# The Effects of Antitrust Enforcement Events on a Cartel Member's Stock Return and An Empirical Study of Characteristics of Firms Receiving Full Immunity

**A thesis**

**Submitted by**


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**Abstract**

Investigation into the deterrence effect of antitrust penalties on collusive behavior has evolved significantly since the early work of Werden (1989). While it is now recognized that the ability of fines to disrupt the "no deviation" conditions necessary for successful collusion means that effective deterrence does not require fines as large as the expected collusive profit, the question of how great the disincentive for collusion is remains. In this paper, I examine a separate channel, namely, stock market reaction to price-fixing revelations. In this area, event study methodology has been quite formal and standard, thus I use this method by choosing two separate events relating to the investigation and conviction of a cartel member. On the other side, as many of the recent cartels have been discovered due to the confession by a cartel member under the Justice Department's leniency program, I also investigate the characteristics of those firms receiving leniency. The latter study is based on the model Marvao (2012) built in her study but adding several financial variables.

**Acknowledgement**

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## 1. Introduction

In this paper, I examine the impact on a firm's share price of being named as a potential conspirator in a price-fixing cartel. For this purpose, I use an event-study methodology that treats such a revelation as "news" that may generate abnormal price changes and equity returns. In this view, the paper can be seen as part of the Efficient Markets Hypothesis (EMH) literature that measures the speed with which market prices incorporate new information.[1]

However, the analysis is also closely tied to two strands in the literature on cartels. One is the empirical question that was indirectly raised by Harberger (1954) in his more general analysis of the impact of non-competitive pricing across the national economy in general. The narrower version of that question relevant to the study here is the extent of the price-raising and welfare loss effects of cartel behavior. The second and related issue has to do with the appropriate legal penalty for those that violate price-fixing statutes. To the extent that the market reaction to exposure and the presumed end of a cartel provides a dollar measure of the cartel's profit, it also indicates how large the fines must be for effective deterrence.

This paper provides evidence on both issues. To preview the main results briefly, I find that the announcement that a firm is under investigation for price-fixing behavior typically leads to a reduction in the share price of that firm or (if it is a subsidiary) its parent of 1.5 to 2 percent. At least half of this dollar drop cannot be accounted for by fines, suggesting that the remaining dollar value reflects the fall in profits that results from ending the cartel.

I also find that the market differentiates between those announced colluders who actually were either the first (in US cases) or among the first (in European cases) to confess and therefore to receive leniency (In this thesis, I'm only focusing the leniency recipients who get full immunity). As the identities of these firms are not released in the US and are only known with

[1] See, for example, Malkiel (2003).

some delay in Europe, this finding indicates that the financial markets are very good at discovering this information. Consistent with the view that the profit-reduction from ending the cartel is an important source of the fall in the equity price of a firm accused of price-fixing, I find that the firms confessing and applying for leniency tend to be the least profitable cartel members. Thus, I find that the share price of these firms, unlike those that do not confess, is largely unaffected by official announcements that they are under investigate for price-fixing.

I review some of the related literature in Section 2. In Section 3, I describe the data and empirical strategy more fully. The basic empirical results regarding share price reactions are presented in section 4. Section 5 briefly examines the issue of which firms apply for leniency. Section 6 provides a brief summary and some conclusion remarks.

**2. Background and Related Literature**

The gains to a firm from participating in a price-fixing cartel are obvious. The suppression of competition permits a higher price-cost margin and greater profits for the duration of the cartel. There are also potential costs. These included criminal fines and civil damages as well as potential loss of reputation and other intangible penalties. The net gain therefore must weigh the value of the extra profit against the value of the potential costs. Efforts to measure both of these factors, and therefore the deterrence effect of antitrust policy, have been an important research goal for 25 years or longer.

Efforts to measure systematically the impact that cartels have on prices relative to those that would exist in the absence of collusion have a long history. A relatively early starting point is the analysis of Werden and Simon (1987) that proposed that a conservative estimate of the average price markup generated by collusion relative to the non-collusive price is ten percent. Posner (2001), in his review of 12 cartels found a median price increase of 38 percent. Levenstein and Suslow (2006) review 22 cartels and find a median price increase of 44 percent.

In what may well be the most complete meta-study reviewing all other analyses and covering over 1500 estimates of cartel overcharges, Connor and Lande (2012) find that since 1974, cartels have typically raised prices on the order of 15 to 39 percent with national cartels typically at the lower end international cartels usually at the higher end of this range.

Estimates of the cartel price effects and the profit gains they generate lead naturally to a consideration of effective deterrence strategies. Broadly speaking, there are two approaches to this issue. The first is built on the rational crime behavior of Becker (1968). This analysis essentially weighs the gain from the cartel against the expected loss. Let $m$ be the pre-cartel markup over marginal cost $c$; $k$ be the cartel markup from the pre-cartel price $P$; ε the elasticity of demand; and $q$ the member firm's pre-cartel output. Thus, the cartel price $P^M = (1+k)P = (1+k)(1+m)c$ and the firm's cartel output is: $q^M = (1-\varepsilon k)q$. Hence, the profit gain due to participating in the cartel is:

$$\pi^M - \pi = \left[(1+k)(1+m)c - c\right](1-\varepsilon k)q - \left[(1+m)c - c\right]q$$

$$= qkc\left[(1+m)(1-\varepsilon k) - \varepsilon m\right] \qquad (1)$$

Let ρ be the probability of a cartel member being caught by the authorities and let $f$ be the fine if caught expressed as a fraction of the cartel revenue, $P^M q^M = qc(1+m)(1+k)(1-\varepsilon k)$. Then the expected fine is:

$$\text{EXPECTED FINE} = \rho f qc(1+m)(1+k)(1-\varepsilon k) \qquad (2)$$

If the fine is to be sufficient to deter participation in a price-fixing cartel, then (2) must be as large as (1). This requires:

$$f = \frac{k\left[(1+m)(1-\varepsilon k) - \varepsilon m\right]}{\rho(1+m)(1+k)(1-\varepsilon k)} \qquad (3)$$

As a prudent example based on the data reviewed above, suppose that the pre-cartel markup $m = 0.1$;that the post-cartel markup $k = 0.15$; that the elasticity of demand $\varepsilon = 2$; and that the probability of detection is $\rho = 0.15$. Then the deterrent fine $f$ expressed as a fraction of the cartel revenue is approximately 0.64. That is, the fine would have to be 64 percent of the cartel revenues over the life of the cartel. If we consider the evidence in Levenstein and Suslow (2011) and Combe and Monnier (2011) that cartels last about five to seven years on average, then the necessary fine would need to be on the order of 320 to 450 percent of one-year's revenue.

Actual fines are rarely as large as the deterrent fine indicated by (3). In 64 cases reviewed by Combe and Monnier (2011), only once was the fine large enough to meet the deterrent standard imposed by equation (3). For the vast bulk of the fines considered, the norm was a fine equal to one-tenth or perhaps one-fifth of the deterrent fine implied by (3). This is essentially the source of Combe and Monnier (2011) argument that claims of antitrust over-enforcement are a myth.

However, the foregoing argument looks only at the participation condition on whether a firm would gain from participation in a cartel versus no cartel at all. It therefore ignores the fact that for any one firm, the choice is not between being part of a cartel and not having a cartel at all. It is between being part of the cartel and deviating or undercutting the cartel, which will usually lead to greater profits in the short run than not deviating. Thus, successful cartels have to overcome this deviation temptation as well. Motta and Polo (2003) and Bucirossi and Spagnolo (2007) are among the first to recognize that this incentive constraint is also affected by antitrust policy.

To see this more dynamic argument, let $\pi^m$= collusive profit per period and $\pi^c$ = competitive profit earned by a firm in the absence of a cartel. Then $\pi^m = M\pi^c$ with $M > 1$. Let $\pi^d$ = the one-period deviation profit for cheating on the cartel and assume that cartel members follow a trigger strategy such that if there is any such deviation, they all resort to competitive pricing. Let $R$ be a

discount factor equal to 1/(1+$r$) where $r$ is the relevant required rate of return. Then, the present value of the collusive profit stream V($\pi^m$) is given by $\frac{\pi^m}{1-R}$.

Given the assumed trigger strategy the present value of deviating is: $\pi^d + \frac{R\pi^c}{1-R}$. The incentive stability condition in this simple case is then

$$\frac{\pi^m}{1-R} > \pi^d + \frac{R\pi^c}{1-R}. \quad \text{Or:} \quad \frac{\pi^d - \pi^m}{\pi^d - \pi^n} < R \tag{4}$$

Matters change dramatically though if one now introduces an antitrust authority so that there is some probability $\rho$ that the cartel is discovered and, if so, cartel members pay a fine $F$. Let $V^m$ be the present value of the cartel profit if not caught. In the current period, with probability 1-$\rho$ a member firm goes undetected and gets $\pi^m$ and the collusive game starts again. The present value of this event is: (1-$\rho$)($\pi^m$+ $RV^m$). With probability $\rho$ however, the firm gets $\pi^m$ but the cartel is discovered and the firm pays a fine $F$, at which point we assume the industry reverts to the non-cartel equilibrium. The probability-weighted value of this event is: $\rho\left(\pi^m - F + \frac{R\pi^c}{1-R}\right)$. We then have the overall value for a firm that decides to participate in the cartel this period $V^m$ is

$$V^m = (1-\rho)\left(\pi^m + RV^m\right) + \rho\left(\pi^m - F + \frac{R\pi^c}{1-R}\right) \tag{5}$$

Solving for $V^m$ yields:

$$V^m = \frac{\pi^m - \rho F + \frac{\rho R\pi^c}{1-R}}{1-R(1-\rho)} \tag{6}$$

Again, this must be compared with the gains from deviating, $\pi^d + \frac{R\pi^c}{1-R}$. So, cartel stability requires

$$\frac{\pi^m - \rho F + \frac{\rho R \pi^c}{1-R}}{1-R(1-\rho)} > \pi^d + \frac{R\pi^c}{1-R} \tag{7}$$

To see the difference that this more dynamic approach can make, suppose that the competitive markup *m* in our earlier analysis and therefore $\pi^C$ above are both zero. Then that earlier analysis would imply a necessary fine *f* as a fraction of annual revenue of T

$$f = \frac{k}{\rho(1+k)} \tag{8}$$

If *k* and $\rho$ are both taken as before to be 0.15, the necessary *f* value is about 0.87 or 87 percent. Further calculation shows that in this case, a firm's cartel profit is about 13 percent of its cartel revenue.

Now assume that the profit of a firm that cheats on the cartel $\pi^D$ is 18 percent of the cartel level revenue. Then with $\pi^C = 0$, equation (7) implies:

$$\frac{\pi^m - \rho F}{1-R(1-\rho)} > \pi^d \tag{9}$$

If the discount factor *R* is 0.91, then the needed fine to destabilize the cartel is just 59 percent of cartel revenue. While this value is still large, it nevertheless illustrates the fact that antitrust detection and fines can have a much more powerful effect working through the cartel stability condition than simply offsetting the expected cartel profit gains.

This is where leniency can play a key role. To begin with, it can raise the probability of detections as the evidence in Miller (2009) suggests occurred in the U.S. Second, leniency could extended from an fine reduction for first-confessing firms to an actual positive reward as suggested by Bucirossi and Spagnolo (2007).

Whatever conceptual framework is used, it is clear that determination of optimal fines requires some measure of a price-fixing firm's profit. In this regard, the stock market reaction to price-

fixing charges should, if the EMH is correct, be helpful in obtaining such a measure. Broadly speaking, the response of the stock market should reflect two factors both of which should negatively impact the firm's share price. One is the prospect of legal expenses—criminal fines and civil damages. The other is the loss of the cartel profit assuming that detection forces an end to the price-fixing conspiracy. To the extent that I have a measure of the fines to be paid, I can get some measure of the value of the cartel profit lost.

I use the event study method to examine stock market reactions to price-fixing charges. The event study has long been a standard method to exam the effect of specific disturbance on a firm's market value since early work by Fama, Fisher, Jensen and Roll (1969). An early study that applies this approach to antitrust announcements Ellert (1975). Garbade, et al (1982) use daily observation of stock price to examine the market reaction to antitrust suits in general and not just price-fixing violations. Bosch and Eckard (1991) analyze the profitability of price-fixing activity and test stock price responses to Wall Street Journal announcement of authorization's (US DOJ) decision for indictment. Günster and Van Dijk (2012) study the efficiency of antitrust policy in Europe and test the stock market's reaction to several antitrust conducts including investigation announcement, infringement decisions and appeals.

The event study approach is not without potential problems. The normality of the daily stock returns is sometimes questioned [Brown and Warner (1980)]. Other possible problems include cross-sectional dependence; the potential for greater variance increases during the event period; and autocorrelation in return shocks over time. Some of these problems may be addressed fairly easily however. Thus, Gershon (1974) use the standardized average abnormal return to conduct more robust *t* tests. A general discussion of event study under the condition of event-induced variance could be found in the paper by Boehmer Musumeci and Poulsen (1991). Another approach is to use non-parametric tests. Corrado (1989) discusses the method of rank test for a one

day window especially at the event day. A comparison of testing power between non-parametric test and other tests are made by Cowan (1992).

As described more fully below, I use the daily observed stock returns to estimate over a 220-day period a model of normal stock price movements for each firm in the data set. I then look at actual returns during the event window. Comparison of these actual returns with those predicted by the estimated model then identifies any abnormal returns that may reflect the market's reaction to the price-fixing charges. In order to detect the impacts of events on stock return precisely, I report both the t-test significance of mean abnormal return and cumulative abnormal return as well as the standardized mean abnormal return and cumulative abnormal return. Standardization could be considered as a way to reduce the impact of heteroscedasticity. In the meantime, since the status of joining in the Leniency Program (LP) or not could have considerable influence on a Cartel member's total monetary loss, I also study how the impact of either event is affected by a firm receiving leniency.

There are four major hypotheses.

*Hypothesis 1*: A public firm involving in the cartel behavior will suffer significant stock return loss when the criminal action is announced.

*Hypothesis 2*: The effect of announcing price-fixing investigations (or settlements) on a firm's stock return may extend for several days as the market may take time to learn the full implications of the event but efficient markets will limit the time this takes.

*Hypothesis 3*: Firms receiving leniency may not witness such significant stock return declines comparing to those firm who do not.

*Hypothesis 4*: Firms applying for leniency are likely firms that do not receive large benefits from cartel participation, i.e., they tend to be less profitable members of the cartel.

## 3. Data and Event Study Methodology

In this section, I describe my data and the basic event study approach used.

*3.1 Data*

My data on cartel activity by firms are taken from the Private International Cartel (PIC) data set collected by Professor John Connor of Purdue University. This is an extensive data set that covers over 9000 firms participating over 500 cartels over the years 1984 to 2014. Stock price data are taken daily from Bloomberg database. I focus on 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. Some list only on foreign exchanges. Focusing on firms that avoid these limitations limit the sample to 253 observations on individual companies, using the date of announcement that the firm is under investigation as the event date.[2] Because a number of cases are still open and/or no penalty has been assessed, this number declines to 160 if the event date is chosen as the date the case closes and/or the first penalty is set. In either case, my data set 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 Event Study Model*

The standard event study approach, e.g., Brown and Warner (1985), Campbell and MacKinlay (1997) addresses the financial market's reaction to a specific event as measured by the movement in a firm's stock price in a window of time around the event. The "event" in this case is either: a)

[2]Often the companies listed in an 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, I use the stock price of the parent firm, as typically, the subsidiaries do not list on any exchange.

the announcement by antitrust authorities that a firm is being investigated for cartel activity; or b) the settling of a case and the possible payment of any criminal fines.[3]

Measuring the response of a firm's equity return to a specific event requires that one separate the return due to the event itself from the return due to other factors. Assuming that the event is, at least to some extent, unanticipated this is equivalent to identifying a stock's abnormal return during the window surrounding the event. This in turn requires identification of the normal return or the return that would have been expected in the absence of the event.

Let the event be the date that the firm is identified as being under investigation for cartel activity and define this date as $\tau$. I define a 31-day window that runs from $\tau$-15 to $\tau$+15.

To estimate the normal or expected return I use the Fama-French (1993) three-factor model. This differentiates this study from most earlier work that relies on a simple, one-factor model consistent with the original Capital Asset Pricing Model of Sharpe (1964). Specifically, I estimate the following equation for the daily return

$$R_{it} = \alpha_i + \beta 1_i R_{Mt} + \beta 2_i \mathrm{SMB}_t + \beta 3_i \mathrm{HML}_t + \varepsilon_{\mathrm{it}} \qquad (10)$$

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 $t$; $\mathrm{SMB}_t$ 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 capitalized values, again on day $t$; $\mathrm{HML}_t$ is a similar, day $t$ index of the premium on value firms with high book-to-market values; and $\varepsilon_{\mathrm{it}}$ is a random error term. Data for the three return-generating factors $R_{Mt}$ , $SMB_t$, and $HML_t$, are available at the on-line data library maintained by French.

[3]Often, investigations are 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, I take the 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.

I choose a 270-day period for estimation of equation (1). This period runs from 250 trading days to 29 days prior to the event date $\tau$. This nine-month period contains about 220 actual trading days. The estimation period ends thirty days prior to the start of the event window so as to avoid comingling the expected return calculation with the event return data.

The estimated coefficients from equation (10) are then used to generate the expected or normal daily returns over each day of the event window $ER_{it}$. The abnormal daily $AR_{it}$ is then easily calculated as the actual daily return $R_{it}$ less the normal or expected return for each stock. That is:

$$AR_{it} = R_{it} - ER_{it} \qquad (11)$$

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 abnormal cumulative return $ACR_{it}$ as the difference between $CR_{it}$ and $ECR_{it}$.

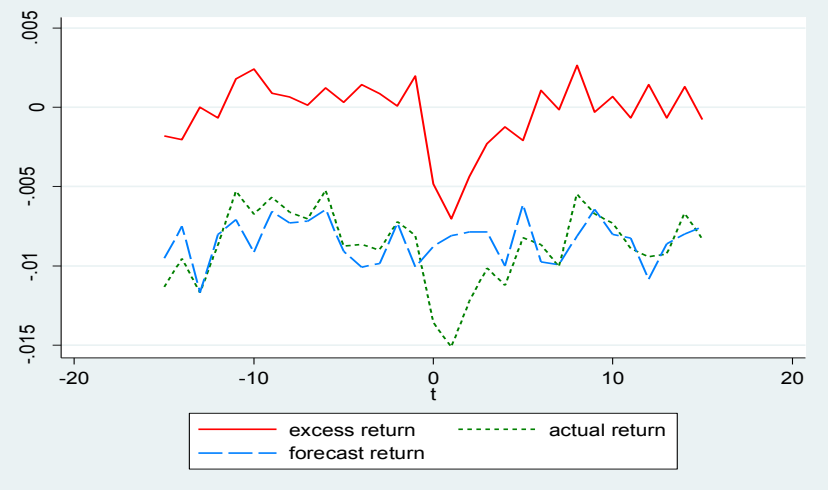
**4. Empirical Results**

To the extent that the public revelation that a firm is being investigated for illegal price-fixing behavior comes as news to the markets then, under the Efficient Market Hypothesis ((EMH), the firm's equity price should react quickly to that news. In general, we would expect this reaction to be negative for two reasons. First, assuming that the firm's earnings to that date reflects the super-normal profit of non-competitive pricing, the discovery and presumptive ending of that collusion will lower the firm's projected net income in the future. Second, the discovery that a firm may be involved in illegal price-fixing raises the possibility that the firm will face legal and civil fines going forward. Note that to the extent that the market learns over the course of investigation the likely investigative outcome, the announcement of such a an actual finding of guilt and an associate settlement will come less as a shock and therefore have less impact on the stock returns.

*4.1 Announcement of Investigation Impact*

Figure 1 shows the actual, expected, and the abnormal (the difference between the actual and the expected) return for each day of the event window averaged across all 253 cases, when the event is defined as the date the firm is publicly identified as under investigation for cartel behavior. It is readily apparent from this figure that on average, such an announcement leads to a visibly negative actual and abnormal return. On average, equity returns fall below normal by close to half a percentage point on the day of the announcement. They fall further for the next few days before stabilizing and returning to essentially normal levels thereafter.

**Figure 1**
**Daily Actual, Predicted, and Abnormal Returns,**
***t* = 0 is date of Investigation Announcement**




The visual impression given by Figure 1 is supported by more formal statistical evidence. In Table 1A, I show the daily abnormal returns alongside their standard errors and the corresponding t-statistics for the event day and the five days that follow.[4] While there is little evidence of any abnormal movement prior to the announcement, the abnormal returns for these days falling immediately on the heels of the announcement are consistently negative and the first three (and

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

marginally the fourth) are significantly so. 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 abnormal 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, I have here calculated the abnormal

Table 1A
Daily Abnormal Returns, Investigation Event

| *t* | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0 | -0.00484 | 0.00193 | -2.510 | 0.0127** |
| 1 | -0.00704 | 0.00239 | -2.951 | 0.0035*** |
| 2 | -0.00436 | 0.00204 | -2.136 | 0.0336** |
| 3 | -0.00232 | 0.00140 | -1.663 | 0.0976* |
| 4 | -0.00123 | 0.00169 | -0.727 | 0.4677 |
| 5 | -0.00211 | 0.00140 | -1.501 | 0.1345 |

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 not 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 as significant if not more so when this standardized measure is used.

Table 1B
Daily Abnormal Returns, Investigation Event,
Standardized Relative to Stock Return Volatility

| *t* | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0 | -0.3061 | 0.10082 | -3.036 | 0.0026*** |
| 1 | -0.4033 | 0.09199 | -4.384 | 0.0000*** |
| 2 | -0.2006 | 0.07695 | -2.607 | 0.0097*** |
| 3 | -0.1533 | 0.07228 | -2.121 | 0.0349** |
| 4 | -0.0149 | 0.06744 | -0..221 | 0.8253 |
| 5 | -0.0785 | 0.06647 | -1.181 | 0.2386 |

A natural question to ask in light of the above findings is whether the negative abnormal returns in the immediate wake of the investigation announcement are live for only a few days or are sustained. Figure 1 is suggestive in this respect as it does not indicate any clear evidence that the negative returns are later offset by more positive ones. In Table 2A, I show the statistical tests for the average abnormal 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 $t = 15$ These are also illustrated in Figure 2.

Table 2A
Cumulative Abnormal Returns, Investigation Event

| Span | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0-5 | -0.0220 | 0.00605 | -3.639 | 0.0003*** |
| 0.10 | -0.0.185 | 0.06322 | -2.856 | 0.0046*** |
| 0-15 | -0.0.175 | 0.06570 | -2.663 | 0.0082*** |

As Figure 1 suggests, Table 2A strongly confirm that the negative abnormal returns on the day that a firm's investigation for cartel activity is announced is lasting. Wile 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 abnormal 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. Announcement of an official investigation for price-fixing is bad for a firm's equity value.

Table 2B
Cumulative Abnormal Returns, Investigation Event,
Standardized Relative to Stock Return Volatility

| Span | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0-5 | -1.1607 | 0.22971 | -5.053 | 0.0000*** |
| 0.10 | -0.8953 | 0.25994 | -3.444 | 0.0007*** |
| 0-15 | -0.9738 | 0.31730 | -3.069 | 0.0024*** |

*4.2 Case Closing or Settlement Impact*

I now consider the effect of the cartel case event when the date of the event is the date that the case is closed and any settlement has been announced. As noted earlier, the EMH implies that to the extent that market follows the development of the case after the investigation announcement and forecasts the case implications for the firm's legal liability, those forecasts should affect the share price immediately. Hence, the realization of the settlement and case closure should have little impact on the firm's share price and return.

Tables 3A, 3B, 4A and 4B repeat the analysis above on daily and cumulative abnormal returns with the only change being that the event date is now the date that the case closure and settlement is announced. As can be quickly seen, the EMH is essentially confirmed. Any costs associated with the firm's settlement is rationally anticipated and priced into the firm's equity in advance. Thus, there is little sign of any abnormal return—positive or negative—at the time of the case closure. Note though that the fact that there is no positive abnormal return at this time is further evidence that the negative abnormal returns observed when the investigation is announced are not subsequently reversed. That initial loss is long lasting. Overall then, both Hypothesis 1 and Hypothesis 2 are confirmed by the evidence.

Table 3A
Daily Abnormal Returns, Settlement Event

| *t* | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0 | 0.00052 | 0.00162 | 0.320 | 0.7495 |
| 1 | -0.00049 | 0.00197 | -0.249 | 0.8034 |
| 2 | -0.00000 | 0.00206 | -0.019 | 0.9851 |
| 3 | 0.00012 | 0.00193 | 0.063 | 0.9499 |
| 4 | -0.00019 | 0.00193 | -0.098 | 0.9220 |
| 5 | -0.00057 | 0.00182 | -0.313 | 0.7546 |

Table 3B
Daily Abnormal Returns, Settlement Event,
Standardized Relative to Stock Return Volatility

| *t* | Mean | Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0 | 0.06696 | 0.06019 | 1.112 | 0.2676 |
| 1 | -0.05248 | 0.07515 | -0.698 | 0.486 |
| 2 | -0.00502 | 0.06870 | -0.073 | 0.9419 |
| 3 | -0.00564 | 0.07746 | -0.073 | 0.9421 |
| 4 | -0.00022 | 0.07474 | -0.003 | 0.9976 |
| 5 | -0.02910 | 0.07392 | -0.394 | 0.6944 |

Table 4A
Cumulative Abnormal Returns, Settlement Event

| Span | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0-5 | -0.0007 | 0.00518 | 0.126 | 0.9002 |
| 0.10 | 0.0051 | 0.00617 | 0.830 | 0.4077 |
| 0-15 | 0.0103 | 0.00822 | 1.241 | 0.2164 |

Table 4B
Cumulative Abnormal Returns, Settlement Event,
Standardized Relative to Stock Return Volatility

| Span | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0-5 | -0.0327 | 0.20805 | 0.157 | 0.8753 |
| 0.10 | 0.1815 | 0.26432 | 0.687 | 0.4933 |
| 0-15 | 0.3533 | 0.32424 | 0.997 | 0.3202 |

*4.3 Impact of Leniency*

Since 1993, corporations have been able to avoid criminal convictions and fines despite being party to a price-fixing conspiracy prosecuted the U.S. Department of Justice if they are the first member of the cartel to confess to the authorities and cooperate fully with the subsequent investigation. 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.

There are at least two reasons that the financial markets may differentiate between the first confessor and the other members of the cartel. One is the obvious reason 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, at least, the name of the leniency recipient is not formally released. Seasoned observers and those with inside information may of course know the informant's identity. 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. This permits running the event study separately for the two groups—leniency recipients and non-recipients. The results of this analysis for the event window defined as the investigation announcement are shown in Tables 5A and 5B below.

Table 5A
Leniency Recipients
Daily Abnormal Returns, Investigation Event

| *t* | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0 | -0.00680 | 0.00612 | -1.111 | 0.2738 |
| 1 | 0.00000 | 0.00542 | 0.018 | 0.9855 |
| 2 | -0.00416 | 0.00341 | -1.220 | 0.2304 |
| 3 | 0.00250 | 0.00283 | 0.884 | 0.3825 |
| 4 | 0.00000 | 0.00380 | 0.010 | 0.9921 |
| 5 | 0.00371 | 0.00353 | 1.054 | 0.2991 |

Table 5A
Non-Leniency Recipients
Daily Abnormal Returns, Investigation Event

| *t* | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0 | -0.00466 | 0.00198 | -2.356 | 0.0194*** |
| 1 | -0.00827 | 0.00263 | -3.146 | 0.0019*** |
| 2 | -0.00440 | 0.00232 | -1.894 | 0.0596* |
| 3 | -0.00315 | 0.00156 | -2.022 | 0.0444** |
| 4 | -0.00144 | 0.00187 | -0.773 | 0.4406 |
| 5 | -0.00310 | 0.00152 | -2.040 | 0.0426** |

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 Abnormal Returns, Investigation Event

| Span | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0-5 | -0.0046 | 0.00962 | -0.479 | 0.6349 |
| 0.10 | -0.0082 | 0.01415 | -0.559 | 0.5800 |
| 0-15 | -0.0027 | 0.02415 | -1.100 | 0.2788 |

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

| Span | Mean | Std. Error | *t*- Statistic | P-value |
|---|---|---|---|---|
| 0-5 | -0.02502 | 0.00688 | -3.634 | 0.0003*** |
| 0.10 | -0.01975 | 0.00697 | -2.832 | 0.0051*** |
| 0-15 | -0.01954 | 0.00792 | -2.447 | 0.0152** |

Hypothesis 3 is thus also confirmed. It is readily apparent 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 being investigated for illegal price-fixing has little or no impact on the equity price and market return of the firm that receives leniency, those firms not confessing suffer a significant loss. The negative abnormal return on the day of the announcement and the few days that immediately follow for non-leniency firms is on the order of 2.5 percentage points. There is 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. [5]

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 at least tow reasons. First, it implies that the markets must regard the presumptive end of the cartel as having little effect on the firm's profit. 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.

**5. What is Different About Leniency Firms?**

The result above that the market differentiates between LP recipients and non-recipients in reacting to announcements of price-fixing investigations deserves further consideration. If one thinks of the negative response to such announcements as reflecting some combination of expected fines and lost cartel profits, it is clear that one reason for LP recipients better share price outcome is that they do not need to pay the criminal fines. This still leaves the negative effect of lost profits though as a force that pushed LP recipient share prices down somewhat if

[5] 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.

not as much as the price decline of the non-recipient cartel members.[6] In turn, this suggests that those firms applying for leniency are among the least profitable members of the cartel. Because they do not earn much cartel profits, official actions that signal the end of the cartel has little effect on these firms' share prices.

Relatedly, Levenstein and Suslow (2011) find that cartels are less likely to survive if there are financial pressures from lenders. Thus, cartels in which firms have a low interest coverage ratio or perhaps a high debt-to-equity ratio seem to have less duration. This suggests that a further distinguishing feature of LP recipients is that they are under financial pressure as well.

In the US, the Department of Justice grants more or less complete criminal leniency to the first and only the first cartel member firm to reveal the collusion. However in the European Commission, multiple firms in a same cartel can be eligible for different degrees of leniency. Marvao (2012) therefore looks at European LP recipients not from the viewpoint of why they sought leniency but as an analysis of why and how much leniency they were awarded. Thus, Marvao (2012) looks at variables such as prior legal actions for price-fixing behavior, recidivism, and cartel duration and does not consider financial data as part of the explanation. However, if either the duration of a cartel or a prior history of cartel behavior are related positively to the ultimate criminal fine and civil damages, then these factors too could lead a firm to seek leniency.

I again use the PIC and Bloomberg Professional Service data. However, as complete financial data is not available for many firms, the number of observations had to be reduced to 495 securities. Within this group, there were 87 firms identified as LP recipients, 46 of them receive leniency in the US. Again, the European and Canadian cases may reflect different degrees of leniency. However, my target of this study only lies on firms receiving full immunity through leniency program. For the purpose of this analysis though, I simply code each firm with

[6] Bosch and Eckard (1991) suggest a third force reflecting negative signals that the announcement generates regarding the firm's honesty or customer relations.

a 1,0 dummy variable where 1 indicates an LP recipient with full immunity and 0 represents that the firm otherwise. There are then 87 firms coded as 1 in this case.

To explain this LP decision, I use a simple Probit regression as follows.

$$\boldsymbol{LP_i = \beta_0 + \beta_1 ROE_i + \beta_2 (D/E)_i + \beta_3 RDS_i + \beta_4 NO_i + \beta_5 CD_i + \beta_6 ECD_i + e_i} \quad (12)$$

Where

$LP_i$ = 1,0 dummy indicating whether firm *i* sought and received leniency

$ROE_i$ = firm *i*'a return on equity in quarter previous to the investigation announcement

$(D/E)_I$ = firm *i*'s deb-to-equity ratio in the quarter previous to the investigation announcement

$RDS_i$ – a 1,0 dummy indication whether firm *i* has been involved in other cartels

$NO_i$ = the number of other firms involved in the cartel for which firm *i* is being investigated

$CD_i$ = the number of years the cartel for which firm *i* is being investigated was in operation prior to the investigation announcement

$ECD_i$ = a measure of the duration of the European Commission investigation into the cartel for which firm *i* is being investigated

As noted, equation (12) is estimated as a probit equation. I do this with and without fixed industry effects to control for unobserved factors that vary by industry and that may affect a firm's decision to confess an seek leniency. The results are shown in Tables 7 and 8.

From the value of coefficients, it is readily apparent that that the number of firms, cartel duration and EC investigation duration have very little impact on a cartel member's seeking and getting antitrust leniency. Although in some cases these variables are statistically significant, they are not consistently so. Even when they do achieve statistical significance however, their coefficient estimates are so small that they have no real economic significance.

**Table 7**
**Probit Regression of LP Decision Without Fixed Effects**
**Dependent Variable = $LP_i$**

| Variables: | LP Status | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| $ROE_i$ | -0.0950* | -0.0883** | -0.0934** |
| | (0.049) | (0.042) | (0.039) |
| $(D/E)_i$ | -0.0064* | -0.0052* | -0.0033 |
| | (0.004) | (0.003) | (0.003) |
| $RDS_i$ | | 0.1240*** | 0.1080*** |
| | | (0.025) | (0.025) |
| $NO_i$ | | | -0.0016* |
| | | | (0.001) |
| $CD_i$ | | | -4.15e-06 |
| | | | (2.57e-06) |
| $ECD_i$ | | | 0.0005** |
| | | | (0.0003) |
| Ob | 495 | 495 | 469 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Table 8**
**Probit Regression of LP Decision With Fixed Effects**
**Dependent Variable = $LP_i$**

| Variables: | LP Status | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| $ROE_i$ | -0.0866* | -0.1060** | -0.1350*** |
| | (0.052) | (0.046) | (0.049) |
| $(D/E)_i$ | -0.0019 | -0.0032 | -0.0033 |
| | (0.003) | (0.003) | (0.003) |
| $RDS_i$ | | 0.1120*** | 0.0996*** |
| | | (0.030) | (0.030) |
| $NO_i$ | | | -0.0010 |
| | | | (0.001) |
| $CD_i$ | | | -5.05e-06* |
| | | | (2.67e-06) |
| $ECD_i$ | | | 0.0006* |
| | | | (0.0003) |
| Ob | 443 | 443 | 421 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

I now turn to the interest financial variables of interest. Somewhat surprisingly, a firm's debt-to-equity ratio appears if anything to have a negative effect on a firm's leniency status. That is, the likelihood of being a cartel member that seeks and obtains leniency seems to decline with the debt-to-equity ratio. However, this effect vanishes when industry fixed effects are allowed. A similar pattern is observed if I replace the debt-to-equity ratio with the interest coverage ratio as an alternative measure of firm liquidity pressures.

As expected, however, the profitability of the firm is a very important determinant of a firm's likely leniency status and enters with the expected negative sign. This finding is consistent across specifications and continues to hold even after fixed industry effects are included. In general, a one-percent increase in a firm's recent return on equity leads to at least an equivalent one-percent drop in the probability that the firm will seek and get leniency. This is a relatively large effect and suggests that firms with even a limited profit differential may exhibit significant differences in applying for and receiving leniency. Hypothesis 4 is confirmed.

## 6. 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 some estimated return generating process with the actual returns at the time of the event In this paper, I 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, I use the richer three-factor model suggested by Fama and French (1993).

I find that firms pay a significant stock market price once they are identified as under investigation for illegal collusion. Specifically, these firms lose on average close to 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 at 1.75 percent or higher at the end of

the even window two weeks later. However, those cartel members that confess first and receive criminal leniency as a result do not suffer any negative return at the time the investigation is announced. Despite the lack of any official statement identifying these firms, the market seems to ferret their identity out and to price their securities differently. The lack of any equity price effects for these firms also suggests that they earned little extra profit from their cartel membership.

In contrast to the impact of an investigation announcement, the news that the case is settled generates little market reaction. Presumably, this reflects the fact that the market can follow the legal process that follows the start of an investigation and incorporate the settlement into its pricing well ahead of the actual settlement data. Along with the market's ability to work out the identity of leniency-receiving firms, the fact that it also rationally reflects any settlement effects into equity prices well in advance of the settlement date may both be taken as fairly strong evidence that the market is informationally efficient.

I also find that less profitable firms are more likely to seek and obtain leniency. Because these firms incur no or little criminal liability, this finding is roughly consistent with the fact that these firms do not suffer a negative abnormal return when the investigation is announced. If firms that were earning substantial profit from the cartel sought and received leniency, I would then expect that the end of the cartel and the loss of that profit would be reflected in a share price decline.

**Appendix-Figures and Tables**

**Table 0. Daily Mean Abnormal Returns**

| | Mean Abnormal Return | | | |
|---|---|---|---|---|
| | First Notice | | Case Close or First Penalty | |
| span | mean | sd | mean | sd |
| -15 | -0.001794 | 0.0216451 | 0.0028541 | 0.0198117 |
| -14 | -0.002049 | 0.0174951 | 0.0004936 | 0.0183186 |
| -13 | 0.0000183 | 0.0182002 | -0.0007394 | 0.0246579 |
| -12 | -0.000657 | 0.0171048 | 0.0039848 | 0.0234744 |
| -11 | 0.0017572 | 0.017917 | -0.0003938 | 0.0299455 |
| -10 | 0.0024228 | 0.0192314 | 0.0007762 | 0.0318471 |
| -9 | 0.0009053 | 0.0183908 | 0.0011059 | 0.0263335 |
| -8 | 0.0006424 | 0.0235137 | 0.0054656 | 0.025776 |
| -7 | 0.0001285 | 0.0202761 | 0.0012307 | 0.0197322 |
| -6 | 0.00119 | 0.0209015 | 0.0013013 | 0.0215827 |
| -5 | 0.0003233 | 0.019183 | 0.0002554 | 0.0197572 |
| -4 | 0.0014373 | 0.0195225 | 0.001009 | 0.0209615 |
| -3 | 0.0008531 | 0.0185882 | -0.0009137 | 0.0198378 |
| -2 | 0.00008 | 0.0166105 | 0.0024227 | 0.024196 |
| -1 | 0.0019962 | 0.020891 | 0.0016605 | 0.0186508 |
| 0 | -0.004842 | 0.0306879 | 0.0005171 | 0.0204525 |
| 1 | -0.007043 | 0.0379549 | -0.0004921 | 0.0249667 |
| 2 | -0.004364 | 0.0324945 | -0.0000386 | 0.0261001 |
| 3 | -0.002321 | 0.0222031 | 0.0001212 | 0.0243577 |
| 4 | -0.001226 | 0.0268014 | -0.000189 | 0.0243832 |
| 5 | -0.002106 | 0.0223142 | -0.0005691 | 0.0229902 |
| 6 | 0.0010618 | 0.0289782 | 0.0005509 | 0.021833 |
| 7 | -0.000167 | 0.0193453 | 0.0030318 | 0.0208768 |
| 8 | 0.0026928 | 0.0238995 | -0.0011333 | 0.0235921 |
| 9 | -0.000284 | 0.0230378 | 0.0028016 | 0.0193994 |
| 10 | 0.0006687 | 0.0254826 | 0.0006282 | 0.0257234 |
| 11 | -0.000698 | 0.03269 | 0.0028123 | 0.0225915 |
| 12 | 0.0014367 | 0.0298957 | 0.0027655 | 0.0259226 |
| 13 | -0.000688 | 0.0244046 | 0.0017566 | 0.022329 |
| 14 | 0.0013095 | 0.0270499 | -0.002464 | 0.0213687 |
| 15 | -0.0008 | 0.0245897 | -0.0000385 | 0.0169176 |

**Figure 2 Cumulative Abnormal Return**

***t* = 0 is date of Investigation Announcement**

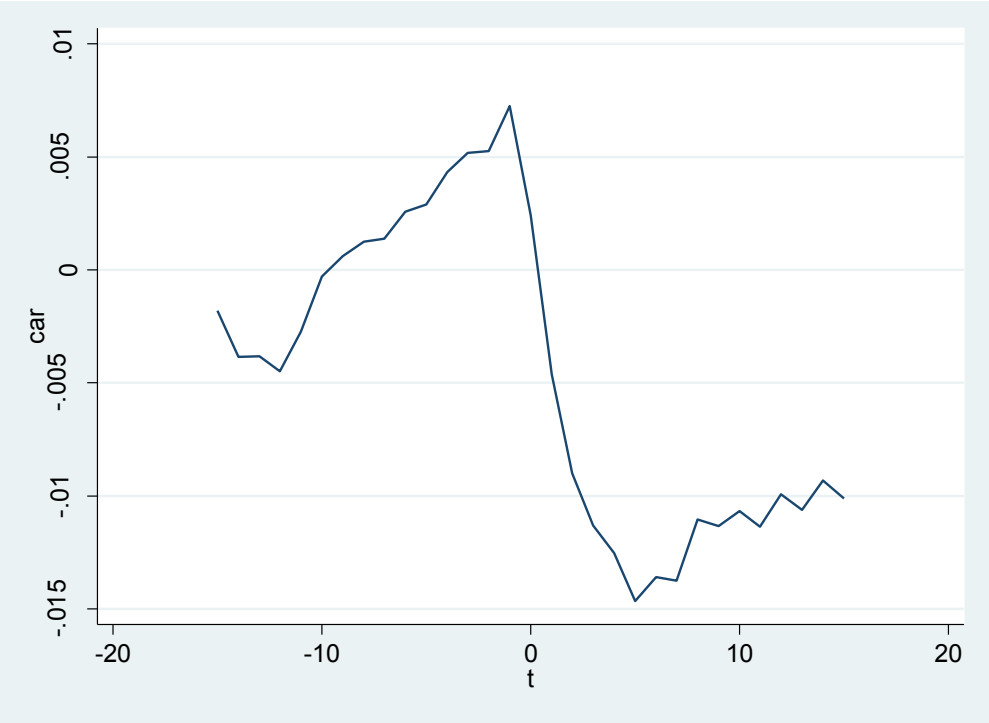
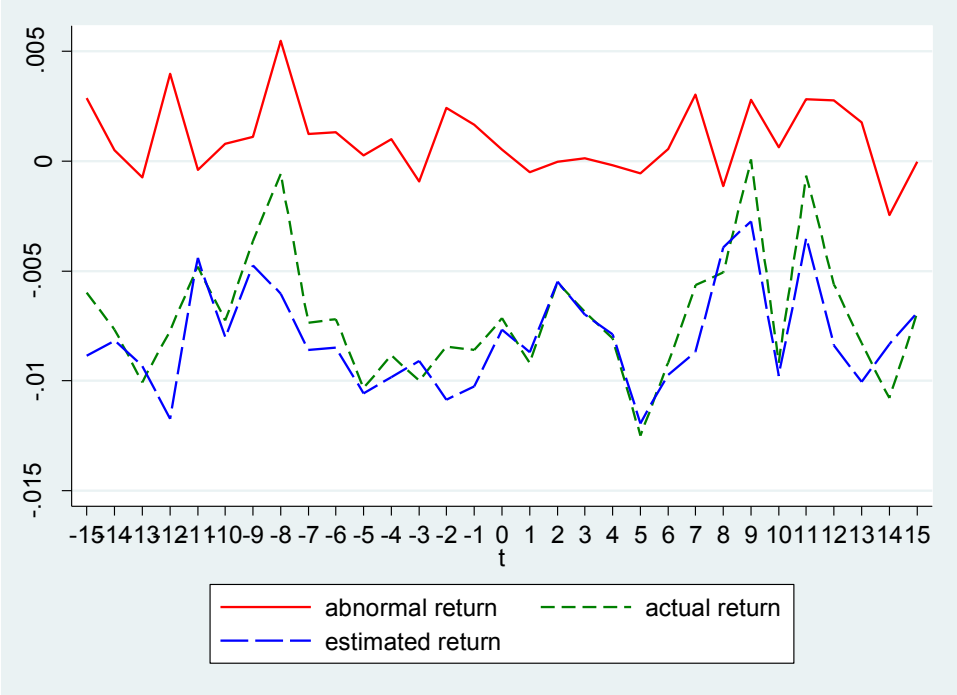


**Figure 3**

**Daily Actual, Predicted, and Abnormal Returns,**

***t* = 0 is date of Settlement Announcement**



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