beta_6 JAPAN_t + \beta_7 BRITAIN_t + \beta_8 CARTEL_t*FRANCE_t + \beta_9 CARTEL_t*GERMANY_t + \beta_{10} CARTEL_t*JAPAN_t + \beta_{11} CARTEL_t*BRITAIN_t + \beta_{12} TIME_t$$

economic intuition says that cartel presence, rig count, and steel price should be positively correlated with the export price of tubes. Of the exporting country fixed effects, which control for factors such as differential production costs or export product variations, the one associated with Britain is expected to be the highest. The British cartel participant, British Steel, left the industry in 1993, suggesting that the firm was pricing its exports higher than the other cartel members, possibly to cover higher production costs, and consequently could not maintain its market position. The interaction terms capture variations in the additional markup charged by each cartel member upon collusion, and with the exception of the one between cartel and Britain, are expected to have coefficients close to 0, as the cartel presumably set a uniform price increase and would have punished members who sought higher profit margins than the other member. I expect the that between cartel and Britain to be positive from looking at Figure 2.2 where Britain is shown to have raised its export prices sharply in the early 1990s.

Econometrically speaking, the coefficients of the cartel and export countries dummies each tell us by how much the mean price, in thousands of U.S. dollars, given the condition specified by the dummy, differs from the mean price of exports from Italy in a competitive market holding all other variables constant. According to Halvorsen and Palmquest, the antilog of the estimated dummy coefficient minus one gives the appropriate percentage change in the dependent variable. The coefficients of
log(\text{STEELPRICE}_{t-1}) \text{ and } \log(\text{RIGCOUNT}) \text{ express the percent change in price for every percent change in the price of steel and rig count, respectively.}

The following table reports the results of the price model in the specification presented above, those of three variations of the model, and the sample means of the variables.

Table 2.2

| Price Model, 1985-1999 (N=450) |
|------------------|------------------|------------------|------------------|------------------|
| (1)              | (2)              | (3)              | (4)              | Sample Means    |
|                  |                  |                  |                  |                  |
| **Dependent Variable** |                  |                  |                  |                  |
| TUBEPRICE        | 1,300.752        |                  |                  |                  |

<table>
<thead>
<tr>
<th><strong>Explanatory Variable</strong></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>-1.251*</td>
<td>-7.60*</td>
<td>-6.672*</td>
<td>-0.36</td>
</tr>
<tr>
<td>(0.563)</td>
<td>(0.765)</td>
<td>(0.870)</td>
<td>(0.183)</td>
<td></td>
</tr>
<tr>
<td>CARTEL</td>
<td>0.145*</td>
<td>0.125*</td>
<td>0.122*</td>
<td>0.156</td>
</tr>
<tr>
<td>(0.039)</td>
<td>(0.045)</td>
<td>(0.038)</td>
<td>(0.046)</td>
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<td>POSTCARTEL</td>
<td>-0.028</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.029)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEELPRICE\text{t-1}</td>
<td>0.207**</td>
<td>0.135</td>
<td>1.066*</td>
<td>0.02</td>
</tr>
<tr>
<td>(0.088)</td>
<td>(0.116)</td>
<td>(0.141)</td>
<td>(0.003)</td>
<td>683.496</td>
</tr>
<tr>
<td>RIGCOUNT</td>
<td>-0.008</td>
<td>-0.009</td>
<td>-0.011</td>
<td>-0.00007</td>
</tr>
<tr>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.018)</td>
<td>(0.001)</td>
<td>162.267</td>
</tr>
<tr>
<td>OILPRICE</td>
<td></td>
<td></td>
<td>0.109**</td>
<td>-0.113</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.049)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>OILPRICE\text{2}</td>
<td></td>
<td></td>
<td></td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.004)</td>
</tr>
<tr>
<td>GASPRICE</td>
<td></td>
<td></td>
<td>-0.568*</td>
<td>0.803</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.073)</td>
<td>(0.164)</td>
</tr>
<tr>
<td>GASPRICE\text{2}</td>
<td></td>
<td></td>
<td></td>
<td>-2.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.029)</td>
</tr>
<tr>
<td>BRITAIN</td>
<td>0.298*</td>
<td>0.294*</td>
<td>0.293*</td>
<td>0.404</td>
</tr>
<tr>
<td>(0.033)</td>
<td>(0.033)</td>
<td>(0.031)</td>
<td>(0.037)</td>
<td>Fixed effect</td>
</tr>
<tr>
<td>FRANCE</td>
<td>0.233*</td>
<td>0.233*</td>
<td>0.233*</td>
<td>0.322</td>
</tr>
<tr>
<td>(0.034)</td>
<td>(0.034)</td>
<td>(0.032)</td>
<td>(0.039)</td>
<td>Fixed effect</td>
</tr>
<tr>
<td>GERMANY</td>
<td>0.088*</td>
<td>0.088</td>
<td>0.088*</td>
<td>0.106</td>
</tr>
<tr>
<td>(0.034)</td>
<td>(0.034)</td>
<td>(0.032)</td>
<td>(0.039)</td>
<td>Fixed effect</td>
</tr>
<tr>
<td>JAPAN</td>
<td>0.014</td>
<td>0.014</td>
<td>0.014</td>
<td>0.016</td>
</tr>
<tr>
<td>(0.034)</td>
<td>(0.034)</td>
<td>(0.032)</td>
<td>(0.039)</td>
<td>Fixed effect</td>
</tr>
<tr>
<td>CARTEL*BRITAIN</td>
<td>0.214*</td>
<td>0.226</td>
<td>0.224*</td>
<td>0.378</td>
</tr>
<tr>
<td>(0.058)</td>
<td>(0.058)</td>
<td>(0.054)</td>
<td>(0.066)</td>
<td>Fixed effect</td>
</tr>
<tr>
<td>CARTEL*FRANCE</td>
<td>-0.093***</td>
<td>-0.093***</td>
<td>-0.093***</td>
<td>-0.119</td>
</tr>
<tr>
<td>(0.054)</td>
<td>(0.054)</td>
<td>(0.051)</td>
<td>(0.062)</td>
<td>Fixed effect</td>
</tr>
<tr>
<td>CARTEL*GERMANY</td>
<td>-0.081</td>
<td>-0.081</td>
<td>-0.081</td>
<td>-0.094</td>
</tr>
<tr>
<td>(0.054)</td>
<td>(0.054)</td>
<td>(0.051)</td>
<td>(0.062)</td>
<td>Fixed effect</td>
</tr>
<tr>
<td>CARTEL*Japan</td>
<td>-0.053</td>
<td>-0.053</td>
<td>-0.053</td>
<td>-0.067</td>
</tr>
<tr>
<td>(0.054)</td>
<td>(0.054)</td>
<td>(0.051)</td>
<td>(0.062)</td>
<td>Fixed effect</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>.420</td>
<td>.420</td>
<td>.491</td>
<td>.610</td>
</tr>
</tbody>
</table>

Note – * denote significance at the 1% level, ** at the 5% level, and *** at the 10% level. Standard deviations are shown in parentheses Column (3) presents the results of the level model because the logged quadratic model unexplainably dropped the variables, OILPRICE and GASPRICE.
The signs of all the coefficients in the basic specification, shown in column 1, are consistent with expectations. CARTEL, the primary coefficient of interest, is shown to be associated with a 15.6% increase in the price of tube exports (which has a sample mean of $1,300.75 per metric ton) with t-statistic of 3.7. Note that this estimate is higher than the 10% used in the previous chapter to derive the overcharge, signifying that the cartel’s ability to raise price was higher than previously believed! The coefficient of lagged steel price is also shown to be positively correlated with tube price. A 1% increase in price of steel bought in the previous year is associated with a .2% increase in the price of tube exports in the current year, and the coefficient is estimated with a t-statistic of 2.4. Contrary to expectation, the coefficient of RIGCOUNT is not economically or statistically significant in the basic model and also exhibits an unexpected negative sign. The model concludes that price is not significantly affected by consumption of tubes, as expressed by rig count.

The exporting country dummies, with the exception of Japan, are found to be statistically significant, and as expected with Britain at the top. The coefficient of the dummy, BRITAIN, is associated with exports priced approximately 34.7% higher than those of Italy, the reference country. The dummy, FRANCE follows with a coefficient of .233, implying that its exports were 26.2% higher than those of Italy. Recall that the average price per metric ton is $1,300.75. Consider now the results for the interaction terms. That between CARTEL and BRITAIN appears to be the only one statistically distinguishable from 0: the interaction term is associated with an additional 23.9% premium on the price of exports compared to the markup charged by the other cartel host countries. Britain clearly stands out as the most expensive exporter of seamless steel tubes during the sample period, and also the country that raised the price of its exports the most upon collusion. The rapid decline of its exports to China after it raised its export prices and the renewed interest of China, Libya and Nigeria in its products when the price plunged, are indicative of consumer sensitivity to price.

Figure 2.6

\[ e^{.145} - 1 = .156 \]
\[ e^{.298} - 1 = .347 \]
\[ e^{.233} - 1 = .262 \]
\[ e^{.214} - 1 = .239 \]
Remember that price consists of two parts — production cost and markup. Theoretically speaking, the higher export price may be a result of higher production costs that rose even higher during the period of collusion, higher markups, or a combination of both. British Steel’s exit from the industry supports the first explanation because a firm is unlikely to abandon business activities that bring in a profit. Furthermore, had British Steel marked up its price solely to increase profits, it would have elicited punishment from the other cartel participants, and there is no evidence in support of that.

These results, with the exception of STEELPRICE in one model, are robust to changes in specification. In particular, the effect of cartel on price is found to be larger than 10% in all four regressions. In a variation of the basic specification, I test whether the fixed effect of collusion is unique by dividing the sample period into three segments — pre-cartel, cartel, and post-cartel — and adding to the model a dummy variable for the
post-cartel period. This makes 1985-1989 the reference period and allows coefficients of CARTEL and POSTCARTEL to be interpreted as differentials from the prices of the pre-cartel period. The results strongly support the significance of the cartel fixed effect: the coefficient for POSTCARTEL is shown to be statistically indistinguishable from 0, while the coefficient for cartel is estimated with a t-statistic of 2.8 at .125, implying that the presence of cartel is associated with prices 13.3% higher than the regression average.

Yet another variation of the basic specification adds prices of oil and gas as explanatory variables to account for the possibility that attitude changes towards the energy industry that have not yet altered the amount of drilling activities, may affect the price of seamless steel tubes. The results, shown in column 3, indicate that there is in fact an additional channel, other than rig count, through which energy prices affect the price of seamless steel tubes. (It’s interesting that the correlation between energy prices and tube price is stronger than that between rig count and tube price.) But this specification did raise one concern – if rig count is strongly correlated with energy prices, the model would be biased by the problem of collinearity. I tested the correlation between rig count and energy prices by running a reduced model of rig count on oil price and gas price. The explanatory power of the model is very low, with an adjusted $R^2$ of .056, rejecting the possibility of strong correlation between rig count and energy prices.

This second variation of the original model finds every percent increase in the price of oil to be associated with approximately .1% increase in the export price of tubes, and every percent increase in the price of gas to be associated with approximately a .5% decrease in export price of tubes. That oil and gas prices affect the price of tubes in opposite directions is very puzzling and encourages me to model a quadratic price model with second degree polynomials in OILPRICE and GASPRICE. Results of the model are presented in column 4. The quadratic terms are found to be statistically significant, and as expected, take on opposite signs of their first degree counterparts, implying that the divergent effects of oil price and gas price on the export price of tubes level off as oil price and gas price increase in value. This study unfortunately is not equipped to fully explain the opposite effects of oil and gas prices on the price of seamless steel tubes, but these highly interesting results should be examined in future studies.
The most important finding of the four models is the robust cartel fixed effect. All three logged models and the level model find the presence of cartel to be significantly associated with tube prices more than 10% above the average. The explanatory powers of all four specifications are also relatively high, with adjusted $R^2$ at .420 for the basic specification and as well for the variant with post-cartel fixed effect, at .491 for the variant including oil and gas prices, and at .610 for the quadratic level model. The favored model is the logged version that accounts for the effects of energy prices.

Determination of Demand

In the model:

$$\log(\text{TUBEUNITS}_{xt}) = \beta_0 + \beta_1 \log(\text{TUBEPRICE}_{xt}) + \beta_2 \log(\text{RIGCOUNT}_{it}) + \beta_3 \text{ALGERIA}_t + \beta_4 \text{LIBYA}_t + \beta_5 \text{NIGERIA}_t + \beta_6 \text{CHINA}_t + \beta_7 \text{INDONESIA}_t + \beta_8 \text{YEAR86} + ... + \beta_{21} \text{YEAR99}$$

the coefficient of $\text{TUBEPRICE}$ is expected to be negative and that of $\text{RIGCOUNT}$ positive.

The rest of the variables on the right hand side are fixed effects intended to allow substantial flexibility to the model. Fixed effects of developing countries control for variations in their demand schedules, and those of each year of the sample period control for world events and cyclical factors in the industry that affect all countries’ import patterns. It’s hard to postulate their signs without substantial background information about each developing country and events that influenced the demand and supply curves of the oil industry, which would in turn affect the seamless steel tubes industry. I only expect the fixed effects around the time of Gulf War to be positive to reflect production growth in OPEC countries after the oil embargo was imposed on Iraq.

In a variation of the above model where a time trend is used in place of the time fixed effects, the trend coefficient would capture sustained rises or falls in the demand over time, if such patterns exist.

$$\log(\text{TUBEUNITS}_{xt}) = \beta_0 + \beta_1 \log(\text{TUBEPRICE}_{xt}) + \beta_2 \log(\text{RIGCOUNT}_{it}) + \beta_3 \text{ALGERIA}_t + \beta_4 \text{LIBYA}_t + \beta_5 \text{NIGERIA}_t + \beta_6 \text{CHINA}_t + \beta_7 \text{INDONESIA}_t + \beta_8 \text{TIME}_t$$

The results of both specifications and the variables’ sample means are shown in the following table, where (1) designates the time fixed effect model and (2) designates the time trend model.
Table 2.3

Demand Results from OLS, 1985-1999 (N=447)

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>Sample Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUBEUNITS</td>
<td>30,878.930</td>
<td>30,878.930</td>
<td>(113,633.700)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>Fixed effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>7.088</td>
<td>(5.508)</td>
<td>4.19</td>
<td>...</td>
</tr>
<tr>
<td>TUBEPRICE</td>
<td>-4.845*</td>
<td>(.437)</td>
<td>-2.821*</td>
<td>1,300.752</td>
</tr>
<tr>
<td></td>
<td>.264</td>
<td>(.920)</td>
<td>.785</td>
<td>162.267</td>
</tr>
<tr>
<td></td>
<td>.414</td>
<td>(1.17)</td>
<td>1.066</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.329</td>
<td>(1.173)</td>
<td>.984</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.651</td>
<td>(1.173)</td>
<td>1.300</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>1.943*</td>
<td>(.332)</td>
<td>2.056*</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.292</td>
<td>(.332)</td>
<td>.405</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.138</td>
<td>(.452)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.109</td>
<td>(.469)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>1.080**</td>
<td>(.469)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>1.325*</td>
<td>(.510)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>1.872*</td>
<td>(.503)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>1.532*</td>
<td>(.491)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>1.709</td>
<td>(.552)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.646</td>
<td>(.605)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>-.271</td>
<td>(.634)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.085</td>
<td>(.639)</td>
<td>...</td>
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</tr>
<tr>
<td></td>
<td>.471</td>
<td>(.582)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>-.752</td>
<td>(.580)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.989</td>
<td>(.628)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.651</td>
<td>(.932)</td>
<td>...</td>
<td>Fixed effect</td>
</tr>
<tr>
<td></td>
<td>.016</td>
<td>(.033)</td>
<td>7</td>
<td>(4.325)</td>
</tr>
<tr>
<td>TIME</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As expected, the export price of tubes is found to be negatively correlated with units of tubes exported, and the coefficients produced by both specifications are highly statistically significant. Rig count, on the other hand, is not found to be correlated with units of tube exports. That is surprising because demand for seamless steel tubes is expected to be determined by the amount of drilling taking place. The time fixed effects between 1988 and 1992 are statistically significant and positive, confirming the hypothesis that demand for energy industry equipments rose around the time of the Gulf War in response to increased production. The time trend is not significant, implying that there are no sustained upward or downward trends in the adjusted real prices of seamless steel tubes.

Before providing more explicit interpretations of the results, remember that TUBEPRICE is expected to be endogenous in the demand models and must be replaced with an instrument and the model re-estimated by the 2SLS method. I now take the dummy variable, CARTEL, which is shown to be statistically correlated with TUBEPRICE in the price model, to be the main instrument and regress the basic model, without either time fixed effects or trend, using 2SLS. Additional instruments include OILPRICE, GASPRICE, and the cartel host countries. The time fixed effect model cannot be used because perfect collinearity between the time dummies and the cartel dummies during collusion would bias the regression results. There is no need to add a time trend to the model as that was found to be insignificant.

In the 2SLS model, instrumented for TUBEPRICE is expected to be negatively correlated with TUBEUNITS, and RIGCOUNT is expected to be positively correlated with TUBEUNITS. Table 2.4 presents the 2SLS findings. The second regression, whose results are shown column 2, dropped the fixed effects of Algeria, Nigeria, and Indonesia.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUBEUNITS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explanatory Variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONSTANT</td>
<td>6.247*</td>
<td>9.288*</td>
</tr>
<tr>
<td></td>
<td>(2.243)</td>
<td>(.781)</td>
</tr>
</tbody>
</table>
The Hausman test is performed to test the necessity of replacing OLS estimation with 2SLS estimation. The test produces a chi² of 49.79 for the first model, which estimates the fixed effects of all the developing countries, and 51.68 for the second model, clearly favoring 2SLS in both cases. The following discussion interprets the results.

Consider first the results in column 1. The elasticity of demand for seamless steel tubes by the select developing countries from the cartel host countries is very high. Every percentage increase in the price of tube exports is associated with a 5.96% decrease in the quantity exported, and this result is robust with t-statistic of –9.8. (Assuming that the elasticity of demand is constant everywhere on the demand curve.) Again, we are surprised to find that the model rejects the hypothesis of correlation between rig count and the quantity of tubes exported. Literature on the seamless steel tubes industry have consistently emphasized the importance of rig count in demand determination, but the results here do not support that relationship. The only country fixed effect that turned out to be statistically significant at the 5% level is CHINA, with coefficient of 2.01 and t-statistic of 6.4. The interpretation is that China imported on average 2.0% more seamless steel tubes each year from the six cartel host countries than did Venezuela and the other

Note – * denote significance at the 1% level, ** at the 5% level, and *** at the 10% level.

13 But this conclusion is contingent upon the accuracy of the original specification. A prerequisite for the validity of the Hausman Test is that the OLS regression used for comparison must provide the correct specification of the model. To the extent that the OLS regression can be accepted as the proper specification for the estimating the elasticity of demand for seamless steel tubes imports, the Hausman Test can be accepted.
countries, holding all other variables constant. China also distinguishes itself as the biggest importer. It purchased over 300,000 metric ton of seamless steel tubes from the five cartel host countries in 1985, more than the total by the other developing countries in that year. A little background research reveals that China is the only net energy importer of the six developing countries and its domestic demand for energy was growing rapidly with the growth of the economy. Given this information, it makes sense that China’s demand for energy industry equipments would be higher than that of other countries given a specific price level.

A price model that drops the fixed effects of ALGERIA, NIGERIA, LIBYA, and INDONESIA is estimated. As expected, it produces similar results. A percentage increase in the export price of tubes is associated with a reduction of the quantity exported of approximately 6.0%.

The 2SLS method produced similar, but more robust and precisely estimated coefficients. The effect of TUBEPRICE on TUBEUNITS found by OLS, -2.8 in percentage terms, is about half that found by 2SLS, -5.96 and –6.03. The explanatory power of the models estimated by 2SLS, with adjusted R² of .083 and .078, are lower than the original model estimated by OLS that produced adjusted R² of .217. That is probably a result of country-specific and firm-specific factors not captured by the model.

The Dead Weight Loss

In economic terms, the DWL results from the purchases that did not take place as a result of the price distortions. It is one of the two kinds of losses suffered by consumers from collusion, the other being the overcharge. The overcharge to developing country consumers by the seamless steel tubes cartel, derived from the estimated 13.3% price increase, amounted to approximately $1.3 billion. Estimation of the DWL falls a little under $49 million.

\[
\text{DWL} = (\text{number of cartel years})(\text{number of developing countries})(\text{Arnold Harberger's estimation of DWL})
\]

\[
= 0.5 \times (\epsilon \times d^2 \times P \times Q) = 48,973,725
\]

\[
\epsilon = e^{1.942} - 1 = 5.973
\]

\[
\text{Overcharge to selected developing countries} = \frac{\text{imports to those countries}}{1 + \text{price increase}} \times \text{price increase} = \frac{11,315,537,000}{1 + 0.133} \times 0.133 = 1,328,302,225
\]

\[
\text{DWL} = (6)(5)(5.960)(0.133^2)(1205.775)(25683.610) = 48,973,725
\]

14 $e^{1.942} - 1 = 5.973$

15 Overcharge to selected developing countries = (imports to those countries) / (1+ price increase) * (price increase) = ($11,315,537,000)/(1+0.133) * 0.133 = $1,328,302,225

16 DWL = (6)(5)(5.960)(0.133^2)(1205.775)(25683.610) = $48,973,725
where $\varepsilon = \text{the elasticity of demand as estimated by the log regression model}$

\[
d = \text{price-cost margin} = \frac{(P - P_c)}{P_c}
\]

\[
P = \text{average price per metric ton of tubing during cartel period}
\]

\[
P_c = \text{competitive price}
\]

\[
Q = \text{average metric tons of tubing purchased per country during cartel}
\]

How does the DWL compare to the level of overcharge? The estimated DWL is approximately 3.7% of the overcharge suffered by the six selected developing countries.

This study illustrates that the magnitude of DWL is fairly small in comparison to the overcharge in the case of seamless steel tubes cartel. We should be careful about generalizing the results to a greater set of cartels because the price increase generated by the seamless steel tubes cartel is on the low end along the spectrum of price distortions from collusion. The vitamins cartel, for example, raised prices of some classes of vitamins by 100% and the graphite electrode cartel raised prices by 45%. A cartel's ability to raise the price above the competitive level is a function of the elasticity of demand for that product. As the ultimate goal of a cartel is to maximize profits, and a high elasticity of demand can limit the cartel's ability to raise prices, we would expect the elasticity of demand in cases where the cartel raised the price by a large margin to be low. Given the monopoly quantity, the less elastic – the steeper – the demand curve, the greater the deadweight loss. As such, cartels that were able to raise prices considerably would have generated dead weight losses representing a larger fraction of total consumer loss, in comparison to the seamless steel tubes cartel.

**Conclusion**

According to the monopolist condition specified by $(p - MC)/p = -1/\varepsilon$, an elasticity of $-5.96$ is associated with a markup of 16.8%. The markup derived by the favored price model of this study is $13.3\%$, which is approximately half way between the previously observed 10% and the monopoly level. The consequent overcharge represents
approximately 63% of total overcharge to developing countries\textsuperscript{17}, which is roughly $2.11 billion. If the elasticity of demand for seamless steel tubes were constant across all developing countries, the implied total dead weight loss for developing countries would be about $78 million.

The results confirm the hypothesis that the seamless steel tubes cartel had significant market power in the seamless steel tubes industry throughout the six years of collusion. In fact, it came relatively close to monopolizing the market. The highly elastic demand curve faced by the producers limited their ability to raise the price of seamless steel tubes by a greater margin, to levels comparable to that of the other cartels discussed in the last chapter. What may explain the elasticity of the estimated demand curve? In 1985, China was by far the biggest importer of seamless steel tubes from the cartel host countries of the developing countries examined by this study. Over the course of the next decade and a half, its demand fell drastically. At the same time, Chinese seamless steel tubes production grew, leading one to suspect that domestic production could have become the cheaper alternative for Chinese energy producers. But because Chinese steel tubes have been found to be of lower quality than the exports of the established producers, and many of the major energy producers in the other developing countries were US and European multinationals that observed API standards, the other countries would presumably not have bought from the Chinese producers. That is in fact consistent with the findings of the study. In future studies, a more precise demand model could be estimated with information on the prices of domestic seamless steel tubes in China. The divergent demand behaviors of China and the other five countries may also be explained by OPEC membership, as China is the only non-OPEC sample country. There is another interesting phenomenon that has not been fully explained by this study - it is somewhat of a mystery why British Steel, one of the primary coordinators of the cartel, left the industry so abruptly in 1993. Its experience certainly tells us that while the cartel as an organization firmly captured the market examined by this study, competition among the cartel members still existed.

\textsuperscript{17} Total overcharge to developing countries = ($17.97 billion)/1.133*.133 = $2.11 billion. Percentage accounted for by overcharge calculated in this study = $1.33 billion/$2.11 billion = 63%.
The empirical results of this study are robust and economically significant, strongly arguing for further research on the seamless steel tubes cartel. If possible, future studies should incorporate labor costs to the current price model, and inventory levels to the demand model. To investigate the effect of short-term prospects in the energy industry on the price of seamless steel tubes, one could add futures prices of oil and gas to the price model. To test for potential umbrella price effects of collusion, one could look at export prices of non-cartel members by expanding the sample. And an issue of technicality that could be addressed more extensively is serial correlation, with the help of the first difference method.

The results also strongly argue for further research on welfare effects of other cartels discussed in the previous chapter, as the implied dead weight losses of cartels operating in industries with less elastic demand curves would be much larger fractions of total consumer losses than that found in the seamless steel tubes market.
Existing national anti-cartel enforcement is insufficient to fight international cartels on a global basis…

National policy makers are responsible for maximizing national welfare, which is the sum of consumer surplus, producer profits, and tariff revenue. The optimal national competition policy regarding cartels in theory, therefore, is to ban price-fixing arrangements in the domestic market but allow them to be made by domestic firms in the foreign market. This is in fact the policy adopted by most countries. Competition authorities of the U.S. and OECD countries, for example, do not have the jurisdiction to prosecute cartels whose activities cannot be shown to affect prices of imports or domestic goods.

Furthermore, a great number of governments allow their domestic firms to establish export cartels so long as these cartels do not affect their domestic markets. The following are countries that exempt export cartels from their domestic competition laws: Australia, Brazil, Canada, Croatia, Estonia, Hungary, Japan, Latvia, Lithuania, Mexico, New Zealand, Portugal, Sweden, and the United States. Note that some developing countries also have export cartel exemptions, and producers who benefit may be both domestic and MNCs originating from industrialized countries.

Jurisdiction of the U.S. Department of Justice

The U.S. allows foreign plaintiffs (governments or private parties) to bring suits against international cartels to U.S. courts, but only in instances where operations of the cartel have directly injured the U.S. market. If they have not directly injured the U.S. market, the foreign plaintiff’s access to U.S. courts would be denied. Access to U.S. courts is governed by the Foreign Trade Antitrust Improvement Act of 1982. To gain access, the FTAIA requires foreign plaintiffs to show that 1) the alleged competitive
behavior had a direct, substantial and reasonably foreseeable effect on the U.S. marketplace and 2) an anticompetitive effect on the U.S. marketplace gave rise to the plaintiff's claimed injuries. As such, only a handful of foreign plaintiffs have the right to press charges against international cartels in U.S. courts. In Ferromin International Trade Corp. v. UCAR International, Inc., 27 foreign plaintiffs brought charges against the graphite electrodes cartel (1992-1997) for the damages they suffered as a result of price fixing and market allocation. The U.S. district court dismissed the claims of 16 of the plaintiffs. The plaintiffs failed to prove that the damage they suffered stemmed from anticompetitive effect on the U.S. market created by the cartel. The court found that the damage suffered by the 16 foreign plaintiffs stemmed from anticompetitive effects of the cartel on foreign markets.

International cartel operations that hurt developing countries as a result of their anticompetitive effects on developing markets (but not directly on the U.S. market) are outside the scope the U.S. anti-trust laws. The purpose of U.S. anti-trust laws is, naturally, to protect the interest of the U.S. market. What would the U.S. gain by allowing the above 16 lawsuits to proceed in its courts? It could be argued that in today’s integrated global economy, any anticompetitive conduct that affects foreign markets could potentially affect the U.S. market. As such, the deterrent effect of prosecuting the 16 lawsuits on firms that intend to collude in the future could potentially benefit the U.S. market. What must also be taken into account, however, are the costs associated with expanding the jurisdiction of the U.S. antitrust laws. The benefits stemming from increased competition in the U.S. market as a result of broader jurisdiction should be weighed against these costs. If the benefits outweigh the costs, then the U.S. should broaden access to foreign plaintiffs. If not, then the current system should be preserved.
Two methods of achieving the economically efficient outcome…

The optimal policy for the world as a whole is to ban all cartels because they create a deadweight loss – the losses to consumers from the cartel’s output restriction exceed the gain in profits to the cartel members. This optimal outcome can be achieved through a supra-national competition authority, or without a supra-national competition authority by allocating the rights to set competition policy to the importing countries who have an incentive to protect their domestic markets – they would choose to ban cartels.

Some have argued that it would be sufficient to equip developing countries with competition policies and authorities. This proposal would be feasible if all competition authorities are equal in strengths, making it impossible for one country to beat the system and gain, in total national welfare, at the loss of others. In reality, however, competition authorities in developing countries are unlikely to receive the degree of respect given to their counterparts in industrialized countries. For example, consider U.S. soda ash producers from the U.S. cartelized Indian and European export markets. Indian and European competition authorities both made attempts to ban soda ash imports from the U.S., but while the European Commission was successful, the Indian competition authority was not. India succumbed to external pressure applied by the US soda ash lobby, which threatened to India $1 million in GSP (General System of Preferences) duty free benefits unless it revoked the embargo. The diverging outcomes of the soda ash cartel dispute in Europe and India illustrate the lack of bargaining power of developing countries in face of powerful external players, even when competition authorities exist in those countries.

Others have endorsed multilateral initiatives. Historically, cooperation among national competition agencies has been difficult to achieve due to the unwillingness of governments to share potentially sensitive information of national firms, trade secrets, or their differences in legal principles. But recently, as countries have strengthened their commitment to maintain competition in the marketplace, they have become much more willing to offer each other assistance in cartel prosecution. Since the 1980s, the DOJ has enjoyed significantly greater access to documents or depositions by firms headquartered outside the U.S. in its investigations of global price fixings.
Bilateral agreements, an important development in international competition cooperation, emerged in the 1970s. The U.S. and Germany signed the first in 1976. The U.S. subsequently signed six more such agreements with Australia (1982), Canada (1984), the EU (1991), and Israel, Japan and Brazil (1999). These bilateral agreements allowed the Executive Branch of the U.S. government and the ministries of other countries to cooperate in enforcement, information exchange, the provision of technical assistance and the development mechanisms for dispute avoidance.

The U.S. also took another significant step in 1994 towards international cooperation by passing the International Antitrust Enforcement Assistance Act (IAEAA) in Congress to allow U.S. antitrust agencies to engage in reciprocal exchange of confidential information with foreign antitrust agencies (except for merger filings). The U.S. signed the first IAEAA agreement with Australia in 1999. U.S. and foreign antitrust agencies in general “seem to favor continuation and deepening of these various bilateral agreements.”

The best form of international cooperation, in theory, is the establishment of a multilateral antitrust organization because only such an organization can look out for the interests of those countries currently lacking antitrust agencies. The International Trade Organization negotiated in 1948 had an important antitrust function but it was rejected by the U.S. Senate and replaced by the weaker GATT containing no clauses relating to antitrust. The World Trade Organization (WTO) now stands in place of GATT, and it too is focused on trade issues. There has been some talk by the agency and its members about expanding its jurisdiction to sponsoring international antitrust rules. (Only less than half of WTO’s 135 members have antitrust laws.) The U.S., while aggressive in negotiating bilateral agreements, has unfortunately been reluctant to endorse expanding the powers of the WTO.18

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18 It did signal in 2000 that it would be interested in establishing an international antitrust agency wholly unconnected to the WTO
I propose a third method…

Prosecution of cartels exists for the purpose of ending the crime, compensating the victims, and deterring similar activities in the future.

The most common weapon of deterrence is a monetary fine. (In the U.S. chief organizers of cartel may also face criminal charges.) The fine can be set to maximum legal liability, to the economic harm caused to customers (customer overcharge, which equal is the transfer of surplus from consumers to producers, deadweight loss is the value of lost sales as a result of higher prices driving some consumers out of the market), or to the monopoly profits generated by the cartel. In the U.S. for example, the fine is specified to be the larger of a) US $10 million (corporations) and US $350,000 (others), or b) twice the amount gained by the cartel from the violation or lost by the victims. The European Union allows fines of up to 10% of the cartel participants’ previous year global turnover. Because assessing the true impact of the cartels on consumers and producers is difficult, it is hard to say whether the maximums set by the various antitrust agencies have provided sufficient deterrence.

Most economists agree that effective deterrence necessitates a fine that accounts for both the extra profits of collusion and the probability of cartel detection. Collusion pays if the probable costs are less than the expected profits. So if a cartel faces 20% probability of being caught and holds half of its operations outside of the U.S., then to successfully deter is formation, the fine must be 10 times the firm’s legal profits in the U.S. In practice, the DOJ fined cartels it prosecuted in the 1990s approximately double their legal profits. (EU fines, if the EU prosecutes the cartels following U.S. prosecution, would add to the U.S. fines the level of the firms’ legal profits. But the sum still does not necessarily meet the level needed for successful deterrence.) For example, Connor (2001) estimates that the vitamins cartel raised global profits of vitamin producers by at least $6.7 billion (which equals consumer overcharge) and caused an additional $1 billion in deadweight loss. The sum of punishment imposed upon the cartel members through government fines and private antitrust suits in North America recovered about a third of these losses. It is unlikely that the EU would impose fines totaling two-thirds of these losses. As such, the vitamins cartel paid off even though it suffered sanctions from
several antitrust agencies. More obvious indications of the insufficiency of current fines include Hoffmann-La Roche’s continuation of its cartel activities in the vitamins market for another year after suffering a $14 million fine, and the rise of ADM stocks after the level of its fine $100 million, was made public.

If the fine can be increased to a level that sufficiently deters collusion on the international level, fines may be today’s most practical method of fighting international price fixing. While it would be very difficult, politically and economically, to pool support for the establishment of a multilateral antitrust authority, it is much easier to coordinate an increase in fines by the existing national antitrust agencies. To do so, nations should first agree to a rule of single prosecution – that is, each cartel could be prosecuted only once, whether it is by the DOJ or the EC or another antitrust agency. Next, they should agree to prosecute on the global scale, taking into account the harm suffered by consumers across the world. The incentive for prosecuting on behalf of other countries can be built by allowing the agency carrying out that prosecution to keep the entirety of the fine. As such, antitrust agencies of the developed world can and will have the incentives to fight cartels on behalf of the developing nations.
References


Worldwide export data retrieved from www.wits.worldbank.org
Regional rig count data retrieved from Baker Hughes databases www.bakerhughes.com/investor/rig.
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