

DETERMINANTS OF CARTEL DURATION:  
A CROSS-SECTIONAL STUDY OF  
MODERN PRIVATE INTERNATIONAL CARTELS

Jeffrey E. Zimmerman  
and  
John M. Connor

Department of Agricultural Economics  
Purdue University, West Lafayette, Indiana

April 2005

The authors thank the participants of the 3<sup>rd</sup> Annual International Industrial Organization Conference, Atlanta, 2005. The ideas and opinions expressed in this paper are of the authors and do not represent any positions endorsed by Purdue University.

## **ABSTRACT**

This research identifies and measures factors that contribute to the duration of modern-era private international cartels. This research utilizes a unique sample of modern-era private international cartels discovered between 1990 and July 2004. This sample is fitted using the Cox proportional hazards model. Some former empirical results are verified, while some new factors explaining cartel durability exhibit statistical significance.

The regression results demonstrate the significance of five categories: market structure, internal cartel organization, industry-specific conditions, external macro-economic conditions, and antitrust law environment. Consistent with previous cartel duration studies, industry concentration and market share have positive effects on cartel duration. Contrary to former findings, the present analysis exhibits a positive relationship between economic downturns and cartel duration. This suggests that illegal profit incentives during periods of downward economic pressure encourage the maintenance of cartel contracts.

I find many internal cartel organization characteristics to have some statistical significance on cartel duration; such as, the number of participating firms, overcharge percentage, cultural diversity, bid-rigging, among others. Independent variables pertaining to antitrust law environment, unique to this study, add explanatory power in assessing cartel duration and therefore need to be included in future analyses of cartel duration. In addition, a temporal period analysis of 1990-2004 concludes that increased use of anti-trust leniency programs have had a significant negative impact on cartel duration.

## **Introduction:**

Illegal private cartel activities have resulted in substantial consumer welfare losses for decades. These losses consist mainly of overcharges paid by customers: victims of illegal price-setting schemes paying supra-competitive market prices for products and/or services. From a comprehensive empirical study of 167 private international cartels discovered between 1990 and 2003, \$539 billion of projected sales to direct buyers were affected by illegal price-setting schemes. Connor (2003) also notes that the overcharges, or illegal profits, collected by international cartels averaged between 25% and 35% in most of the affected markets. Hence, \$135 to \$138 billion of projected illegal profits were reaped from the sampled 167 cartels studied. This significant figure does not include national cartels, nor social welfare losses, nor the losses of covert cartels yet to be or never to be uncovered.<sup>1</sup> Moreover, accrued social welfare losses from cartels are, in many respects, irretrievable.

Cartel duration or longevity is an essential factor in determining cartel effectiveness and, *ceteris paribus*, the potential economic damage to markets. Cartel duration refers to the total life span of an effective illegal price-fixing agreement from its formation to abandonment, possibly spanning multiple episodes. An episode is defined by the absence of changes in nature of the contract agreement. Redefining terms of the contract, such as, membership additions or departures, modifying internal penalty structure, establishing a joint-sales agency, among others, are all deemed a change in the nature of the contract agreement and would result in a new episode. Cartel duration

should not be confused with cartel stability, which is signaled by a low variability in prices or the overcharge rate within an episode. The determinants of both cartel duration and stability may be similar. While it is not clear that cartel stability affects aggregate long term consumer loss, it is self-evident that long-lived cartels are in general more destructive than short-lived cartels with equal overcharges.

Industrial Organization (IO) research has identified many factors contributing to duration; however, not all of these factors have yet to become “stylized facts” for researchers and policymakers. One innovation in this paper is the unprecedented use of modern-era international cartel data for a formal cross-sectional analysis. The findings of this paper differ from previous studies of duration utilizing pre-World War I and inter-war cartel data. This fact alone reinforces the significance of empirical findings for current theoretical views, not only in scope, but across time as well. Furthermore, empirical findings from modern-era international cartels lend themselves toward greater relevance for the development of anti-cartel policy.

### **Scope:**

This scope of this research is limited to a sample of international private cartels that were discovered from January 1990 to July 2004. By “discovered” is meant anti-trust authorities sanctioned or are likely to sanction cartel offenders for a price fixing violation from January 1990 forward. In a few cases, discovery refers to cartels that paid antitrust damages to private parties even though no government indicted or fined the

---

<sup>1</sup> Approximately 67-90 percent of all cartels remain clandestine, hence total income transfers were probably in the range of \$500 to \$1,500 billion over the time period of this study. Umbrella effects of cartels may also be substantial.

cartel. Accessibility to credible and more complete information is one reason for limiting the scope of this research to cartels after 1989.

The year 1990 is also a reasonable starting point since it marks the first year that the current U.S. fine structure for antitrust violations was in force. Around the same time the U.S. Department of Justice (DOJ) enhanced its investigatory techniques (Connor 2001). This structural change in U.S. anti-trust laws and enforcement is one reason for an increased discovery of cartel violations post-1989. International anti-trust agencies, i.e. Canada and the EU, followed suit and added to the increased number of cartel prosecutions from 1990 forward. Hence, an adequate number of post-1989 observations are available on which empirical analysis may be performed. Despite the January 1990 cutoff, a large sample remains of modern-era cartels possessing a greater number of characteristics desirable for theoretical analysis of duration and post research policy application.

Many desirable characteristics for research stem from the international membership of the cartels. The size of consumer losses of such cartel agreements tend to be greater when price fixing extends to several nations (Connor 2003). Moreover, one could argue that international cartels would require more complex agreements, thus providing a greater range of conducts for analysis. For instance, international agreements face more potential demand shocks, challenges from cross-cultural internal discipline, and problems arising from volatility of currency exchange rates (Alexander 2003). Finally, because of the difficulty of gathering extraterritorial evidence, international cartels are inherently more difficult to prosecute than domestic ones.

Policy adjustments need to take in to account the increasingly global nature of all transactions, especially in homogenous product markets that continue to experience a global convergence among sellers. Global cartels are international cartels that operated in two or more continents; many crossed three of them. Much of this convergence has been observed in “the triad” involving the most industrialized regions of the world – Western Europe, North America, and East Asia. Many of the most destructive modern-era international cartels observed operated throughout the triad, in stark contrast to inter-war cartels (Kudo and Hara, 1992).

The time period is significant in light of heightened anti-trust law enforcement worldwide, but particularly within the United States. In 1990 the current U.S. fine structure had become operational.<sup>2</sup> Subsequently, 1993 marked the adoption of the present U.S. corporate leniency program that spurred an increased rate of cartel discovery. Because amnesty is granted automatically under certain pre-specified conditions, the 1993 policy change has been widely praised for a marked increase in lenience application and prosecution. Overall, improved investigative and prosecution techniques worldwide have uncovered many significant modern-era international cartels that otherwise would not have been included in this research.

### **Objectives:**

The positive economic objective of this paper is to identify factors that contribute to the duration of modern-era, private, hard-core international cartels and estimate their economic importance. This research aims to verify some of the former findings while testing for significance of new factors of cartel duration. Private cartels are the desirable

type to be studied because of the recent increase in their discovery and increased effect on consumer loss. All the cartels engaged in “hard-core” or “naked” horizontal market restraints. That is, the cartels deliberately set prices or allocated market shares or both. Moreover, public cartels are beyond the scope of antitrust laws. By definition international cartels are those that have one or more corporate or individual participants with headquarters, residency, or nationality outside the jurisdiction of the investigating antitrust authority.

A post-research normative economic objective of this paper would be to help maximize the welfare benefits of the resources devoted to anti-trust law enforcement by targeting cartels that exhibit factors contributing to duration. Pertinent empirical findings contributing to duration could be posited as a rational screening guide for anti-trust law enforcement authorities against cartelists in question. This would help allocate limited resources of anti-trust agencies more efficiently.

### **Literature Review:**

Economic theory of industrial organization does not possess an established model for predicting cartel duration, nor does it precisely specify appropriate explanatory variables. Overarching theories on oligopoly provide some general guidance; however, to extract relevant hypotheses relating to cartel duration from these studies in most cases becomes too far reaching. Hence, in the oligopoly theory discussion that follows, I am cautious when drawing inferences about determinants of cartel duration.

George Stigler (1964) provided the first rigorous cartel model that showed in order to optimize collusive behavior, firms must control free-riding and cheating

---

<sup>2</sup> In mid-2004 maximum U.S. fines were raised again (Connor 2004).

incentives. Without establishing effective mechanisms for monitoring, control, or self-policing, collusive behavior among the firms would be detected by a cartel member and result in a shorter-lived cartel. Stigler showed from a theory of information flow that detection becomes more eminent as information channels increase. Stigler then went on to analyze the effect of industry structure and product characteristics on an oligopoly's ability to self-police a pricing agreement. His model predicts that high concentration results in high cartel price. Inferences about cartel duration from Stigler's cross-industry regression analysis are very limited; however, one might imagine that the model supports a positive relationship between industry concentration levels and cartel duration. In addition, from Stigler's theory of information flow one could very cautiously infer support of a negative relationship between buyer concentration levels and cartel duration.

Grossman (2004) acknowledges cross-sectional studies are useful towards identifying factors contributing to cartel duration and greater profitability. He further acknowledges the potential for such studies to enhance the effectiveness of anti-trust law enforcement. Limitations do exist when attempting to compare between such studies, which does prolong the adoption of styled facts into anti-trust law enforcement. Current quantitative research on cartel duration can be broadly subdivided into purely descriptive analysis and empirical analysis involving a theoretical model.

To date, three significant empirical analyses - Marquez (1992), Dick (1996), and Suslow (2001)- have greatly contributed to identifying the determinants of duration among international cartels.<sup>3</sup> The majority of cartels sampled across these three studies

---

<sup>3</sup> Two significant studies on determinants of duration among domestic cartels were conducted by Posner (1970) and Hay and Kelley (1974), in which both found the number of firms in the cartel to positively related to its duration. Hay and Kelley also found cartel duration to be longer in markets with high degrees of industry concentration (Hay and Kelley 1974, p. 26.).

were legal cartels operating under different contractual conditions that result in different findings from the present study. The use of duration as the dependent variable for cartel performance research is recognized as well as the use of profit margins, which is very difficult to measure.<sup>4</sup> Marquez (1992) found the median cartel duration to be 5.2 years among his international cartel observations. Dick found median cartel duration of 5.3 years for legal Webb-Pomerene export cartels, while Suslow reported the shortest median of 3.7 years for international cartels. The majority of cartels sampled across these three studies were legal cartels operating under different contractual conditions that result in different findings from the present study. These studies are consistent in their findings of cartel market share and industry concentration being positively associated with cartel duration. Both Suslow and Dick show economic uncertainty and downturns to have a negative effect on cartel duration. Internal cartel organization characteristics are shown to have mixed results across the three duration studies (Table 1).

### **The Data:**

The data for this study consists of information on 207 international private manufacturing, commodity, or services oriented cartels discovered between 1990 and July 2004.<sup>5</sup> This data set is new and therefore unique in its observation period, scope of participating industries and countries, and large sample size. The cartels observed are international in their membership and often in geographic scope (See Appendix B). The

---

<sup>4</sup> Eckbo (1976) utilized profit margins as the dependent variable in a sample of 51 international cartels in 18 industries, 1819-1964. He found a positive relationship between cartel profitability and increased industry concentration and market share.

<sup>5</sup> The original 167 cartels in Connor (2003) plus updating since mid-2003.

modern era cartels observed in this data set differ significantly from the predominantly inter-war cartels used in previous cartel duration analyses.

This sample exhibits limitations due to the covert nature of cartels, which results in inherent challenges in the data selection and acquisition process. The covert nature of cartel contracts in fixing prices or allocating production does not allow for easy data collection. Data were acquired after the legal prosecution and/or investigation of failed cartel agreements. As a result, this research will apply to the population of failed cartel agreements. Previous research suggests cartel data collected from prosecuted price-fixing cases tends to overstate duration (Dick 1996). Inferences drawn from this data set may be limited in their application toward all cartel agreements that remained clandestine.

Data was collected from three different sources. First, discovered cartel information was retrieved from public press releases of government prosecuting entities on fines, a guilty plea, or indictment announced. Second, data was procured from private press services in the form of business newspapers, trade magazines, business-and-law search engines; i.e. Factiva, LexisNexis, among others. Third, data was retrieved from compiled data sets of current academic or government researchers, including: working papers by Levenstein & Suslow (2002), Levenstein, Suslow, & Oswald (2003), Clarke and Evenett (2003), and publications by Connor (2000, 2001, 2002, 2003).

### **Description of Variables:**

The descriptive statistics of the dependent and independent variables can be found in Table 2. The dependent variable for this study is duration of the cartel measured in

months. The longest reported duration for each cartel observation is used. The independent variables to be examined pertain to five main hypothesized areas of influence: market structure, internal cartel organization, external macro-economic conditions, industry-specific attributes, and antitrust law environment. These explanatory variables are measured at some given point during the lifespan of the cartel. The inaccuracy of data sources did not allow for measurements universally to be taken at the beginning or end of the cartel agreement. In addition, many cartels are still under prosecution and in such cases; only known measurements up to the time of this study were included. Therefore, the conservative nature of some the measurements; i.e. amount of sanctions, should be noted. Table 1 also shows the hypothesized effects on the hazard ratio. Further delineation of independent variables will be discussed in the results section of this paper.

### **Methodology:**

The duration of each cartel will serve as the dependent variable in a proportional hazards model (Cox Model) while using cartel specific characteristics as explanatory variables (Cox 1972). Hazard models have been used for empirical analysis of technology adoption (Levin 1987). Following Suslow's approach, I examine the empirical relationship between cartel duration and modern-era specific cartel characteristics and surrounding economic and law environmental conditions. The objective is to identify significance of specific cartel characteristics on cartel duration using the data sampled from 207 modern-era cartels.

The unit of observation is the cartel duration measured in months. Let  $T_i$  denote the  $i$ th cartel episode's length in months such that  $(i=1, \dots, N)$ . The probability that a cartel episode ends at time  $t$ , given the hazard rate,  $\lambda$ , for  $T$  is the conditional density of  $T$ ; i.e.,  $T > t \geq 0$ , is defined by,

$$\lambda(t) = \frac{f(t)}{1 - F(t)}$$

where  $f(t)$  is the probability density for  $T$  while  $F(t)$  is the cumulative distribution function for  $T$ .

The data in this sample set includes completed non-censored cartel episodes. Hence the likelihood model, not including a right-censoring indicator variable, is:

$$L(\beta) = \prod_{i=1}^N f(t_i; \beta, z_i)$$

The likelihood function is then interpreted as a function of  $\beta$ , a vector of parameters to be estimated, and the vector  $z$ , includes characteristics of the cartel's operating environment, i.e. market structure, internal cartel organization, external economic conditions, industry-specific characteristics and antitrust law environment.

The Cox proportional hazards model identifies the probability that a cartel ends in a given month, conditional on the cartel operating in the previous month. The Cox Model utilizes a hazard function,  $\lambda$ , dependent on time,  $t$ , and a vector of explanatory variables serving as a shift factor,  $z$ , and associated parameters where,

$$\lambda(t; z) = \lambda_0(t) \exp(z\beta)$$

This model will identify those factors that are statistically significant in increasing or decreasing the probability that a cartel ends. We hope to describe the directional relationship between these factors and cartel duration as well as compare the weight of influence. Dummy variables will be utilized for factors that may have significant explanatory power and where proxy values are not available.

This study utilizes a pseudo-R-squared measure of dependence developed by Kent and O'Quigley (1988) for Cox proportional hazard likelihood models. This measure is interpreted as the percentage of variance in survival time of Y explained by the independent variable or variables fitted to the model.

Model 1 is fitted with a sample of 59 observations of those cartels where complete information was available across the greatest number of explanatory variables. Model 2 is fitted with the same sample of 59 observations and omits independent variables that resulted in a zero coefficient and/or were significantly correlated to parallel variables at the 1 percent level or more. Model 3 is fitted a sub-sample of 33 observations from Model 2 and substitutes known cartel market share percentages for the dummy cartel market share variable. Model 4 is fitted with 32 observations from Model 2 and adds AVESHRCR, largest firms' concentration ratio share, while reducing the independent variables to achieve adequate degrees of freedom.

A two-sample statistical means test based on a t-distribution was conducted between the base model data set containing 59 observations (Model 1) and the overall piecemeal data set containing up to 207 observations conditional to the independent variable. The majority of these cartels were 'big players' resulting in overrepresentation or underrepresentation among some explanatory variables (Table 1).

## **Results:**

The aforementioned five areas of influence on cartel duration categorize the main empirical analysis in this chapter (Table 2). This will be followed by a temporal analysis of the characteristics determined by end date of cartel agreement: 1990-1995, 1996-1999, and 2000-2004 (Tables 4 & 5).

The dependent variable, duration in months, was known for 166 of 207 cartels sampled and discovered between 1990 and July 2004. The average duration was 75.5 months (6.3 years) and the median was 53 months (4.4 years). These figures are consistent with previous studies, indeed falling between medians reported by Marquez, Dick, and Suslow (Table 6). A decreasing trend in duration is observed across the latter two periods of the temporal analysis (Table 4). The decline in cartel durations could be the result of either a divergence among cartelists' ability to remain undetected or more effective anti-trust law enforcement. It is important to note the statistical phenomena of data extraction associated with duration periods are in part responsible for a declining trend.

### **Market Structure**

Economic theory has long posited the significance of the effects of market structure characteristics on cartel duration. Empirical studies have since shown that a significant positive relationship exists between concentration and market share and cartel duration. Data for model 3, a subset of model 2, was extracted to test the known market share percentages against duration and although insignificant, MRKTSHRPCT exhibits an expected negative coefficient (Table 2). Model 1 shows an unexpected positive coefficient for the MRKTSHR, a dummy variable equal to one for cartel whose

market share is greater than 50%; however, in model 3 regressions of the actual known market share percentage exhibits an expected negative effect on the hazard rate. This suggests that MRKTSHR is a poor substitute for the actual percentage. The data set for model 4, a subset of model 2, was compiled specifically to test the largest firms' average concentration ratio, AVESHRCR. AVESHRCR showed partial statistical significance and negative effect on the hazard rate as hypothesized (Model 4, Table 2).

The AFFSALES variable is statistically significant at the 10 percent level on its influence of cartel duration. AFFSALES consistent negative effect across models on the hazard rate supports the alternative hypothesis that larger markets increase profit potential and prolong cartels. Consistent with IO theory, markets possessing a large number of buyers allow for longer cartel duration as shown in NUMBUYERSL being highly statistically significant and negative. Likewise, NUMBUYERSM, a medium number of buyers in a market for a cartelized product also portrays a negative effect on the hazard rate. It should be noted that NUMBUYERSL is significantly negatively correlated to NUMBUYERSM and NUMBUYERS, the latter two being omitted in models 2, 3 and 4. NUMBUYERSSS exhibited a zero for a parameter estimate in the regression of model 1. This is probably due to insufficient differing observations from BIDRIGGING which are very significantly correlated.

Model 5 shows market structure variables are highly significant in their explanatory power under a formal statistic test (Table 3). Interestingly, when omitting these variables we observe the smallest decrease in R-squared value, in comparison to the other categorical areas of influence on cartel duration. This means in market structure

variables contribute the least amount of explanatory power when compared the other areas (compare models 6, 7, 8, and 9).

### **Internal Cartel Organization**

Empirical studies have analyzed varying characteristics of internal cartel organization with mixed results as to their influence on cartel duration. Inconsistencies among the organizational variables analyzed continue to hamper consistency of recommendations proffered by IO economists in this area. The unprecedented modern-era data set used herein attempts to overcome such inconsistencies and establish consistently reasonable organizational variables, in light of limited data availability, when studying modern-era cartels.

One such highly significant variable not previously studied is the percentage of overcharge received by the cartel. OVERCHARGE displays a robust positive significant coefficient inferring a higher overcharge could lead to quicker detection by anti-trust authorities (Models 1 and 2, Table 2). Perhaps incompetent cartels try to maximize short run profits whereas durable conspirators see the value of restraining their prices to avoid detection.

A novel variable denoting cultural diversity among firms, CULTURDV, is significant and positive, implying an increased cultural diversity among cartel members results in shorter lived cartels. The interactive term between firms and cultural diversity, FIRMSCULTDV, indicates an opposite effect on the hazard. This paradoxical finding could be a result of an overrepresentation of EU cartels among the sample that involve many firms and have assistance of a trade association cover allowing longer durations.

This is indicated by a statistically significant positive correlation at the 1 percent level between FIRMSCULTDV and the two variables DISCOVERYEU and THIRDPARTY.

The number of firms, FIRMS, is the only organizational variable repeated in this study that previous studies have analyzed. The coefficient is positive, as expected, and significant at the 5 percent level. Thus, large numbers of firms makes disagreements more likely. The relationship between cartel duration and a dominant firm, DOMFIRM40 and DOMFIRM, were mixed in Model 1 and insignificant (Table 2).

The interactive term between third party support and the number of firms is highly significant and negative, indicating if the cartel contains a substantial number of members the conspiracy will be prolonged under the cover of a trade association. Also, of interest is a significant correlation at the 1 percent level between the interactive term FIRMSTHRPTY and cartels discovered in the by EU authorities, DISCOVERYEU. This brings into question the wisdom of the EU commission's policy of promoting supra-national industry involvement, i.e. trade associations, with many members. A paradoxical finding shows third party support itself to have a non-significant positive coefficient in model 1, with mixed results across other models. These same mixed results are paralleled by government assistance and central sales agency variables in Suslow's findings. Hence, there is an insignificant relationship between third party support and cartel duration, except perhaps in cases where large numbers of firms are involved.

Cartels that operate as bid-rigging conspiracies are shown to last a long time, as indicated by the significant negative effect on the hazard rate. Thus, the contractual agreement among cartel members may be less cumbersome to maintain once established.

The interaction between the number of firms and bid-rigging cartels also displays a negative partially significant coefficient as expected.

Model 6 shows internal cartel organization variables are highly significant in their explanatory power under a formal statistic test (Table 5). Omitting these variables would cause the second largest decrease in R-squared, just less than the effect on the R-squared under model omission of industry-specific variables.

### **Industry-specific Conditions**

In general, results of the industry dummy variables are insignificant, but remain fairly consistent in their hypothesized expected effect on the hazard rate. Organic chemical industries, ORGCHEMAG & ORGCHEM, were highly significant and positively related to cartel duration. This is consistent with Suslow's finding, although in her study insignificant. This indicates the economic demand environment and specific industry conditions; i.e., high barriers-to-entry, in the chemical sector are favorable to longer cartel duration. Industries of electronic products and construction, ELECPRODS and CONSTRUCT, were also highly significant and positively related to cartel duration. These industries include mainly bid-rigging cartels.

Model 7 shows industry-specific variables are highly significant in their explanatory power under a formal statistic test (Table 5). By omitting such variables we observe the largest decrease in R-squared value, but only by a very small margin in comparison to significance of internal cartel organization characteristics.

## **External Macro-economic Conditions**

The aggregate economic conditions surrounding cartels are difficult to measure and vary over time. Both BUSICYCLE and GRWTRATECYC are highly significant and the negative coefficients showing that declining aggregate economic trends foster cartel duration. This would indicate that they are able to maintain at least some supra-competitive profits during downturns. These findings may also indicate that modern-era cartels are more resilient than former cartels to withstand an increasing rate of occurring business cycles. The sample is drawn from cartels that ended during a period of robust growth. These findings are opposite of Suslow and Dick who find that cartels in their respective samples from earlier decades are shorter lived in the face of economic downturns. The results would support an increase in the formation of cartels during economic downturns, perhaps to ensure higher prices among industry constituents. It should be noted that these two variables, BUSICYCLE and GRWTRATECYL, are highly correlated at the 1 percent significance level and as such, the use of only one variable could be considered. Models 2, 3 and 4 utilize GRWTRATECYL as the aggregate economic index indicator variable, it being more statistically representative of larger sample and population (Table 2). Model 8 shows external macro-economic variables are highly significant in their explanatory power under a formal statistic test (Table 3).

## **Antitrust Law Environment**

Empirical antitrust law environment analysis on cartel duration is unique to this study of modern-era cartels. The increasing number of cartels being prosecuted today shows the role of improved anti-trust law enforcement is an important factor. Indeed,

Connor (2003) has found the discovery rate of cartels to be six times greater in the early 2000's, with over 20 annual discoveries, than in the early 1990's. Regressing measures of anti-trust law enforcement on cartel duration will show its effectiveness on prosecuting cartels and reducing consumer welfare losses.

A negative coefficient sign for sanctions is a paradoxical finding and would imply that the higher sanction levels do not encourage cartel dissolution or 'whistle-blowing' by members. It may imply that members of cartels are risk loving. An ad hoc explanation may be that antitrust authorities place greater fines on more durable cartels; i.e. the causality is the reverse of what was hypothesized. In a separate model, sanctions divided by the duration; i.e. sanctions per year, does exhibit a positive coefficient, but highly insignificant. Hence, reverse causality between sanctions and duration may be the best explanation.

The dummy variables associated with the country of discovery are not significant, except for Canada, but do portray an expected positive effect on the hazard rate. DISCOVERYUSA and DISCOVERYEU are also significantly correlated at the 1 percent level. In model 1, neither DISCOVERYOTH nor DISCOVERYJNT provide significant explanatory power. Likewise, the amnesty program awareness index, AMNESTY, is insignificant, but does portray a positive effect on the hazard rate. This would suggest as anti-trust agency leniency programs become better known among cartel members there is an increased likelihood that 'whistle-blowing' would occur. This behavior would shorten cartel duration for those who choose to participate. Model 9 shows antitrust law environment variables are highly significant in their explanatory power under a formal statistic test (Table 3).

## **Temporal Period Analysis**

A temporal analysis is helpful in determining effectiveness of anti-trust law changes overtime and thus the reduction of consumer welfare losses. The purpose of this analysis is to identify trends in the descriptive statistics as well as patterns in regression significance of antitrust law measures over three periods of time. The three time periods to be analyzed according to the observed cartels known ending date include 1990-1995, 1996-1999, and 2000-2004.

Table 4 portrays many trending descriptive statistics on selected variables, some pertaining to anti-trust law enforcement. However, these descriptive trends are difficult to interpret, which depends in large part on which measurement you use. For example, average sanctions have increased at a faster rate than affected sales over the time period analyzed. On the other hand, the median affected sales have increased more than six-fold over the three samples time periods accompanied by only a near three-fold increase in sanctions. Interestingly, the median number of firms and the median duration in months are inversely related over the sampled time periods, which supports the hypothesized negative relationship. Likewise median annual overcharges inversely correspond to median duration over the sampled time periods and support the hypothesis that longer-lived cartels are more conservative in setting overcharges. However, this does not hold true under analyses of the means. Discoveries have remained fairly steady for the U.S. and EU over the sampled time periods with the U.S. showing a substantial increase during the second period, 1996-1999. More importantly, discoveries made by other national anti-trust agencies have seen a 5 fold increase over the three periods sampled. Finally, AMNESTY, the index portraying leniency program awareness, has steadily increased and more than tripled over the time periods sampled.

Table 5 shows the regression results of cartel observations categorized in three time periods according to their known end-dates. A selected group of determinants is used. The regression on the first period, 1990-1995, will serve as a control benchmark group no effective amnesty program utilization. I hypothesize the results will capture policy changes in effective amnesty program use for the U.S. over the period 1996-1999 and additional use by the EU over the period 2000-2004. Note the highly positive significance in the amnesty program awareness indexed variable across the two latter periods as hypothesized. These results imply the increased use of leniency programs by anti-trust authorities has been effective and in part responsible for shorter-lived cartels.

The high negative significance of the US and EU country of discovery variables in the first period is can be explained on two accounts. First, this period begins my sampling database and as such longer-lived cartels are sampled in this period. Secondly, the longer lived cartels being discovered in the first period is an indication of lax or unsuccessful prosecution in the previous decades as opposed to more successful prosecution by the U.S. and the EU beginning in the 1990's.

### **Conclusion:**

The duration of modern-era private international cartels is determined by many factors: market structure, internal cartel organization, external macro-economic conditions, industry-specific factors, and antitrust law environment. The model fitted to a sample of 59 cartels explains a high percentage of variance in cartel duration (Table 6). This study concludes that variables pertaining to anti-trust law enforcement are important to include in any study of modern-era cartel duration analysis. The internal cartel organization characteristics play a significant role in determining cartel duration and remain a crucial area of consideration in future analyses. The importance of these findings is self-evident in the direct, transparent, and realistic ability to translate internal cartel organization characteristics into effective anti-trust policy measures. The more ambiguous external economic indicators and trends do not lend themselves to regulatory attention.

Several policy recommendations stem from these new research findings. Antitrust agency screening guidelines for targeting cartels to be prosecuted need to be more comprehensive in their assessments. For instance, cartels in highly concentrated sellers markets with large numbers of buyers will tend to be longer-lived. Industries possessing high barriers to entry through high sunk costs and advanced technologies will also tend to be longer-lived. Strict policy attention should exist towards governance of entities that could serve as a cover and offer third-party support, especially where a large number of potential conspirators are concerned. Increased collaboration between national anti-trust authorities would appear to be an important catalyst to uncover geographically dispersed and culturally diverse cartels. In addition, technical assistance

between antitrust agencies, with Canada in particular, should be increased to decrease timeframes of prosecution and ultimately detection. The results also suggest recommend increased targeting of non-classical bid-rigging cartels. In cases where a government is the sole buyer consumer welfare losses are large and widespread through tax revenue losses.

The temporal analysis findings provide support for policy adjustments that increase incentives for the utilization of corporate leniency programs to assist in shortening cartel duration and with the hope of decreasing consumer welfare losses. For example, bounties could be paid to individual whistle-blowers.

In sum, although anti-cartel law enforcement increased after 1990, total global monetary sanctions on these cartels were less than \$11 billion. Because *ex post* penalties are so much lower than the illegal profits and because of numerous examples of recidivism, it is highly likely that current monetary sanctions are under-detering modern international cartels (Connor 2004). This research reiterates that current anti-trust policy measures continue to be ineffective in deterring collusive behavior. It recommends continued antitrust policy progressivism through increased sanctions and fines coupled with improved implementation of current policy programs.

Table 1. Summary of Independent Variables Explaining Cartel Duration (Model 1)

Variable	Description (Source)	Predicted Effect on Cartel's Hazard Rate	Number of Obs. <sup>a</sup>	Mean (Med.)	Std. Dev.
T	Duration- Months- all non-censored (longest reported span)		59	76.25 (52)	145.6
<b><u>Market Structure Characteristics</u></b>					
AVESHRCR	Index largest firms' ave. CR share	-	32 <sup>b</sup>	0.25	0.17
MRKTSHRPCT	Cartel market share (actual %)	-	33 <sup>c</sup>	0.85 <sup>(+)</sup>	0.20
MRKTSHR	Cartel market share <sup>†</sup> ; 1 if $\geq 50\%$	-	59	0.51 <sup>(+)</sup>	0.50
AFFSALES	Affected sales in millions of dollars	+	59	4268	6611
NUMBUYERSL	Large # of buyers <sup>†</sup> ; 1 if $\geq 100$	-	59	0.78	0.42
NUMBUYERSM	Medium # of buyers <sup>†</sup> ; $30 < 1 < 100$	-	59	0.07 <sup>(-)</sup>	0.25
NUMBUYERSS	Small # of buyers <sup>†</sup> ; 1 if $< 30$	+	59	0.15	0.36
<b><u>Internal Cartel Organization Characteristics</u></b>					
FIRMS	Number of participating firms	+	59	11.2 (5)	33.7
OVERCHARGE	Overcharge; % of affected sales	+	59	0.91 (0.25)	3.44
DOMFIRM40	Dominant firm <sup>†</sup> ; $1 \geq 40\%$ mrktshr	-	59	0.25 <sup>(+)</sup>	0.44
DOMFIRM	Dominant firm <sup>†</sup> ; 1 if known to exist	-	59	0.37 <sup>(+)</sup>	0.49
CULTURDV	Cultural Diversity Index; # countries/# firms	+	59	0.68 <sup>(+)</sup>	0.29
FIRMSCULTDV	Interactive term; firms*culturdv	+	59	3.34	1.56
BIDRIGGING	Bid-rigging cartel <sup>†</sup> ; 1 if Yes	-	59	0.12	0.33
FIRMSBIDRIG	Interactive term; firms*bidrigging	-	59	0.66	2.29
THIRDPARTY	Thirdparty support <sup>†</sup> ; i.e., trade association	-	59	0.12	0.33
FIRMSTHPRTY	Interactive term; firms*thirdparty	+	59	5.61	33.4
<b><u>External Macro-economic Conditions</u></b>					
BUSICYCLE	Business cycle (1,2)	+	59	0.17 <sup>(-)</sup>	0.18
GRTHRATECYL	Growth rate cycle index (1,2)	+	59	0.55	0.26
<b><u>Industry-Specific Conditions</u></b>					
<i>Dummy = 1 if cartel in sector</i>					
FOODFEEDTOB	Food, feed, tobacco products <sup>†</sup>	?	59	0.05 <sup>(-)</sup>	0.22
TEXTILE	Textile and clothing <sup>†</sup>	?	--	--	--
ORGCHEMAG	Organic chemicals, food & Ag. <sup>†</sup>	-	59	0.32 <sup>(+)</sup>	0.42
ORGCHEM	Organic chemicals, other <sup>†</sup>	-	59	0.08	0.28
OTHERCHEM	Other chemicals <sup>†</sup>	-	59	0.08 <sup>(-)</sup>	0.28
PAPERPRODS	Paper and printing <sup>†</sup>	?	59	0.05	0.22

Table 1 cont'd

Variable	Description (Source)	Predicted Effect on Cartel's Hazard Rate	Number of Obs. <sup>a</sup>	Mean (Med.)	Std. Dev.
<b><i>Industry-Specific Conditions, cont'd</i></b>					
WOODPRODS	Lumber and furniture <sup>†</sup>	?	--	--	--
PETROCOAL	Petroleum and coal <sup>†</sup>	?	59	0.02	0.13
RUBPLASTIC	Rubber and plastic products <sup>†</sup>	?	--	--	--
GLASSGRAPH	Stone, clay, glass, graphite <sup>†</sup>	?	59	0.07	0.25
METALS	Primary metals <sup>†</sup>	+	--	--	--
METALPRODS	Metal Products <sup>†</sup>	?	59	0.08 <sup>(+)</sup>	0.28
MACHEQUIP	Machinery and equipment <sup>†</sup>	?	59	0.03	0.18
ELECPRODS	Electronic products <sup>†</sup>	?	59	0.03 <sup>(+)</sup>	0.18
CONSTRUCT	Construction <sup>†</sup>	?	59	0.03 <sup>(-)</sup>	0.18
TRANSPORT	Transportation <sup>†</sup>	?	59	0.03 <sup>(-)</sup>	0.18
COMMUNIC	Communications <sup>†</sup>	?	59	0.02	0.13
WRTRADE	Wholesale-retail trade <sup>†</sup>	?	59	0.07	0.25
FINANCEINS	Finance and insurance <sup>†</sup>	?	59	0.03 <sup>(+)</sup>	0.18
OTHERSERV	Other services <sup>†</sup>	?	--	--	--
<b><u>Antitrust Law Environment</u></b>					
SANCT	Sanctions received to date (mil. \$) <i>Dummy = 1 if cartel unveiled by:</i>	+	59	194.9	274.6
DISCOVERYUSA	Discovery- U.S. authorities <sup>†</sup>	+	59	0.51 <sup>(+)</sup>	0.50
DISCOVERYCA	Discovery- Canada <sup>†</sup>	+	59	0.03 <sup>(-)</sup>	0.18
DISCOVERYEU	Discovery- EU <sup>†</sup>	+	59	0.27	0.45
DISCOVERYOTH	Discovery- Other national anti-trust authorities <sup>†</sup>	+	59	0.19 <sup>(-)</sup>	0.39
DISCOVERYJNT	Discovered jointly by national authorities <sup>†</sup>	+	59	0	0
AMNESTY	Amnesty program awareness index; Mean # of monthly 'hits' over span of cartel on Lexus-Nexus Academic	+	59	7.59 <sup>(-)</sup>	2.04

Data Sources. – (1) The World Bank Group, World Development Indicators (WDI) database GNI in current US dollars (1982-2003) [www.worldbank.org/data/dataquery.html](http://www.worldbank.org/data/dataquery.html). (2) Economic Cycle Research Institute (ECRI) (Oct. 2004) [www.businesscycle.com](http://www.businesscycle.com).

-- No observations included in data set for Model 1, N=59.

a – Maximum number of observations for complete data set used in model 1, N=59.

b – Variable indexed and denotes largest firms' average share of concentration ratio; if CR4=80% then index value = 0.20. Coefficient estimate taken from Model 4 (N=32) that included known cartel CR share percentages, a data subset of Model 2. Refer to Appendix A for more detailed model information.

c – Maximum number of observations containing MRKTSHRPCT in complete data subset used in model 3, N=33. Refer to Appendix A for more detailed model information.

Note: Superscripts (-)/(+) both indicate statistically significant difference ( $-1.96 < t_{cr} < 1.96$ ) in mean between independent variables of the large sample (Table 2) and reduced subsample (Table 3).

Table 2. Proportional Hazards Model Explaining Cartel Duration

<i>Variable</i>	Model 1	Model 2	Model 3	Model 4
<b>Market Structure</b>	$\beta$ (Std. Error)	$\beta$ (Std. Error)	B (Std. Error)	$\beta$ (Std. Error)
AVESHRCR	--	--	--	-16.02*** (5.92)
MRKTSHRPCT	--	--	-3.47 (3.56)	--
MRKTSHR	1.16 (1.15)	0.54 (0.97)	--	-2.83 (3.34)
AFFSALES	-107.29* (56.60)	-101.84 (74.22)	-376.52* (207.47)	-230.23*** (81.03)
NUMBUYERSL	-6.95*** (2.08)	-3.65*** (1.21)	-14.30*** (5.15)	5.45** (2.15)
NUMBUYERSM	-3.92 (2.43)	--	--	--
NUMBUYERSS	0	--	--	--
<b>Internal Cartel Organization</b>				
FIRMS	0.09** (0.04)	0.05 (0.03)	1.41** (0.60)	-0.05 (0.45)
OVERCHARGE	0.25*** (0.09)	0.25*** (0.08)	0.40*** (0.13)	0.82*** (0.25)
DOMFIRM40	1.23 (1.41)	0.39 (0.64)	1.00 (1.04)	0.20 (0.79)
DOMFIRM	-0.21 (1.38)	--	--	--
CULTURDV	4.77*** (1.73)	1.88 (1.67)	2.39 (4.11)	3.22 (3.71)
FIRMSCULTDV	-0.66** (0.27)	-0.59** (0.24)	-2.37*** (0.65)	-1.76*** (0.52)
BIDRIGGING	-5.55** (2.38)	-4.00** (1.86)	-20.54*** (7.32)	--
FIRMSBIDRIG	-0.54* (0.30)	-0.22 (0.30)	--	--
THIRDPARTY	0.89 (1.22)	-0.18 (1.10)	9.88 (7.97)	-12.03*** (4.11)
FIRMSTHPRTY	-0.10*** (0.04)	-0.07** (0.03)	-0.80 (0.67)	1.10** (0.46)

Table 2 cont'd

<i>Variable</i>	Model 1	Model 2	Model 3	Model 4
<b>External Macro-Economic Cond.</b>				
BUSICYCLE	-5.96*** (1.52)	--	--	--
GRTHRATECYL	-4.45*** (1.55)	-3.81** (1.59)	-3.62 (2.25)	-6.29*** (2.04)
<b>Industry-Specific Conditions</b>				
FOODFEEDTOB	1.41 (1.94)	0.63 (1.31)	-5.35* (2.85)	--
TEXTILE	--	--	--	--
ORGCHEMAG	-6.65*** (1.60)	-2.48* (1.42)	-2.91 <sup>b</sup> (2.18)	-- <sup>d</sup>
ORGCHEM	-5.21*** (1.63)	-3.89** (1.67)	-- <sup>b</sup>	-4.91** <sup>d</sup> (1.97)
OTHERCHEM	-1.00 (0.93)	-0.15 (0.96)	0.15 (1.37)	-- <sup>d</sup>
PAPERPRODS	1.64 (1.68)	2.40 (1.55)	-3.84 (2.80)	--
WOODPRODS	--	--	--	--
PETROCOAL	4.99* (2.72)	3.96 (2.42)	--	--
RUBPLASTIC	--	--	--	--
GLASSGRAPH	-2.80 (1.70)	-1.84 (2.01)	6.81 (5.80)	--
METALS	--	--	--	--
METALPRODS	-1.62 (1.54)	-0.57 (1.65)	-9.70*** (3.77)	--
MACHEQUIP	0.83 (3.29)	-1.28 (2.25)	--	--
ELECPRODS	-6.04*** (2.25)	-3.94* (2.11)	--	--
CONSTRUCT	-6.85*** (2.38)	-2.55 (2.19)	--	--
TRANSPORT	-2.75 (2.05)	-1.64 (2.00)	--	--
COMMUNIC	-1.94 (2.21)	-0.53 (2.36)	--	--
WRTRADE	-0.85 (2.02)	0.78 (2.10)	--	--

Table 2 cont'd

<i>Variable</i>	Model 1	Model 2	Model 3	Model 4
<b><i>Industry-Specific Conditions cont'd</i></b>				
FINANCEINS	1.00 (1.80)	1.15 (1.89)	--	--
OTHERSERV	--	--	--	--
<b><i>Antitrust Law Environment</i></b>				
SANCT	-4674*** (1698)	-2693** (1175)	-1551 (1575)	-1626 (1465)
DISCOVERYUSA	2.43 (1.83)	-0.10 (1.01)	-18.26*** <sup>c</sup> (5.19)	-1.49 <sup>c</sup> (2.66)
DISCOVERYCA	8.22*** (2.46)	3.56** (1.68)	-- <sup>c</sup>	-- <sup>c</sup>
DISCOVERYEU	1.32 (1.82)	0.14 (1.20)	-16.57*** (5.23)	-2.83 (3.34)
DISCOVERYOTH	0	--	--	--
DISCOVERYJNT	0	--	--	--
AMNESTY	0.03 (0.63)	-0.19 (0.66)	-5.16** (2.08)	2.28** (1.03)
Number of Obs.	59	59	33	32
R-squared <sup>a</sup>	0.880	0.797	0.961	0.946
-Log likelihood	136.70	146.02	44.64	46.01

-- The model omits this variable on at least one of the following four accounts: 1) no observations in the data set, 2) zero coefficient parameter estimate 3) correlation matrix statistical significance > 1% 4) models 3 and 4 omission required for adequate number of net degrees of freedom.

\* Statistically significant at the 10 percent level (Chi-squared distribution).

\*\* Statistically significant at the 5 percent level (Chi-squared distribution).

\*\*\* Statistically significant at the 1 percent level (Chi-squared distribution).

a – Measure of dependence of Kent and O'Quigley (1988)(computation based on Newton-Raphson method) rho-squared W.

b – Model 3 reduction combined observations for ORGCHEMAG and ORGCHEM (Appendix A).

c – Model 3 &4 reduction combined discovery in the US and Canada into one North American variable placed in DISCOVERYUSA (Appendix A).

d – Model 4 reduction combined all chemical sector observations, placed in ORGCHEM.

Table 3. Significance of Categorical Areas Explaining Cartel Duration (Model 1)

	Model 5	Model 6	Model 7	Model 8	Model 9
Category Omitted from Regression	Market Structure	Internal Cartel Organization	Industry-Specific Conditions	Macro-Economic Conditions	Antitrust Law Environment
-2 Log L of Model (column)	293.290	313.809	317.802	293.899	300.046
-2 Log L of Model 1	273.405	273.405	273.405	273.405	273.405
Difference of -2 Log L	19.885 <sup>4</sup>	40.404 <sup>10</sup>	44.397 <sup>15</sup>	20.494 <sup>2</sup>	26.641 <sup>5</sup>
Significance - $\chi^2$ Distribution	<b>&gt;.995</b>	<b>&gt;.995</b>	<b>&gt;.995</b>	<b>&gt;.995</b>	<b>&gt;.995</b>
R-squared of Model (column)	0.811	0.673	0.669	0.804	0.793
R-squared of Model 1	0.880	0.880	0.880	0.880	0.880
Difference of R-Squared	<b>-0.069</b>	<b>-0.207</b>	<b>-0.211</b>	<b>-0.076</b>	<b>-0.087</b>
Number of Obs.	59	59	59	59	59

a – Measure of dependence of Kent and O'Quigley (1988)(computation based on Newton-Raphson method) rho-squared W.

Note: superscript equal to change in degrees of freedom from base Model 1.

Table 4. Descriptive Statistics - Temporal Period Analysis

Time Period	1990-1995	1996-1999	2000-2004
<i>Select Variables</i>		<i>Median</i>	
		<i>Mean</i>	
		<i>Std. Dev.</i>	
T – Duration ( <i>years</i> )	4 <sup>49</sup> 4.91 4.15	5.21 <sup>64</sup> 8.05 12.84	4.17 <sup>53</sup> 5.55 4.95
FIRMS	5 <sup>49</sup> 6.61 5.09	4 <sup>64</sup> 9.89 32.43	5 <sup>55</sup> 7.16 5.56
AFFSALES ( <i>million \$ per year</i> )	124.29 <sup>38</sup> 679.71 1196.32	159.18 <sup>49</sup> 515.40 1103.17	836.00 <sup>30</sup> 1593.58 3246.77
SANCT ( <i>million \$ per year</i> )	5.88 <sup>46</sup> 17.40 30.97	5.61 <sup>59</sup> 24.58 42.53	16.62 <sup>37</sup> 63.49 203.43
OVERCHARGE ( <i>percent per year</i> )	0.08 <sup>23</sup> 0.54 1.99	0.04 <sup>27</sup> 0.98 4.80	0.07 <sup>18</sup> 0.20 0.34
AMNESTY ( <i># of 'hits' per year</i> )	7.2 <sup>49</sup> 7.12 4.67	14.85 <sup>64</sup> 15.12 2.83	24.33 <sup>53</sup> 26.01 8.95
DISCOVERYUSA ( <i>per yr</i> )	4	7.75	4
DISCOVERYCA ( <i>per yr</i> )	0.83	0	0.22
DISCOVERYEU ( <i>per yr</i> )	2.33	3.75	2.44
DISCOVERYOTH ( <i>per yr</i> )	1	4.5	5.55
DISCOVERYJNT ( <i>per yr</i> )	0	0	0
Number of Obs. for countries of discovery	49	64	55

Note: Superscript indicates cell sample size.

a– Period through July 2004 or 4.5 years.

Table 5. Proportional Hazard Model Results - Temporal Period Analysis

Time Period	Model 15 1990-1995	Model 16 1996-1999	Model 17 2000-2004
<i>Select Variables</i>	B (Standard Error)	$\beta$ (Standard Error)	$\beta$ (Standard Error)
FIRMS	-0.05 (0.31)	0.0003 (0.004)	-0.03 (0.04)
SANCT ( <i>mil. \$</i> )	-525.71 (1135)	-607.49 (640.77)	-547.93 (914.55)
AMNESTY ( <i># of hits</i> )	0.99 (0.61)	3.36*** (0.94)	1.47*** (0.001)
DISCOVERYUSA (#)	-2.32*** (0.62)	0.04 (0.33)	-0.31 (0.48)
DISCOVERYCA (#)	-1.13 (0.74)	--	--
DISCOVERYEU (#)	-2.54*** (0.63)	-0.16 (0.38)	-0.87 (0.63)
DISCOVERYOTH (#)	--	--	--
DISCOVERYJNT (#)	--	--	--
R-squared <sup>a</sup>	0.443	0.439	0.524
-Log likelihood	122.52	175.8	82.25
Number of Observations	46	59	35

-- Insufficient number of observations for regression result.

a – Measure of dependence of Kent and O'Quigley (1988)(computation based on Newton-Raphson method) rho-squared W.

\* Statistically significant at the 10 percent level (Chi-squared distribution).

\*\* Statistically significant at the 5 percent level (Chi-squared distribution).

\*\*\* Statistically significant at the 1 percent level (Chi-squared distribution).

Table 6. Determinants of Duration: Results of International Cartel Studies

<b>Author</b>	<b>Marquez(1992)<sup>1</sup></b> N=52 1888-1982	<b>Dick (1996)<sup>2</sup></b> N=111 <sup>c</sup> 1918-1965	<b>Suslow (2001)<sup>3</sup></b> N= 71 1920-1939	<b>Zimmerman<sup>4</sup></b> N= 59 1990-2004	
<i>Dependent Variable</i>	Proportional Hazard Rate <sup>5</sup> –Dick, Suslow, Zimmerman Duration – Marquez				
<i>Independent Variables</i>					
<b><u>Market Structure Characteristics</u></b>		<b><u>Marquez</u></b>	<b><u>Dick</u></b>	<b><u>Suslow</u></b>	<b><u>Zimmerman</u></b>
Concentration		(+) <sup>***</sup>			(+) <sup>***g</sup>
Market share		(+) <sup>***</sup>	(+) <sup>d</sup>	(+)	(+) <sup>h</sup>
Affected sales					(+) <sup>*</sup>
Large number of buyers <sup>†</sup> ; Dummy =1 if > 100					(+) <sup>***</sup>
Medium number of buyers <sup>†</sup> ; 30 < Dummy =1 < 100					(+)
Small number of buyers <sup>†</sup> ; Dummy =1 if <30					-- <sup>i</sup>
<b><u>Internal Cartel Organization Characteristics</u></b>					
Number of participating firms			(+)	(-)	(-) <sup>**</sup>
Number of countries				(-) <sup>*</sup>	
Repeat episodes/ Experience <sup>†</sup>		(+)	(-) <sup>**, e</sup>	(+)	
Side-agreement <sup>†</sup>			(+) <sup>**</sup>		
Market allocation				(-) <sup>**, f</sup>	
Sales agency <sup>†</sup>			(+)	(-)	
Government involved <sup>†</sup>				(-)	
Patent involved				(+) <sup>***</sup>	
Penalties – Internally imposed between members				(+) <sup>***</sup>	
Dominant firm has 40 pct or more of market share <sup>†</sup>					(-)
Bid-rigging cartel <sup>†</sup>					(+) <sup>**</sup>
Thirdparty support <sup>†</sup> ; i.e., trade association					(-)
Cultural diversity index					(-) <sup>***</sup>
Overcharge; percentage of affected sales					(-) <sup>***</sup>
<b><u>External Macro-economic Conditions</u></b>					
Ended in WWII <sup>†</sup>		(-)	(+) <sup>**, b</sup>		
Post- WWII Developments <sup>†</sup>		(-) <sup>*, a</sup>			
Interest Rate		(-) <sup>*</sup>			
Demand instability; variation in US industrial output				(-) <sup>***</sup>	
Rate of demand growth				(-) <sup>***</sup>	
Business cycle			(-) <sup>†</sup>	(-) <sup>**</sup>	(+) <sup>***</sup>
Growth rate cycle index					(+) <sup>***</sup>
Unanticipated cycle			(-)	(-) <sup>***</sup>	
Anticipated cycle			(-) <sup>***</sup>		

Table 6 cont'd

<b>Author</b>	<b><u>Marquez</u></b>	<b><u>Dick</u></b>	<b><u>Suslow</u></b>	<b><u>Zimmerman</u></b>
<b><u>Industry-specific Conditions</u></b>				
Food, feed, tobacco products <sup>†</sup>				(-)
Textile and clothing <sup>†</sup>				(-) <sup>j</sup>
Organic chemicals, food & Ag. <sup>†</sup>				(+) <sup>***</sup>
Organic chemicals, other <sup>†</sup>			(+)	(+) <sup>***</sup>
Other chemicals <sup>†</sup>				(+)
Paper and printing <sup>†</sup>				(-)
Lumber and furniture <sup>†</sup>				(-) <sup>j</sup>
Petroleum and coal <sup>†</sup>				(-) <sup>*</sup>
Rubber and plastic products <sup>†</sup>				(-) <sup>j</sup>
Stone, clay, glass, graphite <sup>†</sup>			(+)	(+) <sup>*</sup>
Primary metals <sup>†</sup>			(-)	(-) <sup>*,j</sup>
Metal Products <sup>†</sup>				(+)
Machinery and equipment <sup>†</sup>				(-)
Electronic products <sup>†</sup>				(+) <sup>***</sup>
Construction <sup>†</sup>				(+) <sup>***</sup>
Transportation <sup>†</sup>				(+)
Communications <sup>†</sup>				(+)
Wholesale-retail trade <sup>†</sup>				(+)
Finance and insurance <sup>†</sup>				(-)
Other services <sup>†</sup>				(+) <sup>j</sup>
Raw Materials <sup>†</sup>			(-)	
Renewable products <sup>†</sup>	(-) <sup>*</sup>			
<b><u>Antitrust Law Environment</u></b>				
Sanctions received to date by defendants				(+) <sup>***</sup>
Discovery U.S., unveiled by U.S. authorities <sup>†</sup>				(-)
Discovery Canada <sup>†</sup>				(-) <sup>***</sup>
Discovery EU <sup>†</sup>				(-)
Discovery by other national anti-trust authorities <sup>†</sup>				
Discovered jointly by national authorities <sup>†</sup>				
Amnesty program awareness index				(-)
Duration in years (median)	5.2	5.3	3.7	4.3
R-squared value (primary model)	0.273	N/A	N/A	0.880 <sup>1</sup>
-Log-likelihood (primary model)	53.036	320.67	68.9	136.70

Source: Adapted from How Cartels Endure and How They Fail (Grossman 2004); Table 1.6 Determinants of Cartel Duration: U.S. and International Cartel Studies, Chapter 1 pg. 24-25 (Levenstein and Suslow).

<sup>†</sup> Dummy variable

\* Statistically significant at the 10 percent level.

\*\* Statistically significant at the 5 percent level.

\*\*\* Statistically significant at the 1 percent level.

*Table 6 cont'd*

- 1 – Coefficient estimates taken from Model 1, Table 3 Log-Normal Formulation (Marquez 1992) unless otherwise noted.
- 2 – Coefficient estimates taken from Models 5 & 6, Table 4 Semiparametric Proportional Hazard (Dick 1996).
- 3 – Coefficient estimates taken from Models 1,2 & 3, Table 5 Proportional Hazards Model (Suslow 2001).  
Significance levels based on Chi-squared distribution.
- 4 – Coefficient estimates taken from Model 1, Table 4 Proportional Hazards Model unless otherwise noted.
- 5 – Hazard rate coefficients interpreted as the hypothesized effect on the duration; (+) increased duration, (-) decreased duration.
- a – This variable showed significance at the 5 percent level under the OLS log-linear formulation (Model 1).
- b – Not discussed by author.
- c – Cartel episodes – uninterrupted cartel activity.
- d – Dummy equals one for cartels covering  $\geq 50\%$  of industry exports (Dick 1996).
- e – Length of prior cartel episode(s) discounted 20% annually during interim period (Dick 1996).
  - f – “Negative correlation exhibited in production quotas. Other market allocation measures (exclusive territories, export quotas) were positive but insignificant (Suslow 2001).”
  - g – Variable indexed and denotes largest firms’ average share of concentration ratio; if CR4=80% then index value = 0.20. Coefficient estimate taken from Model 4 (N=32) that included known cartel CR share percentages, a data subset of Model 2.
- h – Coefficient estimate taken from Model 3 (N=33) that included known cartel market share percentages, a data subset of Model 2.
- i – Not significantly different from Bid-rigging independent variable to be considered in model iterations.
- j – Coefficient estimates not calculable from Model 1 data set; as such, taken from Model 12 (N=164) a biased data set including only industry-specific condition variables as outlined above.
- k – Coefficient estimates not calculable from Model 1 data set; as such, taken from Model 14 (N=141) a biased data set including only the antitrust law environment variables as outlined above.
- l – Measure of dependence of Kent and O’Quigley (1988)(computation based on Newton-Raphson method) rho-squared W: 0.8812. SAS macro ‘KENTOQNR’ was utilized to calculate the Rho-squared value (Harald Heinzl 2000). SAS Macro retrieved at ‘<http://www.akh-wien.ac.at/Harald.Heinzl/sasmacro/kentoq.zip>’.

## References:

- Alexander, Barbara. "The Impact of the National Industrial Recovery Act on Cartel Formation and Maintenance Costs." Review of Economics and Statistics, 76(2), (1994): 245-254.
- Alexander, Barbara. "The Impact of Exchange Rate Levels and Changes on International Cartels: Implications for Liability and Overcharges." Antitrust Law Journal, 70(3), (2003).
- Clarke, Julian L. and Simon J. Evenett. *The Deterrent Effects of National Anti-Cartel laws: Evidence from the International Vitamins Cartel: Working Paper 02-13*. Washington, DC: AEI-Brookings Joint Center for Regulatory Studies (December, 2002).
- Clarke, Julian L. and Simon J. Evenett. "The Deterrent Effects of National Anticartel Laws: Evidence from the International Vitamins Cartel." Antitrust Bulletin 48 (2003): 289-726.
- Connor, John M. Global Price Fixing: Our Customers Are the Enemy. Boston: Kluwer Academic Publishers (2001).
- Connor, John M. *Private International Cartels: Effectiveness, Welfare, and Anticartel Enforcement, Staff Paper 03-12*. W. Lafayette, IN: Purdue University (November, 2003): 145 pp. [<http://agecon.lib.umn.edu/cgi-bin/view.pl>]
- Connor, John M. "Global Antitrust Prosecutions of Modern International Cartels" The Journal of Industry, Competition, and Trade 4 (September 2004): 239-267.
- Connor, John M. *Price-Fixing Overcharges: Legal and Economic Evidence AAI WORKING PAPER #04-05*, November 2004 [<http://www.antitrustinstitute.org>].
- Cox, D.R. "Regression Models and Lifetables." Journal of the Royal Statistical Society B 34, (1972):187-220.
- Dick, Andrew R. "When Are Cartels Stable Contracts?" Journal of Law and Economics, Vol. 39, No. 1 (Apr., 1996): 241-283.
- Eckbo, Paul L. The Future of World Oil. Cambridge, Ballinger Publishing, 1976.
- Escrhuella-Villar, Marc. "Cartel Sustainability and Cartel Stability." The Fondazione Eni Enrico Mattei Note di Lavoro Series 44 (2004). [<http://www.feem.it/Feem/Pub/Publications/Wpapers/default.htm>]

- Green, Edward J. "Non-cooperative Price Taking in Large Dynamic Markets." Journal of Economic Theory 22 (1980): 155-82.
- Green, Edward J., and Porter, Robert H. "Non-cooperative Collusion under Imperfect Price Information." Econometrica 52 (1984): 87-100.
- Griffin, James M. "Previous Cartel Experience: Any Lesson for OPEC?" in Lawrence R. Klein and Jamie Marquez, eds., Economics in Theory and Practice: An Eclectic Approach. Dordrecht: Kluwer Academic Publishers, 1989, pp. 179-206.
- Grossman, Peter Z. How Cartels Endure and How They Fail, Edward Elgar Publishers (2004): 1-50.
- Hay, George A. and Daniel Kelley. "An Empirical Survey of Price Fixing Conspiracies," Journal of Law and Economics 17 (1974):13-38.
- Heinzl, Harald. "Using SAS to calculate the Kent and O'Quigley measure of dependence for Cox proportional hazards regression model." Computer Methods and Programs in Biomedicine 63 (2000): 71-76.
- Kent, John T and John O'Quigley. "Measures of dependence for censored survival data." Biometrika, 75(3) (1988):525-534.
- Kudo, Akira and Terushi Hara. International cartels in business history : proceedings of the Fuji Conference / International Conference on Business History 18, University of Tokyo Press (1992).
- Levenstein, M., Suslow, V., and Oswald, L. *International price-fixing and developing countries: a discussion of effects and policy remedies*, Working paper 9511. National Bureau of Economic Research: Cambridge, MA, February 2003.
- Levenstein, M., Suslow, V. *What Determines Cartel Success?* Working Paper January (2002): 53 pp.
- Levin, Sharon G., et al. "A Dynamic Analysis of the Adoption of a New Technology: The Case of Optical Scanners." Review of Economics and Statistics 69 (1987): 12-17.
- Marquez, Jaime. "Life Expectancy of International Cartels: An Empirical Analysis," Review of Industrial Organization, 9 (1992): 331-341.
- Posner, Richard A. Antitrust Law, 2<sup>nd</sup> edition, University of Chicago Press (2001).
- Neter, John; Micheal H. Kutner; Christopher J. Nachtsheim; William Wasserman. Applied Linear Statistical Models, 4<sup>th</sup> Edition (1996): 1333-1364.

Scherer, F.M and David Ross. Industrial Market Structure and Economic Performance, 3<sup>rd</sup> edition (1990): 411-448.

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

Suslow, Valerie Y. *Cartel Contract Duration: Empirical Evidence from International Cartels*, University of Michigan (October 2001): 58 pp.

## APPENDIX A

### Description of Regression Models

Model 1 – Maximum number of observations and variables possible when omitting MRKTSHRPCT, TEXTILE, WOODPRODS, RUBPLASTIC, METALS, and OTHERSERV. The variables AFFSALES and SANCT, expressed in millions of dollars, have been standardized by dividing values by 1,000,000.

Model 2 – Data subset of Model 1, retains one variable and omits paired dummy variables whose correlation is significant at the 1 percent level or greater. Also removes variables whose coefficient is equal to zero in Model 1. Variables omitted include: DISCOVERYOTH, DISCOVERYJNT, DOMFIRM, NUMBUYERSM, NUMBUYERS, and BUSICYCLE.

Model 3 – Data subset of Model 2, restricts data set to observations of known market share percentage, MRKTSHRPCT. In addition to omissions in Model 1 and 2, Model 3 omits variables whose coefficient was equal to zero after first regression test due to inadequate observations, which include: FIRMSBIDRIG, ELECPRODS, FINANCEINS, and WRTRADE. The variables ORGCHEMAG and ORGCHEM were consolidated as well as DISCOVERYUSA and DISCOVERYCA (North America). Model reductions were necessary for adequate net degrees of freedom given limited observations.

Model 4 – Data subset of Model 2, restricts data set to 32 observations of potential largest average firm concentration ratio, AVRSHRCR. In addition to omissions from Models 1, 2 and 3, Model 4 omits BIDRIGGING, FOODFEEDTOB, PAPERPRODS, PETROCOAL, GLASSGRAPH, METALPRODS, MACHEQUIP, CONSTRUCT, TRANSPORT, and COMMUNIC. All chemical sector variables – ORGCHEMAG,

ORGCHEM, OTHERCHEM – are consolidated into one, ORGCHEM.

DISCOVERYUSA and DISCOVERYCA (North America) are consolidated as well. Model reductions were necessary for adequate net degrees of freedom given limited observations.

Model 5 – Omits market structure characteristic variables from Model 1 data set to determine significance of such variables.

Model 6 – Omits internal cartel organization variables from Model 1 data set to determine significance of such variables.

Model 7 – Omits external industry-specific variables from Model 1 data set to determine significance of such variables.

Model 8 – Omits macro-economic variables from Model 1 data set to determine significance of such variables.

Model 9 – Omits antitrust law variables from Model 1 data set to determine significance of such variables.

Model 10 – Data set containing cartel observations whose end date falls between 1990 and 1995. Duration regressed against only antitrust law environment variables and FIRMS.

Model 11 – Data set containing observations whose end date falls between 1996 and 1999. Duration regressed against only antitrust law environment variables and FIRMS.

Model 12 – Data set containing observations whose end date falls between 2000- July 2004. Duration regressed against only antitrust law environment variables and FIRMS.

APPENDIX B

List of Sampled Cartels

Obs.	Cartel	Span	Duration	Firms
1	Adhesive label stock*	?-2003		3
2	AIIC translators' assn.	1956-1996	480	2
3	Airlines, Latvia	08/98-10/99	14	2
4	Aluminum phosphide	1/90-11/90	11	4
5	Anti-anxiety drugs	1/98-12/98	12	4
6	Asphalt paving, Finland	1995-2002	216	6
7	Asphalt, Sweden*	1993-2001	108	11
8	Auditing services, IT	1991-1998	96	6
9	Auto refinishes*	1/93-5/01	101	5
10	Ball bearings, France, int'l	1993-1997	60	6
11	Beef, France	10/01-12/02	15	6
12	Beer, Belgium, HORECA	1/93-1/98	61	2
13	Beer, Belgium, Pvt. Label	10/97-7/98	10	4
14	Beer, France*	3/21/96-	1	2
15	Beer, Italy *	?	?	?
16	Beer, Korea	?	?	3
17	Beer, Luxemburg HORECA	1985-1999	180	4
18	Beer, Netherlands *	?	?	?
19	Beer, Portugal *	?	?	2
20	Beta carotene	9/92-12/98	76	2
21	Bicycles, NL	1998-2003	72	5
22	Biotin (vitamin H)	1/91-4/94	40	6
23	Bitumen*	?	?	9
24	Bridge, California	12/94-08/96	21	2
25	Bridges, cable-stayed, US	09/96-12/97	15	2
26	British sugar, UK	6/86-7/90	50	4
27	Bromines	07/95-4/98	34	2
28	Cable, High voltage DE	1902-4/97	1144	13
29	Calcium carbide*	?	?	2
30	Canthaxanthin	5/93-12/98	68	2
31	Carbon black*	12/99-?	?	6
32	Carbon cathode block	6/95-12/97	31	5
33	Carbon electrical products	1/90-5/00	125	4
34	Carbon fiber*	93-5/02	113	8
35	Carbonless paper, EU	1/92-9/95	45	11
36	Carotenoids	3/93-12/98	70	2
37	Cartonboard	1/86-12/91	72	19
38	Cement I, DE	1993-2003	132	19
39	Cement II, Germany	7/03-03/04	10	11
40	Cement, EU	1/83-4/89	76	22
41	Cement, Hungary	?-2001	?	2
42	Cement, IT*	1999-2002	60	10

43	Cement, Quebec City, CA	?	?	4
44	Cigarettes, IT	6/93-3/01	95	2
45	Citric acid	3/91-5/95	51	5
46	Coffee CZ	6/94-7/94	2	2
47	Coffee Hungary	6/94-10/94	4	5
48	Compressed gas, Canada	6/89-5/90	12	5
49	Compressed gas, NL	89-91	36	8
50	Compressors, Australia	12/93-3/98	52	2
51	Concrete engineering, NL	?	?	?
52	Concrete reinforcing steel	1989-2000	144	8
53	Concrete, Lombardy, IT	1999-2002	48	10
54	Concrete, Ready-mix,	95-98	48	69
55	Concrete, special	12/00-1/02	14	2
56	Construction, marine, US	90-1/97	84	8
57	Construction, NL*	?-2002	?	30
58	Construction, NL, HSL &	?	?	?
59	Construction, NL, road	?	?	?
60	Construction, NOR*	94-00	84	4
61	Construction, sports tracks,	?-2000		5
62	Construction, USAID	5/88-9/96	101	5
63	Copper concentrates*	11/01-5/03	18	6
64	Copper tubes	05/88-03/01	155	8
65	Cosmetics	5/94-6/03	110	17
66	Creosote*	?	?	5
67	Danish air route	9/98-2/01	30	2
68	Diabetes testing devices,	?	?	5
69	Diamonds, dispatching Isreal	1997-1999	36	2
70	Diamonds, Industrial	1991-1992	24	2
71	Diesel fuel, Italy	May-98	1	19
72	Diesel fuel, Metro Transport	1/98-05/01	41	19
73	Distribution, elec. goods, FR	?	?	7
74	District heating pipe	12/1/1990-	64	10
75	DRAMs*	7/99-6/02	37	5
76	Drugs, OTC, commissions*	?	?	2
77	DVD Players, "3C" Patent	?	?	3
78	Electric wiring services, DE	1990-1998	108	256
79	Elevator repair services, Italy	?	?	15
80	EPDM synthetic rubber*	1/96-10/02	82	10
81	Euro zone banks	12/97-1/02	50	12
82	Explosives, commercial	85-12/93	108	7
83	Extruded graphite	2/93-12/96	47	2
84	Ferries, Adriatic	1987-7/94	91	7
85	Ferries, channel	11/1/1992-	3	5
86	Ferrosilicon	10/89-8/91	23	5
87	Film Printing Chemicals,	?	?	3
88	Fine art auctions	12/92-1/00	86	2
89	Flat glass, U.S.	8/91-12/95	53	5
90	Folic acid	1/91-6/94	42	4
91	Fuels, military, Japan	4/95-11/98	44	11

92	Fuels, military, Korea	98-00	36	5
93	Gases. Industrial	01/89-12/98	75	7
94	Gasoline, Chile*	79-03	300	4
95	Gasoline, Czech Republic	01/2001-	12	6
96	Gasoline, France	01/99-06/00	18	4
97	Gasoline, Italy	1994-1999	78	8
98	Gasoline, Netherlands	4/2000-	4	4
99	Gasoline, Spain	10/98-	27	3
100	Gasoline, Sweden	11/99-2/00	4	5
101	Generic drugs, UK*	1/96-4/00	52	6
102	Glass containers, Italy	93-96	48	4
103	Glass containers, US	1/70-12/82	156	10
104	Glyphosate insecticide*	03/88-03/03	180	4
105	Graphite electrodes	3/92-2/98	72	8
106	High Fructose Corn Syrup	1/89-6/95	78	5
107	Holographic printing, U.S.	97-99	36	2
108	Hydrogen peroxide*	04/03-	?	4
109	Infant formula (Episode I),	?-3/01	?	6
110	Inland chemical barges*	?	?	?
111	Insecticide, BT, Canada	10/91-10/92	13	2
112	Insecticides, synthetic,	1/82-12/88	84	2
113	Insurance brokers, US	?-10/04	?	40
114	Insurance, industrial, DE*	10/01-7/02	10	19
115	Insurance, Netherlands	1/03-6/03	6	4
116	Insurance, Non-life, IT	1/90-3/93	39	16
117	Iron oxide	1/84-12/92	108	2
118	Iron Pipe, CA	1/90-9/90	9	2
119	Isostatic graphite	3/93-2/98	60	8
120	Label stock plastic*	?	?	?
121	Lysine	9/95-8/99	36	5
122	Magnetic iron oxide	1/91-4/98	88	4
123	Maltol, synthetic	12/89-12/95	73	2
124	Matches, Italy	1994-2000	84	4
125	MCAA	1/84-8/99	188	5
126	Methionine	2/86-2/99	157	4
127	Methylglucamine	11/90-12/99	110	3
128	MMA* Methyl methacrylate	04/03-	?	3
129	Mobile phone fees, UK &	2000-	?	9
130	Mobile phones, Italy	1/98-10/99	22	2
131	Mobile phones, NL	7/01-12/02	18	5
132	Mobile phones, UK*	2000-	?	5
133	MSG, IMP, GMP:	1/90-11/99	119	8
134	Naphthalene*	?	?	5
135	Neoprene Rubber	1999-2003	48	8
136	Nitrile Rubber	01/02-08/02	8	4
137	Organic peroxides	01/71-01/99	348	5
138	Oxo-alcohols*	?	?	4
139	Paper, corrugated cardboard,	?-1991	?	4
140	Paper, Magazine	7/94-5/04	120	12

141	Paper, office, Canada	99-2002	40	4
142	Paper, release liner	?	?	2
143	Paper, thermal fax	2/90-3/92	26	10
144	Parcel tankers, chemical*	7/98-10/02	53	7
145	Pharmaceutical, Intravenous	1/96-7/98	31	2
146	Pharmaceuticals, cholesterol,	11/95-11/97	25	5
147	Pharmaceuticals, obesity, IT	?	?	2
148	Pharmaceuticals, respiratory,	12/91-12/92	25	2
149	Plasterboard	1/1992-	71	4
150	Plastic dinnerware	12/91-12/92	13	5
151	Polyester polyols, aliphatic	1998-2002	60	?
152	Polyester staple*	09/99-	17	4
153	Polypropylene, JP	1/00-5/00	5	7
154	Power equipment, Norway	1990-1997	96	2
155	Prawns, Netherlands	12/97-12/00	37	16
156	Pulp Baling Wire	01/88-01/89	12	5
157	PVC impact modifiers*	?	?	5
158	PVC plastic	10/80-7/84	46	14
159	PVC, Heat stabilizers*	?	?	14
160	Radiological media, Italy	95-99	60	5
161	Recorded music, Italy	01/96-01/97	12	5
162	Rubber processing chem.	?	?	5
163	Rubber processing	1/94-10/02	106	13
164	Seamless Steel Tubes	1990-1995	72	8
165	Seamless Steel Tubes	1990-1995	72	8
166	Shipping (French – AF.)	1/75-12/92	216	17
167	Shipping (W. Cent. Afr.)	1/72-12/92	252	13
168	Shipping conference FEFC,	?	?	4
169	Shipping, FETTSCA (Far	1/91-12/94	48	15
170	Shipping, TACA (No.	1/94-12/98	60	15
171	Soda ash	1983-	95	2
172	Sodium erythorbate	7/92-12/94	30	3
173	Sodium gluconate	4/87-6/95	99	6
174	Sorbates	1/79-6/97	210	6
175	Stamp auctions*	1/80-6/97	198	8
176	Steel beams	1/84-1/91	84	16
177	Steel, flat stainless	2/94-11/96	33	7
178	Sulfuric acid*	1/88-12/98	132	6
179	Tactile tile, US	3/98-10/98	8	2
180	Tampico fiber, US	1/90-4/95	64	4
181	Tar pitch*	?	?	5
182	Tobacco Leaf Auctions	2000	12	4
183	Tobacco Processing Spain	1996-2001	72	5
184	Toys & games, UK	1/99-4/01	28	3
185	Toys, FR	2001-2003	36	2
186	Transformers, power,	93/99	84	5
187	Transport, marine	1990-5/95	65	4
188	Tubes, laminated	87-95	108	2
189	Urethane plastics	1995-2001	84	3

190	Vinyl food wrap, JP	9/90-5/91	9	8
191	Vitamin A	9/89-2/99	114	4
192	Vitamin B1	1/91-6/94	42	3
193	Vitamin B12	1/91-12/94	48	2
194	Vitamin B2	1/91-12/95	60	3
195	Vitamin B3	1/92-3/98	75	4
196	Vitamin B4 (Choline)	1/88-1/98	121	6
197	Vitamin B5	1/91-2/99	98	3
198	Vitamin B6	1/91-6/94	42	3
199	Vitamin C	1/91-8/95	56	4
200	Vitamin D3	1/94-6/98	54	4
201	Vitamin E	9/89-2/99	114	4
202	Vitamin premixes	1/91-12/97	84	2
203	Waste Collection, DE	9/00-9/03	36	142
204	Water heaters, gas, Italy	95-97	36	7
205	Wine alcohol auctions, EU	3/92-?	?	3
206	Zinc phosphate	3/94-5/98	50	6
207	3 Tenors CD	1/97-12/98	24	2

\* Investigation underway and prosecutions pending as of 2003.

Source: Appendix Tables A1-A12 (Connor 2004) and various sources as outlined in the data section.