Equity Prices and Cartel Activity

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Abstract

We use a new data set to examine the equity price impact of announced cartel investigations. Unlike prior research, we estimate normal returns using the Fama-French (1993) three-factor model. We find that cartel investigation announcements have a long-lasting negative share-price effect of two percent, but one near zero for firms receiving leniency. The two percent loss is notably less than the estimated present value of profits lost due to cartel termination, implying that cartel participation is profitable. However, the results also suggest that the no-cheating stability condition for cartels may often not be satisfied, especially given the incentive to seek leniency.

Keywords: Event Study, Equity Prices, Cartels

JEL Classification: G14 Information and Market Efficiency; Event Studies; L4 Antitrust Issues and Policies

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1. Introduction

The revelation by antitrust authorities that a firm is involved in collusive price-fixing can be expected to impact the firm’s net worth for at least two reasons. First, if the investigation subsequently leads to legal prosecution and conviction, the firm will likely be subject to sizable fines. Second, assuming that the antitrust action ends the collusion, the announcement of such action reveals to all market participants that the firm will no longer generate the extra profit that motivated the cartel in the first place. In addition, the revelation of cartel activity may cause customer relations problems and other issues that can also negatively impact a firm’s anticipated profit and share price.

In this paper, we use an event study methodology to isolate the impact of cartel investigation announcements on a firm’s equity value. In this respect, our work is similar to previous work such as Ellert (1976), Garbade, et al (1982), most particularly Bosch and Eckard (1991), and more recently, Günster and Van Dijk (2012) who focuses on European Union cases. Yet while these studies all investigate stock market reactions either to antitrust violations in general, or illegal price-fixing, in particular, they each rely on the equity returns predicted by a simple one-factor model, essentially the well known, Capital Asset Pricing Model (CAPM), to identify the irregular returns due to antitrust announcements. In contrast, we use the more modern three-factor model proposed by Fama and French (1992, 1993) in the long span of 1994 to 2010.\(^1\) In addition, we also explore how the market response to announcements that a firm is under investigation for cartel behavior differs between those cartel members who cooperate with authorities by seeking leniency and those that do not.\(^2\)

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\(^1\) More recently, Fama and French (2014) have suggested a five-factor model is appropriate for modeling stock returns.\(^2\) Becker’s (1968) analysis of the costs and benefits of illegal activities inspires this line of inquiry, see also Motta and Polo (2003), Miller (2009), and Connor and Lande (2012).
In brief, we find that the announcement that a firm (or its subsidiary) is under investigation for price-fixing leads to an unanticipated decline in the firm’s equity price of roughly two percent in the first few days following the revelation. While there is some subsequent recovery, over 80 percent of this decline or over 1.7 percentage points, appears to be long lasting. The dollar magnitude of these losses is greater than the subsequent fines and damage payments. At the same time however, the equity loss net of fines and damages is generally less than estimates of the discounted value of cartel profits no longer earned unless demand is relatively elastic, the pre-cartel markup is relatively high, and the remaining cartel life is anticipated to be short. Even when these conditions are met, the profits earned during the time of successful cartel operation (eight years on average in our data) remain un-offset. In turn, this raises some question regarding the deterrent effect of anti-trust enforcement.

We provide a brief discussion of our framework in the next section. We then describe the data and our empirical analysis. A summary and concluding remarks then follow in Section 4.

2. Event-Study Framework

As noted, we use an event study framework to identify the impact of antitrust price-fixing announcements on a subject firm’s daily stock returns. This is a relatively common approach to evaluating the impact of “news” on financial markets, e.g., Brown and Warner (1985), Campbell et al (1997). The essential elements of an event study are straightforward. The first requirement is to identify the “event”. For this we use two possible definitions—the date the firm is first announced as the subject of an antitrust price-fixing investigation and, as an alternative, the date that the firm reaches a final settlement with the antitrust authorities regarding the case.

We next define the “window” surrounding the event. In our case, this is defined as a period running from the 15 days prior to the event to the 15 days following it. Thus, the window is 31
days in duration counting the date of the event itself. If that date is identified as \( \tau \), then the window extends from \( \tau - 15 \) to \( \tau + 15 \).

Finally, we determine an estimation period in which the model generating a firm’s “normal” daily stock return is estimated. For this purpose, we use a 270-day period that ends 30 days prior to the event itself. This nine-month period contains about 190 actual trading days. Ending the estimation period 15 days prior to the start of the event window is meant to insure that the “normal” return-generating process is estimated without influence from the “excess” returns that are presumably driven by the event itself. Figure 1 illustrates the typical event study framework along with the specific parameters used in our particular case.

**Figure 1**

**Event Study Framework Timeline**

- Event Date
- \( \tau - 300 \)
- \( \tau - 30 \)
- \( \tau - 15 \)
- \( \tau \)
- \( \tau + 15 \)
- Time
- Estimation Period
- Event Window

Like all empirical research, event studies have potential flaws. One key issue is the process assumed to generate normal returns. In all studies related to antitrust of which we are aware, including Ellert (1976), Garbade, et al (1982), Bosch and Eckard (1991), and more recently, Aguzzoni, Langus, and Motta (2013) and Günster and Van Dijk (2012), the assumed generating function is a simple one-factor model suggested by the CAPM, in which the single variable is the return on some general market index. If, however, other factors are systematically relevant to the return-generating process, then use of a single-factor model may well yield inaccurate results.

Much recent finance research relies on an augmented CAPM or three-factor model for generating systematic equity returns suggested by Fama and French (1992, 1993). In addition to
the market risk factor used in CAPM models, Fama and French (1992, 1993) add both a size premium factor and value premium factor. The prevalence of the Fama-French approach was in fact recognized by the Nobel Prize Committee in its statement awarding the 2013 Economics Nobel to Fama, in which the Committee wrote that following the Fama-French work, Fama and French, “it has become standard to evaluate performance relative to “size” and “value” benchmarks,” rather than to look at a measure of overall returns alone.\(^3\) Countless articles in top finance journals employ the Fama-French analysis for estimating required returns, including recently, Buraschi, Trojani and Vedolin (2014), Berkman, Koch and Westerholm (2014), Ben-David, Franzoni, Landier, and Moussawi (2013), Hu, Pan and Wang (2013), and Boguth and Kuehn (2013).\(^4\)

Another possible problem with an event study approach is the potential for greater variance in the equity prices of those firms involved in the event period. This however can be addressed fairly easily however. For example, Jaffe (1974) and Mandelker (1974) use the standardized average excess return to conduct more robust \(t\) tests.

In short, we believe that an event study framework is a useful one for identifying the financial market’s reaction to news that a firm is possibly engaging in illegal price-fixing behavior. We are equally convinced that the Fama-French (1992, 1993) three-factor model is an appropriate one for generating the normal or expected equity returns deviations from which may reasonably be attributed to the “event”. We now describe the implementation of this strategy for this study.

3. Data and Empirical Analysis

We first describe the basic data. We then describe the estimation strategy and empirical results.

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\(^4\) In addition, the Chartered Financial Analyst Level II certification requires an understanding of how to use the Fama-French model to determine a firm’s cost of equity capital.
3.1 Data

The data on cartel activity by firms are taken from the Private International Cartel (PIC) data set constructed by Professor John Connor of Purdue University. This is an extensive data set that covers over 9000 firms participating in over 500 cartels over the years 1994 to 2010. For each such cartel, the PIC\(^5\) data lists the firms investigated, the date of the first investigation announcement\(^6\) in the US, Canada, and the EU, and other relevant information such as the duration of the cartel and the primary industry involved. In turn, for each firm identified, the PIC data also indicate key characteristics such as whether the firm was a repeat offender and whether the firm applied successfully for leniency under the leniency programs in each of the three national jurisdictions.

We merge the PIC data with data for each firm on stock prices, and other variables taken from the Bloomberg database. As described earlier, we used daily stock prices in conjunction with the Fama-French (1992, 1993) model to estimate the normal return-generating function for each stock, using a 270 calendar-day estimation period that ends 30 days before the “event”.\(^7\)

Because we use the Fama-French factors for US-listed firms, we focus on those firms whose securities are publicly traded in the American market. As it turns out, many of the firms involved in cartels are privately held and do not list on any exchange. In addition, some list only on foreign exchanges. The result is that focusing on firms that avoid these additional limitations reduces the sample to 253 observations on individual companies, if we define the event as the date of announcement that the firm is under investigation.\(^8\)

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\(^5\) Private International Cartels spreadsheet by John M. Connor, Purdue University, Indiana, USA (July 2014).

\(^6\) There are no “official” announcements. The PIC data uses the first announcement made in the public media.

\(^7\) Data for the Fama-French factors for US-listed firms are publicly available at the website maintained by Kenneth French (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).

\(^8\) Often the companies named in a price-fixing investigation are wholly-owned or almost wholly-owned subsidiaries of larger parents. The PIC data set however also lists the parents and in all such cases, we use the stock price of the parent firm, as typically, the subsidiaries do not list on any exchange.
It can be argued, however, that the relevant event is the date that the investigation closes and any penalties have been assessed. We also investigate this possibility using the same event study methodology framework described earlier. Yet, because a number of cases are still open and/or no penalty has been assessed by the last year of PIC data coverage, using the closing as the event date reduces the number of observations to 160. Still, even in this case, the number of observations in either event definition is of the same order of magnitude as the recent study by Günster and van Dijk (2012), that looked at 166 firms, and notably larger than the much earlier study by Bosch and Eckard (1991) that examined data for 127 firms involved in cartels.

3.2 Empirical Estimation and Results

We start by defining the “event” as the date that an antitrust authority announces that a firm is under investigation for participating in an illegal price-fixing cartel. As noted above, we then define the “event window” as the period running from 15 days prior to the event to 15 days after it. The estimation period used runs 270 calendar days and covers the nine months that end 30 prior to the event (15 days prior to the beginning of the event window). For each of the 253 firms in our sample, we then estimate the following, standard Fama-French (1992, 1993) model of “normal” returns:

\[ R_{it} = \alpha_i + \beta_1 R_{Mt} + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_{it} \]  

(1)

Here, \( R_{it} \) is the return on firm \( i \)'s stock for day \( t \); \( R_{Mt} \) is the return on a well-diversified market portfolio also on day \( t \); \( SMB_t \) is the premium on small-capital firms—the difference between the mean return on a portfolio comprised of such firms and one comprised of firms with large

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9Investigations are usually announced by one government authority, e.g., the US and then followed fairly shortly thereafter by an announcement by another government authority, e.g., Canada. For this reason, we take as the announcement event date, the first time that the firm is publicly revealed to be under investigation whether this is in Canada, Europe, or the US. I follow a similar approach when using the case closed date as the event date. See Posner (2001).
capitalized values, again on day $t$; HML$_t$ is a similar, day $t$ index of the premium on value firms with high book-to-market values; and $\varepsilon_i$ is a random error term.

The estimated coefficients from equation (1) are then used to generate the expected or normal daily returns over each day of the event window $ER_{it}$ for each firm. The excess daily abnormal return, $AR_{it}$, is then easily calculated as the actual daily return $R_{it}$ less the normal or expected return for each stock. That is:

$$AR_{it} = R_{it} - ER_{it}$$  \hspace{1cm} (2)

The daily returns may also be summed over intervals of more than one day to calculate a corresponding cumulative normal return $ECR_{it}$ that can then be compared with the actual cumulative return $CR_{it}$ over the same interval to reveal the excess cumulative return $ACR_{it}$ as the difference between $CR_{it}$ and $ECR_{it}$. The measures are then averaged across firms for statistical analysis.

We begin by testing two hypotheses.

**Hypothesis 1**: The announcement that a publicly-traded firm is under investigation for cartel behavior will lead to a decline in that firm’s share price (or the price of its parent) either because of anticipated legal penalties, the loss of profit due to the end of the cartel, or for these and other reasons.

**Hypothesis 2**: The share price decline that follows the announcement that a firm is under investigation for cartel behavior will be smaller for firms that apply for and receive some form of leniency under the guidelines of the various antitrust authorities either because such firms face smaller (possibly no) legal penalties, or because their decision to “fink” on the cartel reflects the fact that such firms were not earning supernormal cartel profits to begin with, or for both reasons.
We begin with Hypothesis 1. Figure 2 plots the average forecast and actual daily return as well as the excess return (Actual – Forecast) for our sample of 253 firms in relation to the $\tau = 0$ date event of an announcement that the firm is under investigation for illegal price-fixing. As the plotted curves make clear, there is no detectable effect in the 15 days prior to the announcement. The market does not “anticipate” this news. However, there is a sharp unexpected decline in prices (negative excess return) immediately on the day of the announcement—one that grows over the three or four days following that news. Subsequently, actual and forecast daily returns move together closely throughout the remaining second half of the event window. The absence of a subsequent positive excess return however, implies that the negative returns suffered in the immediate wake of the announcement are long lasting.

**Figure 2**  
Forecast, Actual, And Expected Daily Return

We can give more precision to the above description with regression analysis. In Table 1A, we show the sample daily excess returns alongside their standard errors and the corresponding t-
The excess returns for these days falling immediately on the heels of the announcement are consistently negative and the first three (and marginally the fourth) are statistically significantly different from zero. On average, the announcement that a firm (or its subsidiary) is under investigation for price-fixing causes its equity price to fall immediately by nearly 0.484 percentage points. The price falls a further 0.7 percentage points the following day and 0.44 percentage points the day after that. Thus, the cumulative excess return over these six days is approximately -2.2%.

Table 1B presents the same story in a slightly different manner. In recognition that the returns of different stocks have different pre-event variances, we have here calculated the excess return following the announcement event on each share’s return relative to the standard deviation of that return. This standardization recognizes that departures from the normal or expected return trajectory are more common for firms with more variable returns and so have to be truly sizeable to register as significant. As Table 1B shows however, the effects of announced cartel investigation remain just as significant if not more so when this standardized measure is used.

Table 1A

<table>
<thead>
<tr>
<th>Day</th>
<th>Mean</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-0.00484</td>
<td>0.00193</td>
<td>-2.510</td>
<td>0.0127</td>
</tr>
<tr>
<td>1</td>
<td>-0.00704</td>
<td>0.00239</td>
<td>-2.951</td>
<td>0.0035</td>
</tr>
<tr>
<td>2</td>
<td>-0.00436</td>
<td>0.00204</td>
<td>-2.136</td>
<td>0.0336</td>
</tr>
<tr>
<td>3</td>
<td>-0.00232</td>
<td>0.00140</td>
<td>-1.663</td>
<td>0.0976</td>
</tr>
<tr>
<td>4</td>
<td>-0.00123</td>
<td>0.00169</td>
<td>-0.727</td>
<td>0.4677</td>
</tr>
<tr>
<td>5</td>
<td>-0.00211</td>
<td>0.00140</td>
<td>-1.501</td>
<td>0.1345</td>
</tr>
</tbody>
</table>

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10 See Brown and Warner (1985) and, especially, Campbell, Lo, and MacKinlay (1997), chapter 4, regarding details of such calculations.

11 The t-statistic under the null hypothesis is obtained as the ratio of the given day mean abnormal return across securities and its estimated standard deviation, e.g. Brown and Warner (1985), p. 7. In the following tables, the statistic is similarly obtained using standardized and/or cumulative abnormal returns.
Table 1B
Daily Excess Returns, Investigation Event,
Standardized Relative to Stock Return Volatility

<table>
<thead>
<tr>
<th>Day</th>
<th>Mean</th>
<th>Std. Error</th>
<th>t- Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.10082</td>
<td>-3.036</td>
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<tr>
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<td>-4.384</td>
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<td>0.07695</td>
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<td>0.0097</td>
</tr>
<tr>
<td>3</td>
<td>-0.1533</td>
<td>0.07228</td>
<td>-2.121</td>
<td>0.0349</td>
</tr>
<tr>
<td>4</td>
<td>-0.0149</td>
<td>0.06744</td>
<td>-0.221</td>
<td>0.8253</td>
</tr>
<tr>
<td>5</td>
<td>-0.0785</td>
<td>0.06647</td>
<td>-1.181</td>
<td>0.2386</td>
</tr>
</tbody>
</table>

A natural question to ask in light of the above findings is whether the negative excess returns in the immediate wake of the investigation announcement live for only a few days or are sustained. As noted, Figure 2 is suggestive in this respect as it shows no evidence that the initial negative excess returns are later offset by more positive ones. Confirming that visual inference, we show in Table 2A, statistical tests for the average excess cumulative returns over three different horizons of increasing length. These are the cumulative return from $t = 0$ to $t = 5$; from $t = 0$ to $t = 10$; and from $t = 0$ to $t = 15$.

Table 2A
Cumulative Excess Returns, Investigation Event

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Mean</th>
<th>Std. Error</th>
<th>t- Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 days</td>
<td>-0.0220</td>
<td>0.00605</td>
<td>-3.639</td>
<td>0.0003</td>
</tr>
<tr>
<td>10 days</td>
<td>-0.0.185</td>
<td>0.06322</td>
<td>-2.856</td>
<td>0.0046</td>
</tr>
<tr>
<td>15 days</td>
<td>-0.0.176</td>
<td>0.06570</td>
<td>-2.663</td>
<td>0.0082</td>
</tr>
</tbody>
</table>

As Figure 2 suggests, Table 2A strongly confirms that the negative excess returns on the day that a firm’s investigation for cartel activity is announced are lasting. While there is some recovery from the 2.2 percent cumulative loss of the first six days, it is relatively small. More than two weeks later, the loss still hovers near 1.8 percent.

Table 2B repeats the earlier standardized procedure of Table 1B for cumulative returns. Again, standardizing excess returns relative to the normal volatility in each alleged conspirator’s
returns only strengthens the significance of the findings. While the interpretation of these effects is less clear in terms of percentage losses, the sign is negative and highly significant. Thus an announcement of an official investigation for price-fixing is bad for a firm’s equity value.\footnote{These qualitative findings are in tune with the results of Günster and van Dijk (2012) for the EU case only. However, their quantitative magnitudes are larger, possibly because they use the simple CAPM model for the normal returns whereas we use the Fama-French 3-factor model that better captures additional systematic risks.}

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Mean</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Days</td>
<td>-1.1607</td>
<td>0.22971</td>
<td>-5.053</td>
<td>0.0000</td>
</tr>
<tr>
<td>10 Days</td>
<td>-0.8953</td>
<td>0.25994</td>
<td>-3.444</td>
<td>0.0007</td>
</tr>
<tr>
<td>15 Days</td>
<td>-0.9738</td>
<td>0.31730</td>
<td>-3.069</td>
<td>0.0024</td>
</tr>
</tbody>
</table>

The foregoing analysis treats the news event as the date that investigation for cartel behavior is first announced. In principle, the event relevant for testing \textit{Hypothesis 1} could instead be the date at which the case is officially closed and any settlement has been reached. However, to the extent that the announcement is itself sufficient to end any price-fixing activity and/or such announcements are typically followed by some settlement and associated monetary penalties it will be quickly reflected in the firm’s share price if financial markets are informationally efficient, see e.g. Malkiel (2003). In that case, the subsequent realization of the settlement and case closure should have little impact on the firm’s share price and return as that impact has already been registered earlier at the date of the announced investigation.

Tables 3A, 3B, 4A and 4B repeat the statistical analysis above on daily and cumulative excess returns with the event date now taken to be the final date of case closure and settlement. As noted earlier, this reduces the sample size to 160. These tables consistently show that there is little excess share price movement at this later, case-closing date. This implies that the costs
associated with the enforcement of antitrust cartel laws are priced into a firm’s share price at the
date investigation of such behavior is announced and not before. Indeed, the fact that there is no
positive excess return at the settlement date is further evidence that the negative excess returns
observed when the investigation is announced are not subsequently reversed. While not the
object of this study, it is worth noting that these finding offer some supportive evidence in favor
of the informational efficiency of the financial markets. Market participants appear to price into
a firm’s price all anticipated profit loss from either cartel breakup, legal fines, or both as soon as
news that the firm is under investigation is announced.

Table 3A
Daily Excess Returns, Settlement Event

<table>
<thead>
<tr>
<th>Day</th>
<th>Mean</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-value</th>
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</thead>
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Table 3B
Daily Excess Returns, Settlement Event,
Standardized Relative to Stock Return Volatility

<table>
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<tr>
<th>Day</th>
<th>Mean</th>
<th>Error</th>
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<td>-1.501</td>
<td>0.1345</td>
</tr>
</tbody>
</table>
3.3 Impact of Leniency

Since 1993, a corporation has been able to avoid criminal convictions and fines (though not damages) despite being party to a price-fixing conspiracy prosecuted the U.S. Department of Justice if it is the first member of the cartel to confess to the authorities and cooperate fully with the subsequent investigation. Somewhat similar leniency provisions have since been introduced in Canada and Europe. In this connection, it is possible that the financial market reaction to the announcement of a price-fixing investigation may be different for firms that are confessing and obtaining leniency from that for other non-confessing conspirators.

Two reasons that the financial markets may differentiate between the first confessor and the other members of the cartel are the obverses of the reasons that that there may be a price reaction for non-leniency seeking firms. One is that the leniency-receiving firm will not be saddled with the criminal fines that its co-conspirators will pay. The other is the likelihood that the first confessor may well be that firm for which the cartel generated little extra profit implying that the cartel’s end will not impose much cost. There is however a counter to such arguments. This is the fact that in the United States, the name of the leniency recipient is not formally released. In
Europe and Canada, it is released but only after some delay. To be sure, seasoned observers and those with inside information may well know the identity of informants despite such information suppression. Whether and how this information reaches the financial markets at the time of the investigation announcement though remains an open question.

Among the 253 colluding firms used in this study, the PIC data set identifies 37 leniency recipients (19 in the US and 18 from Europe and Canada). This is a relatively small sample. Moreover, the award of leniency in the US differs from that in Europe. In the former, leniency amounts to amnesty and is essentially a 100 percent immunity against antitrust penalties. It is also limited to the first conspirator to come forward and confess. In Europe, neither of these features holds. Leniency can be less than 100 percent and it is not limited to the first firm alone. Despite these qualifications, it seems worthwhile trying to ascertain some measure of the impact of leniency by running the event study separately for the two groups—the 37 firms that received any leniency recipients and the remaining non-leniency recipients. The results of this analysis for the event window defined as the investigation announcement are shown in Tables 5A and 5B below.

<table>
<thead>
<tr>
<th>Day</th>
<th>Mean</th>
<th>Std. Error</th>
<th>t-Statistic</th>
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<td>0.00371</td>
<td>0.00353</td>
<td>1.054</td>
<td>0.2991</td>
</tr>
</tbody>
</table>
Table 5A
Non-Leniency Recipients
Daily Excess Returns, Investigation Event

<table>
<thead>
<tr>
<th>Day</th>
<th>Mean</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-0.00466</td>
<td>0.00198</td>
<td>-2.356</td>
<td>0.0194</td>
</tr>
<tr>
<td>1</td>
<td>-0.00827</td>
<td>0.00263</td>
<td>-3.146</td>
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</tr>
<tr>
<td>2</td>
<td>-0.00440</td>
<td>0.00232</td>
<td>-1.894</td>
<td>0.0596</td>
</tr>
<tr>
<td>3</td>
<td>-0.00315</td>
<td>0.00156</td>
<td>-2.022</td>
<td>0.0444</td>
</tr>
<tr>
<td>4</td>
<td>-0.00144</td>
<td>0.00187</td>
<td>-0.773</td>
<td>0.4406</td>
</tr>
<tr>
<td>5</td>
<td>-0.00310</td>
<td>0.00152</td>
<td>-2.040</td>
<td>0.0426</td>
</tr>
</tbody>
</table>

Tables 6A and 6B repeat the leniency/no-leniency comparison for the case of cumulative returns over longer event windows.

Table 6A
Leniency Recipients
Cumulative Excess Returns, Investigation Event

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Mean</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Days</td>
<td>-0.0046</td>
<td>0.00962</td>
<td>-0.479</td>
<td>0.6349</td>
</tr>
<tr>
<td>10 Days</td>
<td>-0.0082</td>
<td>0.01415</td>
<td>-0.559</td>
<td>0.5800</td>
</tr>
<tr>
<td>15 Days</td>
<td>-0.0027</td>
<td>0.02415</td>
<td>-1.100</td>
<td>0.2788</td>
</tr>
</tbody>
</table>

Table 6B
Non-Leniency Recipients
Cumulative Excess Returns, Investigation Event,

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Mean</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Days</td>
<td>-0.02502</td>
<td>0.00688</td>
<td>-3.634</td>
<td>0.0003</td>
</tr>
<tr>
<td>10 Days</td>
<td>-0.01975</td>
<td>0.00697</td>
<td>-2.832</td>
<td>0.0051</td>
</tr>
<tr>
<td>15 Days</td>
<td>-0.01954</td>
<td>0.00792</td>
<td>-2.447</td>
<td>0.0152</td>
</tr>
</tbody>
</table>

The results in Tables 5A – 6B tend to confirm Hypothesis 2. While the sample of leniency recipients is small there is still surprisingly strong evidence that the financial markets do discriminate between the confessing firms, on the one hand, and their co-conspirators, on the other. Specifically, while the impact of announcing that a firm is under investigation for illegal price-fixing results in a significant equity loss for those firms not confessing, it appears to have
little or no impact on those firms that receives leniency. Again, the small sample size of the leniency-receiving group suggests caution in interpreting this result.

Yet if we cannot be completely confident that leniency recipients avoid the negative share price consequences of publicly revealed price-fixing activity, the results do confirm our earlier findings that non-leniency firms do suffer these consequences. Indeed, removing the non-effect for the leniency recipients indicates that for the non-confessing conspirators, the stock price drop following announcement of a cartel investigation is now a bit even more substantial. The estimated excess return for these firms over the first few post-event days now falls to 2.5 percentage points. There is as before, a small bounce back subsequently but the loss is still nearly two percent two weeks after the announcement at the close of the event window.  

The fact that those firms first to confess and receive leniency appear to be exempt from negative consequences in the financial market is noteworthy for a number of reasons. First, it implies that the markets must regard the presumptive end of the cartel as having little effect on these profits of these firms, at least. As noted above, this implies in turn that it is likely those firms that gain least from cartel participation that pursue the leniency option. Second, as the leniency recipients are typically not identified by the Justice Department, it seems clear that the markets nonetheless make that determination and price firm securities accordingly. Lastly, the sharp difference between the market’s reaction to non-leniency and leniency firms may give a strong incentive for firms to confess once an investigation is initiated. In turn, this can have important implications for the stability of the cartel and hence, to the ability to form a cartel in the first place. We return to this point later.

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13 We do not show the results for the event defined as the settlement date. As may be inferred from the earlier results, there is no discernible effect of the settlement on either those firms receiving leniency or those that do not.
14 Bosch and Eckard (1991) suggest a third force reflecting negative signals that the announcement generates regarding the firm’s honesty or customer relations. See also Werden and Simon (1987), and Buccirossi and Spagnolo (2007).
4. What is the Source of the Equity Loss?

We have provided evidence that (at least) non-leniency recipient firms suffer a sizable equity loss with the announcement that they are being investigated for cartel behavior remains unclear. Yet the source(s) of that loss remain unclear. One possibility is that the cost of the likely fines and subsequent legal settlements that the market anticipates in the wake of such an announcement are capitalized into the current stock price. Certainly, we would expect such capitalization in an efficient market. Yet even without discounting, the total of all fines and penalties recorded in the PIC data set across all three jurisdictions (US, Canada, and Europe) is just $34 million on average. This is dwarfed by the average equity loss, which is over three times as large. Indeed, looking only at the non-leniency firms, the ratio of fines and penalties to equity loss is only 0.29 on average. Moreover, this falls to 0.116 if we exclude both those cases in which the fines and penalties were either zero (fairly common) or larger than the equity loss itself (quite rare). Since the fines and penalties are typically not paid for at least a year and often more than three years after the investigation announcement any discounting would reduce these ratios still further. In short, the capitalized value of the anticipated fines and penalties can at most count for a bit less than one-third of the equity loss that the non-leniency firms suffer and probably less than one fourth of that loss with any plausible discount factor.

If anticipated fines and penalties can account for only 30 percent or so of the equity value loss associated with publicly revealed price fixing, the immediate suggestion is that the remaining 70 percent primarily reflects the loss of cartel profit that the end of the collusion implies. Is this the case?

To address the foregoing issue, we return to the PIC data. Included in these data is a measure of the so-called, Overcharges, defined as the product of the cartel’s output, $Q^M$, and the difference
between the cartel price \(P^M\) and the pre-cartel or “but for” price \(P\), i.e., Overcharges = \((P^M - P)Q^M\).

This is an estimate of the extra amount consumers actually paid as a result of the cartel.

The Overcharge Rate \(k\) is the ratio of overcharges to cartel sales corrected for the inflated cartel price. That is, if cartel sales equal \(P^M Q^M\), then cartel sales corrected for the artificially high cartel price may be defined as \(P^M Q^M - (P^M - P)Q^M\).

Hence, the Overcharge Rate is given by:

\[
k = \frac{\left(\frac{P^M}{P} - 1\right)Q^M}{P^M Q^M - (P^M - P)Q^M} = \frac{P^M - P}{P^M Q^M - (P^M - P)Q^M}
\]  

(3)

Let \(Q^M\) be the cartel total output and \(Q\) be pre-cartel output. Hence, if \(\varepsilon\) is the elasticity of demand, \(Q^M = (1 - \varepsilon k)Q\). Also, define the pre-cartel price markup \(\mu\) such that:

\[
P = (1 + \mu) c
\]  

(4)

The pre-cartel profit may then be expressed as:

\[
\text{Pre-Cartel Profit} = \pi = (P - c)Q = cQ
\]  

(5)

The cartel profit is \((P^M - c)Q^M\) is:

\[
\text{Cartel Profit} = \pi^M = (P - c)Q^M = \left[(1 + k)(1 + \mu) c\right]Q^M = \left[k(1 + \mu) + \mu\right]cQ^M(1 - k)
\]  

(6)

It follows that the cartel-generated increase in profit is given by:

\[
(\text{Cartel Profit}) - (\text{Pre-Cartel Profit}) = \left[(1 + k)(1 + \mu) + \mu\right]kcQ
\]  

(7)

Hence, the ratio of the cartel-generated profit increase relative to the cartel overcharges is:

\[
\frac{\text{Overcharges}}{\text{Overcharges}} = \frac{\left[(1 + k)(1 + \mu) + \mu\right]kcQ}{(1 + k)(1 + \mu)kcQ} = 1
\]  

(8)

If the pre-cartel pricing is competitive \(\mu = 0\), the Overcharges would then also be an estimate of the extra profit the cartel generated. To the extent that the pre-cartel setting was one of less than perfect competition, the Overcharges serve as an upper bound on cartel-generated profits.

The PIC data provide estimates of both the Cartel Overcharges and the Overcharge Rate \(k\). In our data, \(k\) is close to 0.3. To be conservative, we round this down a bit to \(k = 0.25\), which is the

---

In the PIC data set, these are referred to as Competitive Sales.
median value found by Connor (2004). The relationship in (8) may then be used to generate estimates of the cartel-generated profit increase and assuming various values for the pre-cartel markup \( \mu \) and the demand elasticity \( \varepsilon \). In turn, the annualized value of these profits serves as an estimate of the yearly loss in profit due to termination of the cartel.\(^{16}\)

The present value of the annualized profit loss depends of course on the expected duration of the cartel in the absence of exposure. Levenstein and Suslow (2002) find that the average duration of a sample of cartels from the 1990’s is five years. For the cartels studied here, we find that the mean duration up to the investigation announcement is closer to eight. Thus, it seems prudent to assume that the cartels in our data would have lasted at most three years in the absence of official investigation.

We therefore take our estimates of the annual cartel-generated profit discount these using a 12 percent required return factor over horizons of one, two, and three years. We then divide these present value estimates by the firm’s equity loss less its fines and penalties. If the ratio is 1, then the equity decline is roughly accounted for by the profit loss due to the cartel’s termination. If it is less than one, the implication is that the cartel loses more with the ending of the cartel than can be explained by lost cartel profits and fines and penalties, perhaps reflecting other factors such as the decline in customer relations or perhaps trust as suggested by Bosch and Eckard (1991). Conversely, if the ratio exceeds one, it suggests that the equity loss that firms suffer, real though it may be, is less than the loss in extra profits from the cartel.

Tables 7, 8, and 9 below show the sample average values for the ratio just described, again assuming a 12 percent required yield and a 1-to-3 year horizon under different assumptions regarding the pre-cartel markup \( \mu \) and the demand elasticity \( \varepsilon \).

\(^{16}\)The ratio in equation (8) relies on the approximation that \( \ln(1+x) \approx x \). In our simulations, this approximation breaks down when \( \varepsilon, \mu \) and \( k \) grow large. For these cases, we use a more exact calculation based on a constant elasticity demand function \( Q = ZP^{-\varepsilon} \).
Table 7
Ratio of Present Value of Annualized Cartel-Generated Profits Relative to Equity Loss less Fines and Penalties
Cartel Overcharge Rate $k = 0.25$
Cartel Continues for 1 Year
Discount Factor = $1/(1.12)$

<table>
<thead>
<tr>
<th>Pre-Cartel Markup</th>
<th>Elasticity</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.8673</td>
<td>1.8673</td>
<td>1.8673</td>
<td>1.8673</td>
<td>1.8673</td>
<td>1.8673</td>
<td></td>
</tr>
<tr>
<td>0.05</td>
<td>1.8254</td>
<td>1.7784</td>
<td>1.7259</td>
<td>1.6672</td>
<td>1.6016</td>
<td>1.5283</td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td>1.7872</td>
<td>1.6975</td>
<td>1.5974</td>
<td>1.4854</td>
<td>1.3601</td>
<td>1.2201</td>
<td></td>
</tr>
<tr>
<td>0.15</td>
<td>1.7523</td>
<td>1.6237</td>
<td>1.4800</td>
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<td>0.9375</td>
<td>0.6809</td>
<td></td>
</tr>
</tbody>
</table>

We do not view these results as definitive given that the underlying estimates are rough. Yet, we do think that they are highly suggestive, particularly regarding one critical result. This is that, given the estimated Overcharges, the equity loss exclusive of penalties and fines will only equal the present value of lost cartel profits if: 1) the cartel’s expected further life is short; 2) the demand elasticity is 2 or greater; and 3) the markup in the absence of a cartel is 10 percent or more.

None of the above three conditions is an unreasonable assumption. It may well be that investors typically foresee the unmasked cartel as only having a year or so more given that it has, on average, already lasted eight years at the time of official investigation. Indeed, the fact of discovery may slant investor expectations in this shorter direction. Likewise, an industry elasticity of 2 or more and a pre-cartel markup of 10 percent or more are also not unrealistic. Yet
unless all three conditions are met, the equity loss suffered with the announcement of an investigation for cartel activity, serious though it may be, is an underestimate of the loss of profits due to termination of the cartel.

Table 8
Ratio of Present Value of Annualized Cartel-Generated Profits Relative to Equity Loss less Fines and Penalties
Cartel Overcharge Rate $k = 0.25$
Cartel Continues for 2 Years
Discount Factor = $1/(1.12)$

<table>
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<tr>
<th>Pre-Cartel Markup</th>
<th>Elasticity</th>
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<th>1</th>
<th>1.5</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
</tr>
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<tbody>
<tr>
<td>0</td>
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<td>3.5345</td>
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<tr>
<td>0.05</td>
<td>3.4551</td>
<td>3.3662</td>
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</tr>
<tr>
<td>0.15</td>
<td>3.3169</td>
<td>3.0735</td>
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<td>2.1571</td>
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</tr>
<tr>
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<td>2.5978</td>
<td>2.2091</td>
<td>1.7745</td>
<td>1.2886</td>
<td></td>
</tr>
</tbody>
</table>

Table 9
Ratio of Present Value of Annualized Cartel-Generated Profits Relative to Equity Loss less Fines and Penalties
Cartel Markup $k = 0.25$
Cartel Continues for 3 Years
Discount Factor = $1/(1.12)$

<table>
<thead>
<tr>
<th>Pre-Cartel Markup</th>
<th>Elasticity</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
</tr>
</thead>
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<td>5.0231</td>
<td>5.0231</td>
<td>5.0231</td>
<td>5.0231</td>
<td></td>
</tr>
<tr>
<td>0.05</td>
<td>4.9102</td>
<td>4.7839</td>
<td>4.6427</td>
<td>4.4849</td>
<td>4.3084</td>
<td>4.1112</td>
<td></td>
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<tr>
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<td>4.8075</td>
<td>4.5665</td>
<td>4.2970</td>
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<td></td>
</tr>
<tr>
<td>0.15</td>
<td>4.7138</td>
<td>4.3679</td>
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<td>2.5218</td>
<td>1.8313</td>
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</tr>
</tbody>
</table>
There are of course responses to the finding that the market reaction to news of a cartel investigation seems to underprice the value of the lost cartel profits and accompanying fines. One possibility is that estimated Overcharges in the PIC data may be too high. Alternatively, one can argue that the equity loss reflects the market’s probabilistic assessment that the investigation will lead to successful prosecution and a fine.\textsuperscript{17} Even in that case, the market may suspect that the cartel will reform later or otherwise have lasting effect on profits so that the capitalized Overcharges again overestimate the value of income lost. In this light, a back-of-the-envelope calculation suggests that the equity loss associated with an announcement of price-fixing investigation reflects a market guess that there is only a 33\% chance that the cartel will end and that the relevant fines will be paid. An alternative, but roughly equivalent interpretation is that the true Overcharges are just 30 percent of those reported in the PIC data. Either of these two interpretations however lend further support to the proposition that antitrust enforcement provides only a weak disincentive to participate in a cartel unless the penalties are augmented, as they are in the US, by the possibility of imprisonment for participating executives.

However, the deterrent effect of antitrust enforcement does not work solely via a Becker-like (1968) calculation of gains and losses. It can also work through its impact on the stability of the cartel and the incentive for firms to cheat on the cartel agreement, as first emphasized by Motta and Polo (2003). It is worthwhile to consider such effects here in the light of our results.

To this end, we imagine a timing framework in which firms make a decision \( t \) to enter into and abide by a price-fixing agreement starting in period \( t \). Given antitrust policy, there is a probability \( \alpha \) that the cartel will be detected and end in period \( t+1 \), which we assume leads to a fine \( F \) and resumption of non-cooperative pricing and profit \( \pi \). Otherwise, the firm earns \( \pi^M \) now

\textsuperscript{17}Note however that in the PIC data set, nearly 64 percent of all firms under investigation ultimately pay a fine.
and then faces the prospect of being detected in the next period and so on. Thus, if a firm joins a cartel the present value of its profit gain $VG^M$ must satisfy:

$$VG^M = \pi^M + \delta VG'$$

where $VG'$ satisfies:

$$VG' = \alpha \left( \frac{\pi}{1-\delta} - F \right) + (1 - \alpha)(\pi^M + \delta VG') \rightarrow VG' = \frac{\alpha \left( \frac{\pi}{1-\delta} - F \right) + (1 - \alpha)\pi^M}{1-\delta(1-\alpha)}$$

From this, it follows that:

$$VG^M = \frac{\pi^M + \delta \alpha \left( \frac{\pi}{1-\delta} - F \right)}{1-\delta(1-\alpha)}$$

Alternatively, the firm can decide to cheat on the cartel and earn the deviational profit $\pi^D$ for one period after which all firms revert to non-cooperative pricing. In this case, the present value of current and future profits is $V^D$ given by:

$$V^D = \pi^D + \frac{\delta \pi}{1-\delta}$$

Successful collusion requires that the incentive constraint $VG^M \geq V^D$, i.e., that:

$$\delta \geq \frac{\pi^D - \pi^M}{(1-\alpha)(\pi^D - \pi^M) - \alpha F}$$

If $\alpha = 0$ (no antitrust enforcement), equation (13) becomes the textbook discount factor required for successful collusion. For any value, $0 < \alpha < 1$, it is easy to see that a higher fine $F$ makes collusion more difficult by raising the required discount factor (or lowering the interest rate) needed for cartel stability. The substantive issue then becomes whether this effect is sufficiently large that it compensates for the apparent lack of a serious disincentive to collusion based solely on the benefits and costs as presented above.

From equations (5) and (6), we may write non-cooperative profits as:

$$\pi = \theta \pi^M; \text{ where } \theta = \frac{\mu}{(k(1+\mu)+\mu)(1-\varepsilon k)}$$
We now write the deviation profit $\pi^D$ as $\pi^D = \phi \pi^D$ with $\phi > 1$. For example, in a simple $n$-firm Bertrand model, $\phi = n$, as the cheating firm would capture the entire market with only a tiny price cut below the collusive level. With these amendments, equation (13) becomes:

$$\delta \geq \frac{(\phi - 1)\pi^M}{(1 - \alpha)(\phi - \theta)\pi^M - \alpha F}$$

(15)

Consider then a “middle” case from above in which we anticipate the cartel is anticipated to last an additional two years in the absence of any investigation and in which we assume parameter values of: $\mu = 0.15; k = 0.25;$ and $\varepsilon = 2$. In this case, we then have $\theta = 0.686$. In addition, if we assume an actual discount factor of $\delta = 1/(1.12) = 0.893$; then the PIC data indicate that $F = 0.089 \pi^M$.\(^{18}\) Hence, for these values, equation (15) implies:

$$\delta \geq \frac{(\phi - 1)}{(1 - \alpha)(\phi - 0.686) - \alpha 0.089}$$

(16)

Werden and Simon (1987) assume that the detection rate $\alpha = 0.10$ while Buccirossi and Spagnolo (2007) regard the slightly higher ratio of $\alpha = 0.15$ as more prudent. However, in their analysis they effectively equate detection (or investigation) to successful prosecution. Since this is unlikely to be the case in practice, we err a bit on the side of caution and set $\alpha = 0.125$. Table 10 then shows the discount factor required for cartel stability under different values of the demand elasticity and the gains from cheating on the cartel $\phi$ relative to the level of cartel profit $\pi^M$.

<table>
<thead>
<tr>
<th>$\phi$</th>
<th>Elasticiy</th>
<th>1.5</th>
<th>1.75</th>
<th>2</th>
<th>2.25</th>
<th>2.5</th>
</tr>
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<td>0.5324</td>
<td>0.5966</td>
<td>0.7060</td>
<td>0.9345</td>
</tr>
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<td></td>
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<tr>
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<td>0.9907</td>
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</tbody>
</table>

The rough calculation is straightforward. Consider for example a “middle-of-the-road” case from Table 8 with a pre-cartel markup of $\mu = 0.15$; and an elasticity of $\varepsilon = 2$. Our analysis of the Overcharges suggests that 70 percent of the equity loss, $0.7EL = (1/2.5)(\delta + \delta^2)(\pi^M - \pi)$. We also have that $\delta \approx 0.893$, and from equation (14), $(\pi^M - \pi) = (1 - \theta)\pi^M$, as well as the empirical finding that the typical fines and penalties are about 30 percent of the equity loss, $F = 0.3EL$. Substitution then yields: $F = (0.3/0.7)(1.69/2.5)(1 - \theta)\pi^M$.\(^{18}\)
Recall that the values in Table 8 assumed an actual discount factor of $1/1.12 = 0.893$. The green-shaded cells in Table 10 are those that imply that the discount factor needed for successful collusion exceed this assumed value and hence, that cartelization is not plausible. Generally speaking, the analysis suggests that collusion is feasible unless either a deviating firm can greatly increase (often double) the profit earned by cooperating or, again, demand is relatively price elastic. Our own view is that given capacity constraints as well as the firm’s hope that its non-cooperative exploitation of the cartel’s reduction in output will remain undetected for some time, it seems unlikely that a deviating firm would double its collusive profit. Accordingly, we see the results shown in Table 10 as mainly confirming our earlier findings that the financial penalties price-fixing firms incur are not likely to deter them from such activities unless the price elasticity of demand is fairly high.

At the same time, it is worth noting that the foregoing results are fairly sensitive to the parameters chosen. In particular, a somewhat higher value of the detection parameter $\alpha$, say $\alpha = 0.15$, would greatly increase the range of feasible collusion to more than half of the table cells. This is relevant given our earlier tentative finding that leniency recipients suffer so little financial penalties when a price-fixing investigation is announced. That finding implies a very large gain to seeking leniency. In turn, the emergence of a confessing firm that cooperates with the authorities serves to raise the likelihood that an investigation leads to a conviction.\(^{19}\)

We therefore interpret our overall findings as follows. First, consideration of the incentive and stability implications of current antitrust policies yields somewhat ambiguous results

\(^{19}\)As Motta and Polo (2003) note, generous leniency policies are a two-edged sword that can induced collusion as well as deter it by giving colluders an “escape route” from prosecution. However, to the extent that leniency is limited to the first confessing firm, the expected fine in an all-confess equilibrium is $n/(n-1)F$. For cartels of three or more firms, this may well be enough to destabilize the cartel when the probability of detection and conviction is high.
regarding the ability of such current policies to deter cartel formation. Some such deterrence though is likely at work (at least in some cases) and this may effect may be more powerful than earlier suspected given what appears to be a strong incentive for colluding firms to confess and seek leniency if an investigation is announced. Second, and despite these findings, it is evident that many firms still do manage to enter into collusive arrangements. For those firms that overcome the stability obstacles to collusion, the payoff is large. The equity loss at the time that an investigation is announced is less than the sum of lost cartel profits plus anticipated fines and penalties. Moreover, even if these magnitudes were roughly equal, this still leaves untouched the extra profits earned over the cartel life up to the investigation date. As noted, this duration averages eight years in our sample. The average profit from collusion can be substantial over this long a time period.

5. Summary and Conclusion

An event study is a useful way to isolate the financial markets' reaction to “news” regarding a firm’s fundamentals by comparing equity returns predicted by an estimated return-generating process with the actual returns at the time of the event. In this paper, we have focused on “news” that the firm is under investigation for price-fixing behavior. Unlike most prior event studies that rely on a single factor model such as the Capital Asset Pricing Model to generate expected returns, we use the richer three-factor model suggested by Fama and French (1993).

We find that firms experience a significant fall in their market value once they are identified as under investigation for illegal collusion. Specifically, these firms (or their parents) suffer average abnormal return of about negative two percent of their equity value in the four to five days immediately following the announcement. While a small part of this loss is later recovered, the loss still stands close to that level even two weeks later. This is especially the case for the
vast majority of firms that do not seek and receive leniency by being an early confessor. Interestingly, those cartel members that confess first and receive criminal leniency as a result appear not to suffer any negative return at the time the investigation is announced, though the small number of observations we have for this group implies caution in interpreting this finding.

While we find that the announcement of a price-fixing investigation has serious stock market consequences for the affected firms, the size of that impact is notably less than that found in other recent studies such as Aguzzoni, Langus and Motta (2013) and Günster and Van Dijk (2012). This may reflect our use of a three-factor return generating function as opposed to the simple one-factor CAPM model these authors use. In addition, we focus on firms trading on US security markets rather than the mainly European firms that comprise the data for these studies.

The source of equity loss we find is not the anticipation of fines and penalties. Consistent with other studies, [see for example the survey in Connor and Lande (2012)], we find that such court-based expenses account for at most 30 percent of the total equity loss. However, unless demand is relatively elastic, the pre-cartel markup is high, and anticipated life of the cartel in the absence of investigation is short, the observed equity loss (net of fines and penalties) also seems notably less than the discounted value of the cartel profits that will no longer be earned. Even when those conditions are met, the profits earned during the cartel’s successful operation are left undiminished. By itself, this would suggest that antitrust enforcement may provide little deterrence to firms to participate in collusive behavior, unless fines are accompanied by the possibility of imprisonment.

However, deterrence also works by raising the discount factor needed to prevent colluders from cheating on their agreement. Our evidence on this score is more mixed. In general, unless demand is fairly elastic or unless deviating firms earn a very substantial increase in profit relative to that earned by colluding, the deterrent effect operating this effect also seems weak. Yet this
conclusion is sensitive to various parameter assumptions. Most notably, the tentative evidence that leniency recipients escape collusion with very little cost suggests a strong incentive to confess. In this case, the ability of the authorities to prosecute successfully may be sufficiently large that policy provides substantial deterrence even without the threat of jail terms.

6. References


________, Private International Cartels spreadsheet by John M. Connor, Purdue University, Indiana, USA (July 2014)


