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Effect of Corporate Leniency Program on Cartel Dissolution under Market Uncertainty

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Abstract

Cartelists operate in an uncertain environment, facing market demand uncertainty and the possibility of being detected by the antitrust agency. We develop a dynamic model in which an incumbent cartel decides whether or not to voluntarily dissolve the cartel based on the observed profit and the antitrust agency's cartel deterrence index when there is leniency program available and when there is none. We find that the government does not have to spend equal amount of resources on cartel detection and prosecution across industries. Based on the market structure such as the concentration level, demand elasticity, industry size, and the cost of entry which determine excess profits jointly, the antitrust agency might be able to use appropriate damage multiplier and allocate just a small amount of resources to result in the self-dissolution of the ongoing hard-core cartels if there is no leniency program. With the introduction of a leniency program, even less resources can be enough to deter cartel operation. Our paper sheds light on the effective allocation of current antitrust resources to limit cartel operation in different industries, and how to evaluate the effect of the leniency program on the cartel's voluntary dissolution decision.

JEL classification numbers: K21, L00, L12
Keywords: Cartel, Leniency, Voluntary Dissolution, Antitrust, Market Uncertainty

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1 Introduction

Cartel is a form of anti-competitive activity where a group of firms fix or raise prices, allocate market shares or sales quotas, or engage in bid-rigging with explicit agreement in at least one market (OFT 2005). Their behavior has affected the consumers, the non-cartel member firms and the wider economy (UNCTAD 2003). There are two types of cartels: public and private. Public cartels are government backed and hence are exempt from punishment, e.g., OPEC and the Canadian Wheat board. The hard-core cartels are private cartels that are not associated with or approved by the government. Their anti-competitive activities are conducted in secrecy, and they would receive financial penalties if detected and found guilty.

Firms collude to increase profits in oligopoly markets usually involving homogeneous or nearly homogeneous products (Connor 2001, 2003, 2004, 2006, 2008; Harrington 2005; Aubert et al. 2006). Huge economic damages have been done to the world economy and the consumers due to firms' collusive behavior, the antitrust agencies in many countries have been striving to detect and deter cartels. The leniency policy has been proved to be rather effective in discovering and detecting cartels. It was first designed and adopted by the U.S. Department of Justic (DOJ) in 1993. Under this porgram the financial penalties are significantly reduced or completely waived for the first member of the cartel that self-reports and provides information about the anti-competitive activities to the antitrust agency prior to any form of investigation, and later collaborates with the agency during the formal investigation of the alleged cartel activities. The leniency program provides great incentives for the member firms to collaborate with the antitrust agency to receive no or reduced penalties and personal jail time. It is currently widely adopted by the world's major competition authorities such as European Commission (EC), Korea and Brazil.

In the industrial organization literature, a number of papers (Spagnolo 2000, 2006; Apesteguia et al. 2007; Hinloopen and Soetevent 2008; Chang and Harrington 2008) argue that the implementation of a leniency program may make collusion harder because the probability of detection and prosecution increases. However, Harrington (2008) notes that leniency may also increase cartel formation. The antitrust agency as a result of leniency might focus the bulk of its efforts on prosecuting cases brought within the leniency program rather than investigate potential cartels outside of those discovered by the leniency program. Sokol and Fishkin (2011) provides qualitative survey evidence of antitrust law firm lawyers that supports Harrington's theoretical insights.

Almost all the prior empirical researches have focused on the detected and prosecuted cartel cases. It is difficult to imply and conclude the impact of antitrust policy on collusion from only the observed cases (Harrington 2006). One central issue is then concerned with whether antitrust agency's efforts on cartel detection are effective enough to stop secret cartels under market uncertainty. Therefore, the main purposes of this article are to examine theoretically the efforts needed by the antitrust agency to deter cartel operations when collusive profit is subject to the market demand uncertainties, to link the theoretical findings with the real world data, and to provide useful antitrust policy implications. The studies closest to ours are those of Harrington (2004, 2005), which consider the relationship between the antitrust agency that polices against cartel behavior and the firm level members of a cartel. But different from Harrington's studies, the primary focus of the present research is on examining how a cartel makes its voluntary dissolution decision based on market conditions,[2] in light of an antitrust agency's increasing deterrence efforts in conditions of a leniency program and no leniency program.

Our study contributes to the literature by the inclusion of both market uncertainty factor and detection uncertainty factor into firms' decision-making process. In addition, we focus on the voluntary dissolution decision made by "undiscovered" hard-core cartels. We assume that all of the cartelists make the voluntary dissolution decision rather than dissolution via antitrust detection or member deviation within the cartel antitrust detection or member deviation within the cartel. We also assume a single antitrust agency and no detection by potential private litigants. Based on these assumptions, tacit collusion as described in Green and Porter (1984) is not discussed. Furthermore, we assume that as long as the cartel is not discovered, there is a possibility of cartel re-formation. The dynamic model characterizes sanctions against illegal collusive behavior by accounting for the probability of cartel detection as well as the market uncertainty. The facts that a cartel operates with the fear of being penalized once found guilty and the possible demand shock provides for a useful and revealing foundation for improved anti-cartel policies.

The decision by cartel members may be very complicated in practice. Thus, instead of finding specific quantitative solutions for the cartelists and the antitrust agency, the qualitative results obtained by the dynamic model have policy relevance for a number of issues faced by an antitrust authority (with and without a leniency program). First, it is harder to sustain the cartel operation when the competitive profits are high. Second, a larger damage multiplier for prosecuted cartels provides greater incentive for the cartel dissolution. Third, if the natural obstacle to detect the cartel is big, it is harder for the cartel to dissolve on its own. These results confirm what were found in previous studies by Apesteguia et al. (2007), Hinloopen and Soetevent (2008), and Chang and Harrington (2008). Fourth, market uncertainty plays an important role in the cartel's dissolution decision. The higher the variance in the profit, the greater the likelihood of cartel dissolution. Fifth, antitrust deterrence efforts can be different across industries depending on the industry characteristics. Industries that seem to have "excess profits" require additional attention by antitrust enforcers. More antitrust resources should be allocated toward those industries that are more cartel friendly, such as

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[2]Voluntary dissolution refers to the cartel breakdown resulting not from antitrust detection or cartel member defection (Harrington 2008).

high concentration, entry barriers, relatively inelastic demand, homogeneous products, and more demand shocks. Finally, the introduction of a leniency program makes collusion more difficult. Thus, if other conditions are held equal, the use of a leniency program requires fewer resources from an antitrust agency to improve cartel detection.

The rest of the paper is organized as follows. Section 2 gives the background of U.S. catel enforcement. In Section 3, we present the economic model of cartel dissolution with multiple parameters under two scenarios: with leniency program and without it. Section 4 examines how those parameters affect the cartel's self dissolution decision under the two scenarios: with a leniency program and without it. Section 5 provides a link between the economic model and the empirical world, and shows how the antitrust efforts can vary in different industries. Section 6 concludes and policy implications are given in this section.

2 Background

Cartel operations still exist worldwide despite the recent development and enforcement of antitrust laws in scores of countries that previously had no such legal framework. Since 1990, 283 hard-core cartels were discovered by antitrust authorities around the world (Connor 2003). According to a 1990s' sample of U.S. DOJ and EC prosecuted cases, the discovered cartels operated in a wide variety of industries such as chemicals, metals, transportation, communication, food, textiles and services (OECD 2002).

In the United States, the Department of Justice's Antitrust Division is the cartel enforcer. The overall budget of the Antitrust Division was $145 million in 2007. The Division's annual real budgets increased almost every year between 1990 and 2002, especially from 1990 to 1995 at a rate of 11.6% annually. From 2002 to 2007, the Division's real budget was 5% lower than the 2002 level. Although there is an increasing trend in the budget allocation, it might not be large enough to attract and keep the best professionals (Connor 2008). In 2007, approximately 29% of the Division's budget was allocated to cartel enforcement.

Four factors help to explain the growth in U.S. cartel enforcement. The growth in the rate of cartel detection from 1990 to the present is partly because of the budget increase in the antitrust division.[3] Another important reason is the adoption of Corporate Leniency Policy of 1993 and the Leniency Policy for Individuals of 1994 (Aubert et al. 2006). Miller (2007) found that the leniency program increased the detection probability by 60%. As part of leniency, the

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[3]The rate of discovery is 6 times higher in the 2000s than the early- and mid- 1990s, increasing from 3 cases each year to 20 cases per year.

leniency applicant avoids treble civil damages and reduced jail time.[4] With significantly increased financial penalties and jail time, this has a chilling effect on cartel formation and stability (Hammond 2010). An additional actor in detecting and prosecutig cartels has been the increased international cooperation and coordination by antitrust agencies across jurisdictions on international cartels. However, even with an increasing emerging empirical literature on cartels, academics still know very little about the motivations for cartel formation and operation. The cartel data available currently are based on government convictions, formal reports on cartel investigations, indictments and guilty pleas and decisions. Moreover, the number of existing cartels remains unknown (Connor 2008). This research attemps to enlighten our understanding of cartel stability by incorporating the majority of the realistic factors and scenarios into the dynamic modeling and simulation.

3 The Dynamic Model

In our model, a hard-core cartel operates in the same jurisdiction as an antitrust agency. The antitrust agency allocates some of its resources on cartel detection and prosecution. Whenever the cartel operates, it runs the risk of detection by the antitrust agency. Once detected and found guilty, the cartel has to pay the corporate penalty (we assume that there is no firm level criminal penalty). In addition to the risk of getting caught, the cartel also faces the market uncertainties that may affect the collusive profits.

At the beginning of each time period (one year), the cartel infers an antitrust index and observes the collusive profit based on the realized market condition.[5] It then decides whether to continue collusion or dissolve the cartel. Two scenarios are considered: the cartel makes its voluntary dissolution decision in the presence of a leniency program and without the leniency program. When there is no leniency, if the cartel dissolves itself, it gets the competitive profit. If the cartel continues with the collusion, it obtains the collusive profit which is higher than the competitive profit. However, it faces the possibility of detection by the antitrust agency and a

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[4] Once the cartel is detected and found guilty, the participants would receive three times the overcharge, which is the difference between the collusive profit and the competitive profit if cartel were not in operation.

[5] The antitrust index is inferred by the cartel from what is observable, such as the antitrust budget, the number of investigations, settlements, trials, statements made by the antitrust agency about cartel enforcement, the number of convictions, the number of outstanding professionals working towards cartel detection and prosecution, etc. This index serves as a proxy measure for the antitrust efforts and can determine the probability of cartel detection.

financial penalty if found guilty. When there is leniency, if the cartel dissolves itself, following the U.K. antitrust division's practice and what Harrington (2008) described as an optimal leniency program, we assume the first firm that applies for amnesty gets zero damages rather than the single damage, and the other firms still have to pay treble damages to the antitrust agency. If the cartel continues to operate, it receives the collusive profit although it operates with a possibility of getting discovered and penalized. The collusive profit (π) is higher than the competitive profit ($\overline{\pi}$), and no larger than the monopoly profit (π^m), i.e., $\overline{\pi} < \pi \le \pi^m$. Cartel profitability is closely related to the industry characteristics such as demand elasticity, industry concentration, product similarity, homogeneity of firms, efficient cartel agreement, and cartel market share (Echbo 1976 and Griffin 1989). The higher the industry concentration, the larger the cartel market share, the more homogeneous the firms are, the more similar their cost structures, the easier for the cartel to raise the price and hence the collusive profit (Echbo 1976 and Griffin 1989). But due to the uncertainties in the market demand, the profit distribution follows an exogenous continuous valued Markov process:

$$\pi_{t+1} = h(\pi_t, \varepsilon_{t+1}) \tag{1}$$

where π_t is the profit measured at year t and ε is the market shock which follows a normal distribution. Specifically, a firm's collusive profit at time $t+1$ is dependent on its profit at time t and an exogenous random shock to the market demand which is unknown at time t.

The antitrust agency's index is considered to be increasing each year until the highest limit is reached. The index is a state variable as well as the collusive profit. It is assumed to be integers and is indicated as $B \in \{1,2,3,...,\overline{B}\}$. The minimum index is 1 and it cannot exceed an upper limit $\overline{B}$ due to the resource constraint. The cartel's action each year is either to continue to collude or to dissolve, so the action variable x is discrete: $x \in \{collude, dissolve\}$. There are two scenarios: (1) cartel operation without a leniency program, and (2) cartel operation under the implementation of a leniency program in a given jurisdiction. The state transition function when there is no leniency program is:

$$g(\pi, B, x, \varepsilon) = \begin{cases} (h(\pi,\varepsilon), B+1), x = collude \\ (h(\overline{\pi},\varepsilon), B+1), x = dissolve \end{cases} \tag{2}$$

When no leniency program is in place, if firms choose to continue colluding, they get the collusive profit π and the colluisve profit in the next period is influenced by the random market demand shock. When the firms choose to dissolve the collusion voluntarily, the firms get the competitive profit $\overline{\pi}$ which is also influenced by the market shock. The budget index keeps increasing by one unit no matter what action the cartelists choose because the antitrust agency is not aware of their actions. Only when the cartel dissoluion is caused by the antitrust agency detection, the budget index would decrease.

In contrast, the state transition function when there is a leniency program is:

$$g(\pi, B, x, \varepsilon) = \begin{cases} (h(\pi, \varepsilon), B+1), x = collude \\ (\overline{\pi}, 1), x = dissolve \end{cases} \quad (3)$$

When there is a leniency program, firms' colluding or dissolving action will affect their profit variable and the antitrust index variable. Specifically, when the cartel dissolves, it gets the competitive profit $\overline{\pi}$ and the antitrust index is redued to the lowest level of 1; when the collusion continues, the cartel gets the collusive profit π and faces the probability of being detected by the antitrust agency and a penalty if found guilty. The penalty amount charged by the antitrust agency is a multiple of the difference between the collusive profit π and the competitive profit $\overline{\pi}$, i.e., $\rho(\pi - \overline{\pi})$ where ρ is the damage multiplier determined by the antitrust agency. Thus, the reward function at each time period without a leniency program is:

$$f(\pi, B, x) = \begin{cases} \frac{k}{k+B}\pi - \frac{B}{k+B}\rho(\pi - \overline{\pi}), x = collude \\ \overline{\pi}, x = dissolve \end{cases} \quad (4)$$

When there is no leniency program, in each period, if the cartel decides to keep colluding, due to the presence of an antitrust agency, there is a probabiliy of being detected and getting penalized if found guilty. In each period, when detected, the firms would pay a mulitple of the overcharge, otherwise it keeps gaining the collusive profit. The expected reward depends on the detection probability, the damage multiplier, collusive profit and the amount of overcharge. If the cartel decides to dissolve voluntarily without the antitrust agency's awareness, it gets the competitive profit in this period.

In contrast, the reward function with leniency program is:

$$f(\pi, B, x) = \begin{cases} \frac{k}{k+B}\pi - \frac{B}{k+B}\rho(\pi - \overline{\pi}), x = collude \\ \overline{\pi} - \frac{n-1}{n}\rho(\pi - \overline{\pi}), x = dissolve \end{cases} \quad (5)$$

When there exists a leniency program, in each period, if the cartel decides to keep colluding, when detected by the antitrust agency, the firms would pay a mulitple of the overcharge, otherwise it keeps gaining the collusive profit. If the firm decides to terminate collusion by reporting to the antitrust agency, it gets the competitive profit in this period. The leniency program gives the first reporting firm full criminal amnesty or reduced monetary damages if the cartel is found guilty. Harrington (2008) proved that the optimal leniency policy is to waive all the penalties to the first firm that reports to the antitrust authorities. We assume zero penalties for the first self-reporter, as a result, the firms have incentive to report to the antitrust agency and receive no penalties. However, only the first firm that applies for the leniency program can get the full amnesty. Suppose these firms are symmetric, when the cartel dissolves, they will all report to the antitrust agency, so the possibility of being the first one and getting zero penalty is only 1/n. There is still a chance of (n-1)/n that the firm still pays multiple damages even it conducts self-reporting.

In the literature, the detection probability is often assumed to be a given constant. But in reality, the detection probability is closely related to the antitrust detection efforts and other factors. Following the method of modeling government efforts in the probability of successfully implementing a policy by Zhuang and Bier (2007), the probability of detecting the cartel is a specified as $\frac{B}{k+B}$. It is a function of the antitrust index B and a constant k, which represents the natural obstacle for the antitrust agency to detect cartels. The value of k can be affected by many factors: the won/lost record for litigated cases, the number of settlement for cases, the existence of individual penalties including jail sentences and individual fines, international cooperations among different antitrust agencies including information sharing, the public awareness of antitrust action against cartels, and discovery technologies. For example, 30 years ago when significant communication between the cartelists was printed documents, it was hard for the antitrust agency to search for the evidence of collusion as the evidence could be kept in jurisdictions without antitrust laws. Therefore, k was large and the cartel detection was more difficult for the antitrust agency at that time. Hence the probability of detection may have been lower in the 1980s. Starting in the late 1990s, the majority of the communication across cartelists is via electronic application. Because of a significant improvement since the 1980s in forensic accounting and antitrust techniques, searching for collusion evidence becomes easier and much faster, so k decreases and the cartel detection improves for the antitrust agency. The detection probability function is twice differentiable. It increases with the antitrust agency's indices, but with decreasing marginal returns, i.e., $\frac{k}{(k+B)^2} > 0$ and $-\frac{k}{(k+B)^3} < 0$. In addition, the probability of cartel detection is 0 if the antitrust agency gives up detecting cartels and it is close to 1 if the agency makes an enormous amount of efforts in cartel detection, i.e., $\frac{B}{K+B} = 0$ when $B = 0$ and $lim_{B\to\infty} \frac{B}{K+B} = 1$. The value for the cartel given the collusive profit and the antitrust index without a leniency program satisfies the following Bellman equation:

$$V(\pi, B)_{no} = max\{\frac{k}{k+B}\pi - \frac{B}{k+B}\rho\pi + \delta E_{\varepsilon}V(h(\pi,\varepsilon), min(B+1,\bar{B})), \quad \bar{\pi} + \delta E_{\varepsilon}V(h(\pi,\varepsilon), min(B+1,\bar{B}))\} \tag{6}$$

The value for the cartel in the presence of a leniency program, satisfies the Bellman equation below:

$$V(\pi,B)_{leniency} = max\{\frac{k}{k+B}\pi - \frac{B}{k+B}\rho\pi + \delta E_{\varepsilon}V(h(\pi,\varepsilon), min(B+1,\bar{B})), \frac{\bar{\pi}}{1-\delta} - \frac{n-1}{n}\rho(\pi-\bar{\pi})\} \quad (7)$$

The Bellman equation (6) shows that the cartel earns π in the coming year if the cartelists decide to keep collusion, and in the next year, the cartel is expecting the antitrust index to increase by 1 unit and the value of the cartel is then $V(\pi', B+1)$, where π' is the next year's collusive profit. However, if the cartel dissolves over this coming year, the cartel will earn competitive profit. Because the cartel breaks down by itself, the firms have the freedom to re-form the cartel in the next year. Since the antitrust index still increases in the next year, cartel operation will reoccur only when the collusive profit in the next year is high enough. When there is a leniency program, the cartel earns π in the coming year if the cartelists decide to keep colluding, and in the next year, the cartel expects the antitrust index to increase by 1 unit and the value of the cartel is then $V(\pi', B+1)$. But if the cartel dissolves during this coming year, the cartel will earn competitive profit. After the dissolution, the cartel disappears and has no opportunity of re-forming, and the firms earn competitive profit indefinitely.

4 Estimation Results and Discussion

There are seven parameters in the Bellman equations (see Table 1). The natural obstacle for cartel detection k is set as 15, the larger this number is, the less possible the cartel can be detected. There are 5 levels of antitrust index, with 1 being the lowest and 5 being the highest. Depending on the index, when $k = 15$, the probability of detecting cartels varies between 6.25% to 25%.[6] The damage multiplier ρ is set to be 2 based upon the double-the-harm/gain standard.[7] Once found guilty, the cartel needs to pay a penalty of twice of overcharge, i.e., the

[6]According to Connor (2008), a survey of 21 academic studies or professional opinion about the probability of detection shows the number generally falls within 10% to 20%. It is very rare that the probability can exceed 33%. Additionally the rate of winning a cartel case is below 90%.

[7]In practice, depending on the number of employees in the cartel member firm, the involvement of the top executives within the company, the firm's history of recidivism, and whether the firm cooperates during the investigation and prosecution process, the culpability multiplier is generally between 1 to 4 (Connor 2008).

difference between the collusive profit and the competitive profit. The competitive profit $\overline{\pi}$ is assumed to be 10. And the collusive profit is between 10 and 30. The market demand is subject to uncertainties which are i.i.d. ~ N(0,1). And the depreciation rate δ is set as 0.9.

Table 1: Simulation Parameters Used in the Model

Parameters	Definition	Value/Value Range
K	Natural obstacle for cartel detection	10~40
ρ	Damage multiplier	1~3
$\overline{\pi}$	Competitive profit	10~30
n	Number of firms in the cartel	2~6
$\overline{B}$	Antitrust deterrence index	1~5
σ	Variance of profit shock	1
δ	Depreciation rate	0.9

The Bellman equations are estimated using the collocation method introduced in Miranda and Fackler (2002). We selected 100 basis functions ϕ_j and 100 collocation nodes (π_i, B_i) to form the value function approximant for $V(\pi, B)$ in equations (6) and (7). The approximant is $\sum_{j=1}^{100} c_j\phi_j(\pi, B)$. We then used the CompEcon Toolbox in Matlab to estimate the coefficients c_j that can solve the following collocation equations:

$$\begin{aligned}\sum_{j=1}^{100} c_j\phi_j(\pi, B) = max\{&\frac{k}{k+B}\pi - \frac{B}{k+B}\rho\pi + \delta\sum_{z=1}^{100}\sum_{j=1}^{100} w_z c_j \phi_j(\hat{\pi}_{iz}, B_i + 1) \\ &+ \delta E_\varepsilon V(h(\pi,\varepsilon), min(B+1, \overline{B})), \overline{\pi} + \delta\sum_{z=1}^{100}\sum_{j=1}^{100} w_\pi c_j \phi_j(\hat{\pi}_{iz}, B_i + 1) \\ &+ \delta E_\varepsilon V(h(\pi,\varepsilon), min(B+1, \overline{B}))\}\end{aligned} \tag{8}$$

and

$$\begin{aligned}\sum_{j=1}^{100} c_j\phi_j(\pi, B) = max\{&\frac{k}{k+B}\pi - \frac{B}{k+B}\rho\pi + \delta\sum_{z=1}^{100}\sum_{j=1}^{100} w_z c_j \phi_j(\hat{\pi}_{iz}, B_i + 1) \\ &+ \delta E_\varepsilon V(h(\pi,\varepsilon), min(B+1, \overline{B})), \frac{\overline{\pi}}{1-\delta} - \frac{n-1}{n}\rho(\pi - \overline{\pi})\}\end{aligned} \tag{9}$$

where $\hat{\pi}_{iz}$ is a function of the collusive profit π_i and quadrature nodes ε_z, and w_z is the weight for the normal demand shock.

Figure 1 shows the value of the cartel as a function of the collusive profit for five different antitrust indices when there is no leniency program. For each index, the value of the cartel is increasing with the collusive profit. The kink shows the critical collusive profit level and the cartel dissolves as soon as the collusive profit drops below the cut-off level. From Figure 1, we also find that the higher the antitrust index, the lower the value of the cartel because higher index will lead to higher probability of detection.

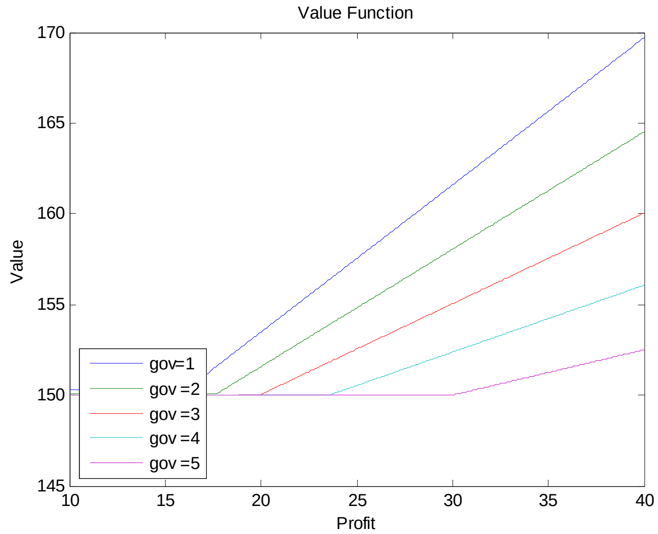

Figure 1: Cartel's Value as a Function of Collusive Profit Without Leniency Program

Figure 2 shows the value of the cartel as a function of the collusive profit for five different antitrust indices when there is a leniency program. With leniency program, we find that the higher the antitrust index, the lower the value of the cartel. Comparing the two scenarios, the cartel's value is higher when a leniency program is in place.

Tables 2 to 5 show the threshold collusive profit values with varying assumptions for the key model parameters under the two scenarios. Specifically, Table 2 shows the threshold collusive profit for the cartel to make the voluntary dissolution decision with a number of alternative possibilities for the damage multiplier ρ. Under both scenarios, when the damage multiplier is fixed, as the government's antitrust index increases, the cartel needs a higher collusive profit to sustain the collusion because the probability of getting caught and fined increases with the antitrust index. When the antitrust index is very small (B = 1, 2), the change in the damage multiplier does not make a difference regarding the cartel's dissolution decision when there is no leniency. And when the antitrust index is intermediate and high (B = 3, 4, 5), a larger damage multiplier will lead to a larger collusive profit needed to sustain the collusion, or make it harder for the cartel to sustain the collusion. When there is a leniency program, for a fixed antitrust index, a higher damage multiplier makes it easier for the cartel to sustain the collusion because the cartelists will hesitate to dissolve due to the fact that dissolution leads to cartel breakdown forever.

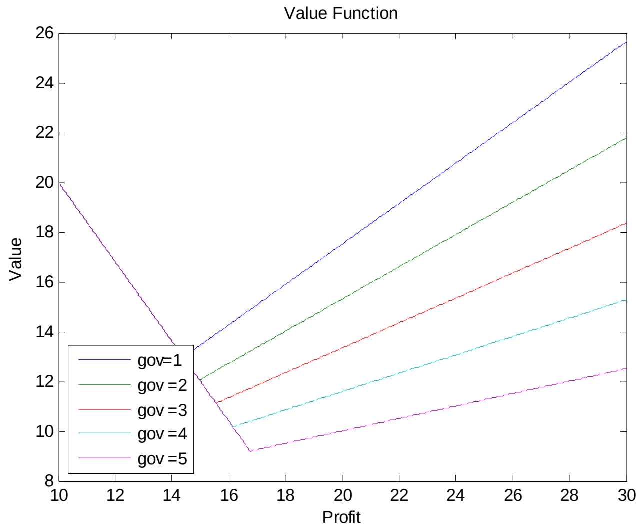

Figure 2: Cartel’s Value as a Function of Collusive Profit With Leniency Program

Table 2: Threshold Profit for Cartel Dissolution with Different Damage Multipliers under the Two Scenarios

Multiplier	Government Antitrust Indexes									
	B=1		B=2		B=3		B=4		B=5	
	no	yes	no	yes	no	yes	no	yes	no	yes
ρ=1	11	16	12	17	13	18	14	19	15	20
ρ=1.5	11	15	12	16	13	17	14	17	17	18
ρ=2	11	14	12	15	13	16	16	16	20	17
ρ=2.5	11	14	12	15	14	15	18	16	30	16
ρ=3	11	14	12	14	15	15	23	15	40	16

The estimation results in Table 3 suggest that a higher competitive profit makes collusion hard to sustain under both scenarios. When the antitrust index is small (B = 1, 2), the collusive profit threshold increases steadily with the competitive profit. When the antitrust index is intermediate (B = 3, 4), the collusion cannot be sustained if the difference between the collusive profit and the competitive profit is less than 10 as $\overline{\pi}$ approaches 30. When the antitrust index is high (B = 5), the cartel will not dissolve itself unless the difference between the collusive profit is over 30 when $\overline{\pi} = 30$. When the competitive profit is given, the higher the antitrust index, the higher the collusive profit is needed to sustain the cartel because the probability of detection is higher. This finding is consistent with what Asch and Seneca (1976) found when they tried to compare industries where cartels occur frequently with those without cartels. Although Asch and Seneca (1976) found that statistically firms with low competitive profits tend to be associated with collusive actions, the authors could not explain why. From historical data, cartel overcharges or excess profits are usually larger in those industries characterized by high concentration, large numbers of buyers/sellers, high cost of entry, inelastic demand, and homogeneous goods (Long, Schramm and Tollison 1973; Levenstein and Suslow 2006; Connor 2008). One common result from the literature is that firms in concentrated industries tend to collude more because it is more likely for them to raise the prices and hence the profits (Levenstein and Suslow 2006). Also from Table 3, we find if the antitrust index is less than the highest level 5, then it is even harder to sustain the collusion when there is a leniency program. But when antitrust index is 5, no leniency makes collusion harder.

Table 3: Threshold Profit for Cartel Dissolution with Different Competitive Profit under the Two Scenarios

Competitive Profit	Government Antitrust Indexes									
	B=1		B=2		B=3		B=4		B=5	
	no	yes	no	yes	no	yes	no	yes	no	yes
π =10	11	15	12	15	13	16	16	16	20	17
π =15	16	22	18	23	20	24	24	25	30	25
π =20	22	29	24	30	27	32	31	33	40	34
π =25	27	36	30	38	33	39	39	41	50	42
π =30	32	44	35	45	40	47	47	49	60	51

Table 4 shows the threshold profit for cartel to make the dissolution decision with a number of alternative possibilities for the parameter k under the two scenarios. Because the value of k can be affected by many factors such as the speed of antitrust division's investigation and sanction imposition, the existence of individual penalties including jail sentences, international cooperations among different antitrust agencies, the public awareness of antitrust actions, and discovery technologies, k can be decreased by imposing jail sentences for the responsible firm executives, strengthening international collaboration with other antitrust authorities and providing educational and compliance training programs. When k is fixed, as the government's antitrust index increases, under both scenarios, the cartel requires a higher collusive profit to sustain the collusion because the probability of being detected and prosecuted increases with the antitrust index. When the antitrust index is small and intermediate (B = 1, 2, 3), the increase in the natural obstacle decreases the threshold collusive profit, and hence makes collusion easier to sustain. And when the antitrust index is large (B = 4, 5), a small natural obstacle (k = 10) might lead to cartel dissolution because no big enough collusive profit can be found to sustain the cartel operation. By comparing the threshold collusive profit numbers under the two scenarios, it is harder to sustain the collusion when a leniency program is in effect.

Table 4: Threshold Profit for Cartel Dissolution with Different Natural Obstacle under the Two Scenarios

Natural Obstacle	Government Antitrust Indexes									
	B=1		B=2		B=3		B=4		B=5	
	no	yes	no	yes	no	yes	no	yes	no	yes
K = 10	11	15	13	16	18	16	30	17	-	18
K = 20	11	14	11	15	12	15	13	16	15	16
K = 25	10	14	11	15	12	15	12	15	13	16
K = 30	10	14	11	15	11	15	12	15	13	15
K = 40	10	14	11	14	11	15	11	15	12	15

Table 5: Threshold Profit for Cartel Dissolution with Different Number of Cartel Firms under Leniency Program

Number of Firms in the Cartel	Government Antitrust Indexes				
	B=1	B=2	B=3	B=4	B=5
n = 2	16	16	17	17	18
n = 3	15	15	16	17	17
n = 4	15	15	16	16	17
n = 5	15	15	16	16	17
n = 6	14	15	16	16	17

Table 5 shows the threshold profit for cartel to make the dissolution decision with a number of alternative possibilities for the number of firms in the cartel n when there is a leniency program. When the number of firms is given, as the government's antitrust index increases, the cartel needs a higher collusive profit to sustain the collusion because the probability of being detected increases with the antitrust index. Given the antitrust index, the cartel needs a lower collusive profit to keep collusion in operation. So it becomes easier to keep collusion when there is more firms in the cartel because with more firms in the cartel, the possibility of getting amnesty is smaller which makes collusion more sustainable.

5 Real World Application

By studying the 260 international cartels discovered during 1990 and 2005, Connor (2008) found that nearly 50% of the sample cartels are in manufacturing industries including chemicals and pharmaceuticals, food and tobacco, and nonmetallic minerals. Moreover, 11% of the cartels are in the raw agriculture and mining materials.

Table 6: Financial Statistics of U.S. Manufacturing Industry (Millions of Dollars)

Industry Group	Sales	After-tax Profits	Profits /Assets	Excess Profits
Food	113,021	6,001	0.202	3594.66
Beverage and tobacco products	36,836	7,226	0.273	5082.02
Textile mills and textile product mills	12,127	427	0.097	70.43
Apparel and leather products	21,936	1,770	0.256	1209.96
Paper	36,209	1,089	0.081	0.00
Printing and related support activities	18,484	936	0.24	620.10
Petroleum and coal products	279,985	31,749	0.317	23636.48
Chemicals	171,049	23,124	0.18	12718.20
Basic chemicals, resins, and synthetics	56,547	3,369	0.16	1663.44
Pharmaceuticals and medicines	69,034	14,488	0.196	8500.61
All other chemicals	45,468	5,267	0.155	2514.57
Plastics and rubber products	42,559	1,915	0.174	1023.53
Wood products	20,215	1,337	0.167	688.51
Nonmetallic mineral products	34,652	3,225	0.341	2458.94
Primary metals	61,126	5,820	0.266	4047.74
Fabricated metal products	64,693	5,367	0.265	3726.52
Machinery except electrical	88,604	7,214	0.192	4170.59
Computer and electronic products	146,400	15,322	0.128	5626.05
Electrical equipment, appliances, and components	50,813	7,064	0.177	3831.32
Furniture and related products	21,407	1,484	0.236	974.66
Miscellaneous manufacturing	34,515	3,939	0.148	1783.20

Data source: U.S. Census Bureau, Quarterly Financial Report, 2006, Quarter 3

Using quarterly financial data from Census Bureau, we calculated the "excess profits" from rates of return on Stockholder's Equity. Specifically, we calculated the "excess profits" numbers in each industry by differences between the rate of return in that industry and the lowest rate of return industry in the manufacturing sector (Long, Schramm and Tollison 1973). In our data, the lowest rate of return industry is the paper industry, so excess profit = (profits/assets-0.081)*assets. Table 6 lists the sales, after-tax profits, rates of return and excess profits in different manufacturing industries. Consistent with what Connor (2008) concluded from the historic cases, we find that the excess profits are large in pharmaceuticals and medicines, food, beverage and tobacco products, and the nonmetallic minerals. Most of these industrial goods are homogenous and are in highly concentrated industries. For example, the four-firm concentration ratio in citric acid industry is 100% in the U.S., three lysine producers account for 95% of the world market in late 1980s, three bulk vitamins producers account for 75% of the world market in the 1990s, three bromine producers account for 76% of the world market in the 1990s, and the five-firm concentration ratio in the U.S. in graphite electrodes industry is 94%; and all these industries have increased the market price by at least 20%, except bromine industry where there is no data available regarding the overcharge, and they all have a large size of customers (Levenstein and Suslow 2006). The excess profits are also high in the petroleum and coal industry, and the computer and electronic products industry. The excess profits are relatively low in several industries such as paper, textile mills and textile product mills, printing, wood products and furniture and related products.

We selected six industries to examine the respective effective antitrust resource allocation. Two of the industries have relatively large excess profits: petroleum and coal, and pharmaceuticals and medicines. Three of them have medium excess profits: beverage and tobacco, nonmetallic mineral, and computer and electronic products. In contrast, textile mills and textile product mills industry has a relatively small excess profit. We assume the only difference among these six industries is excess profit. We assume that other factors such as natural obstacle of cartel deterrence, and market uncertainty are the same across industries, and the antitrust index has 10 levels with 1 being the lowest and 10 being the highest. The effective antitrust index levels for each industry that can fully deter the cartel operation under the two scenarios are listed in Table 7. When there is no leniency, the antitrust index needs to be relatively higher at 7 in the petroleum and coal industry, and the nonmetallic mineral industry. It needs to be at level 6 in the beverage and tobacco industry, and the pharmaceuticals and medicines industry. The antitrust index needed to stop collusion is relatively low in the computer and electronic industry. And it is the lowest at level 3 in the textile mills and textile product mills industry. When there is a leniency program available, the antitrust index needs to be relatively higher at 5 in the beverage and tobacco industry, the petroleum and coal industry, and the nonmetallic mineral industry. It needs to be at level 6 in the beverage and tobacco industry, the pharmaceuticals and medicines industry, petroleum and coal industry, and the nonmetallic mineral industry. The antitrust index needed to stop collusion is relatively low at 4 in the computer and electronic industry. And it is the lowest at level 2 in the textile mills and textile product mills industry. Comparing the two scenarios, the antitrust index is lower when there is a leniency program. This is consistent with what was found in prior studies on the effect of leniency policy on collusion (Apesteguia et al. 2007; Hinloopen and Soetevent 2008; Chang and Harrington 2008). Therefore, from this analysis, the antitrust agency does not have to allocate the same amount of resources and efforts on cartel deterrence in every industry. It is more efficient to allocate more of the resources to the industries that have higher excess profits and less to the low excess profit industries. With the leniency program, the allocation can be lower in the concerned industries.

Table 7: Antitrust Indexes Needed to Deter Cartels in Selected Industries

Industry Group	Excess Profits	Antitrust Deterrence Indexes	
		no leniency	with leniency
Beverage and tobacco products	5082.02	6	5
Petroleum and coal products	23636.48	7	5
Pharmaceuticals and medicines	8500.61	6	5
Textile mills and textile product mills	70.43	3	2
Nonmetallic mineral products	2458.94	7	5
Computer and electronic products	5626.05	4	4

6 Conclusion and Policy Implication

In this paper, we develop a dynamic model in which an incumbent cartel decides whether or not to voluntarily dissolve the cartel based on the observed profit and the antitrust agency's cartel deterrence index when there is leniency program available and when there is none. The cartel is subject to demand shocks and detection by the antitrust agency. At the beginning of each period, the cartel observes its potential short run profit and the antitrust index level that is inferred from the agency's resource allocations on cartel detections and prosecutions, and decides whether to keep colluding or dissolve the cartel. By continuing the cartel, there is a probability that the cartel may be detected and hence financially penalized. By dissolving the cartel, the firms receive competitive profits. But cartel member firms still have the chance of reforming the cartel in the future as long as the cartel is not ended by the antitrust agency. When there is leniency program, the dissolution decision leads to the cartel breakdown forever and only the first firm that applies for leniency can get the full amnesty.

The Bellman equations are solved using Newton's method. Based on the given parameters, we found the optimal values and the optimal actions when different levels of antitrust indexes are observed. The post-optimality analyses show that the value of the cartel is an upward-sloping function of the collusive profit for any antitrust index. The cut-off cartel profit below which the cartel dissolves is calculated when the antitrust agency's cartel deterrence index increases each year. The higher the observed antitrust index, the lower the value for the cartel and the higher the collusive profit required to sustain the collusion. The higher the damage multiplier, the more difficult for the cartel to keep operating when there is no leniency program. But in presence of a leniency program, a higher damage multiplier can make it easier to sustain the secrete cartel operation. The higher the competitive profit firms can earn without collusion, the easier the cartel dissolves. And the higher the natural obstacle is for the cartel detection, the easier it is for the cartel to continue collusion. In general, a cartel is harder to sustain with a leniency program, which confirmed previous studies (Spagnolo 2000, 2006; Apesteguia et al. 2007; Hinloopen and Soetevent 2008; Chang and Harrington 2008). We aslo found that more firms in the cartel can make collusion more sustainable in the presence of a leniency program.

In addition, we calculated the excess profits for the major manufacturing industries in the U.S. using the real world data, and estimated the value functions and the threshold profit numbers for six selected industries: petroleum and coal, pharmaceuticals and medicines, beverage and tobacco, nonmetallic mineral, computer and electronic products, and textile mills and textile product mills industry. The value of the cartel operation increases with collusive profit and decreases with antitrust index in all these industries. However, the antitrust index required to deter the cartel operation varies across these industries. A relatively high level of antitrust index is required for the petroleum and coal, pharmaceuticals and medicines, beverage and tobacco, nonmetallic mineral industries, and a relatively low index is needed in the computer and electronic products, and textile mills and textile product mills industries. In all the industries, a relatively lower antitrust index is needed to stop collusion when the leniency program is available. In other words, fewer resources can be allocated to cartel detection and prosecution due to the implementation of an effective leniency program.

Our results mostly conformed to the current cartel theories. The objective of the antitrust polices should be to increase the anti-cartel index in general, reduce the natural obstacle of detecting cartels, and increase the penalty of collusive behavior once cartel is found guilty. In addition, the government does not have to spend equal amount of resources on cartel detection and prosecution across industries. Based on the market structure such as the concentration level, demand elasticity, industry size, and the cost of entry which determine excess profits jointly, the antitrust agency might be able to use appropriate damage multiplier and allocate just a small amount of resources to result in the self-dissolution of the ongoing hard-core cartels if there is no leniency program. With the introduction of a leniency program, even less resources can be enough to deter cartel operation. Our paper sheds light on the effective allocation of current antitrust resources to limit cartel operation in different industries, and how to evaluate the effect of the leniency program on the cartel's voluntary dissolution decision.

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