Discovering Cartels: Dynamic Interrelationships between Civil and Criminal Antitrust Investigations

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Abstract

This paper focuses on the genesis, taxonomy and timeline of U.S. criminal antitrust investigations, and uses time-series data on enforcement to examine the interrelationships between the various criminal enforcement variables as well as the linkages between criminal and civil enforcement. The key findings are: (1) there appears to be considerable dynamic interplay between the criminal variables. For example, an increase in grand jury investigations or criminal cases initiated or the number of individuals or firms convicted generates increases in most of these (endogenous) variables in future periods. A broad conclusion that can be drawn is that information unearthed during a given criminal investigation and prosecution often reveals information about other conspiracies leading to future investigations and prosecutions; (2) an increase in civil enforcement leads to future increases in the criminal cases and firms and individuals convicted. This suggests that information gleaned during civil investigations, such as mergers or monopolization cases, may reveal information about collusive behavior in markets leading to criminal investigations and prosecutions; and (3) criminal enforcement follows a counter-cyclical pattern with the number of criminal cases prosecuted increasing following an economic downturn. We relate this to the literature which points to cartel instability during economic downturns. Overall, our results point to complementarities in the investigative process within different facets of criminal investigations as well as between criminal and civil investigations.

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1. Introduction

Business conduct related to price-fixing, bid-rigging, output-restriction and market allocation schemes are *per se* antitrust violations as they have clear detrimental effects on (consumer) welfare. While the U.S. has a long history of prosecuting cartels dating back to the late-1890s,[1] the last decade has seen significant ratcheting up of cartel enforcement worldwide. Enforcement of cartels in Europe, for example, has seen a big change in recent years (Harding and Joshua, 2004; Motta, 2004). Criminal antitrust enforcement aims to detect cartels and impose penalties on past and ongoing behavior in order to deter future collusive conduct. As we look at the recent surge of research on understanding cartels and enforcement, one can identify two broad strands. One relates to the fine-tuning of the carrots (incentives for firms and individuals to come clean with information to avoid penalties) and sticks (severity of penalties) approach to detection and enforcement.[2] The second can be thought of as providing insights into firms' behavior and the conditions that are conducive to the formation and stability of cartels.[3]

The broad focus of this paper is on the *genesis* of criminal antitrust investigations. Since cartels are covert, and are known to go to great lengths to avoid detection, information about them is hard to come by. The antitrust authorities have to cast a wide net to catch the colluding firms and the initial

[1] E.g., in the American Tobacco case (1907) the U.S. Department of Justice sued U.S. and British firms for domestic and global market allocation schemes. The U.S. Supreme Court ruled that the conduct was illegal.

[2] E.g., Aubert (2006) provides an insightful discussion of leniency programs in various countries and the penalties versus rewards structure of deterrence programs and their effectiveness. Chen and Harrington (2006) theoretically examine the effects of leniency programs on the formation and stability of cartels. Buccirossi and Spagnolo (2006) present an analysis of the interaction between fines and leniency programs in deterrence. Connor (2006b) examines fines and penalties imposed on modern international cartels and contributes to the current debate about the effectiveness of global antitrust sanctions to deter international price-fixing conduct. The OECD (2005) report provides details on the effectiveness of sanctions and the experiences of different countries.

[3] E.g., Kovacic et al. (2006) infer that vitamins markets that were duopolies had significantly greater likelihood of collusion as opposed to those with greater number of firms. Levenstein and Suslow (2006) present information on market conditions that facilitate stability of cartels. Connor (2002 and 2006a) presents details about conduct and market characteristics in the lysine, citric acid and vitamins cartels.

information – the seeds of (future) investigations and prosecutions – about which firms may be colluding is crucial. In the literature on the antitrust enforcement of cartels, there appears to be relatively little that has been written about the genesis of criminal investigations. What limited knowledge we have is derived from a handful of high profile cases. The reason why there is little knowledge relates to the stringent confidentiality restrictions the Antitrust Division imposes on criminal investigations.[4]

This paper (1) highlights the potential role played by the various conduits through which the antitrust authorities could discover information about the existence of cartels, (2) outlines the taxonomy and timeline of criminal antitrust investigations and (3) uses broad publicly available data on criminal prosecutions, grand jury investigations and the number of firms and individuals convicted to uncover the dynamic interrelationships in the process of criminal investigations as well as the potential linkages between criminal and civil enforcement. While there are numerous studies in the recent literature that use *case-specific* information to gauge the deterrence value of fines and penalties and to identify the characteristics of markets and products that may give rise to collusion and the stability of collusion, this paper contributes to the literature by conducting a systematic econometric analysis of the U.S. criminal enforcement data over a long time-period.[5] Since the U.S. has had the longest distinct criminal (and civil)

[4] To illustrate this point we take a quick look at some recent papers. Connor (2002) presents an insightful discussion of the lysine, citric acid and vitamins cartels. The details presented include affected product markets, specifics of violations, cartel enforcement methods and efforts to cover up evidence. Aside from insights into the leniency and amnesty issues, there is no discussion of the source(s) of information that gave birth to the original investigations. Connor (2006a) contains extensive information on the vitamins cartel, including dates of FBI initiating investigations, grand jury empanelments and duration, and individuals and firms who came forward. He notes (p.56) that in early 1997 the FBI received information about a possible price fixing conspiracy in the vitamins industry and this led to a series of moves by the investigators later that year and subsequent prosecutions. Even in such a detailed and insightful study of one of the most prominent cartel cases in history, there is little information about the true origins of the first investigation – that is, what source(s) of information lead to the first case and prosecution. Even in Connor's (2006c) discussion of the forensics of criminal cases, there is no information on the true genesis of these cases. Undoubtedly, the extreme difficulty in finding such information is due to the strict confidentiality restrictions imposed by the DOJ's criminal investigative process.

[5] Criminal enforcement (price-fixing, bid-rigging and market allocation schemes) is conducted exclusively by the Antitrust Division. In contrast, civil enforcement (merger control, monopolization and restraints of trade) is

antitrust enforcement of any country, this rich background provides us with an opportunity to econometrically examine the historical dynamics in the data.

Our key findings are: (1) there appears to be considerable dynamic interplay between the criminal enforcement variables. An increase in grand jury investigations or criminal cases initiated or the number of individuals or firms convicted generates effects on most of these (endogenous) variables in future time-periods. A broad conclusion one can draw is that information unearthed during a criminal investigation and prosecution reveals information about other conspiracies leading to future investigations and prosecutions; (2) an increase in civil enforcement leads to future increases in the criminal cases filed in court and firms and individuals convicted. An inference that can be drawn is that information gleaned during civil investigations, such as mergers or monopolization cases, serves to reveal information about collusive behavior in markets leading to criminal cases initiated and prosecutions; and (3) criminal cases initiated appear to be strongly counter-cyclical. We relate this to the literature which supports the view of cartel breakdown during economic downturns. Overall, our results on the dynamic interrelationships point to complementarities in the investigative process within different facets of criminal investigations as well as between criminal and civil investigations.

The paper is organized as follows. In section 2 we outline the process and timeline of criminal investigations by the Antitrust Division and section 3 presents the data used in our analysis. The empirical framework for examining the dynamic interrelationships using the Vector-Autoregression methodology is outlined in section 4. Section 5 presents an analysis of detecting structural-breaks in the criminal enforcement data. The results of our estimation using Vector-Autoregressions are presented in section 6, and section 7 presents results from alternative estimation strategies: single-equation and seemingly-unrelated-regressions. The paper concludes with a discussion and final remarks in section 8.

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jointly carried out by the Federal Trade Commission and the Antitrust Division of the Department of Justice.

2. The Genesis, Taxonomy and Timeline of Criminal Antitrust Investigations

Price-fixing investigations traverse complex legal and economic issues and in this section we provide a bird's-eye view of some of the issues involved and the investigative process. First, criminal investigations are very different from, say, merger investigations. As Harrington (2005, p.1) notes: *"…cartels are generally not discovered by the antitrust authorities but rather customers, employees, and even competitors.…In contrast, prospective merger cases are brought by the participants themselves to the antitrust authorities, as mandated by the Hart-Scott-Rodino Act of 1976."* Cartels are covert and not easily detected and, as evidenced by some of the high profile prosecutions in the lysine, vitamins, graphites, and several bid-rigging investigations, firms engaging in price coordination can take elaborate precautions and have complicated schemes to avoid detection. Second, the Antitrust Division does not have the resources to scour the entire economy looking for price-fixing and related violations. The economy is too big and the size of the Division's staff and monetary budget are simply not large enough to handle this workload. Instead, the Division has to rely on other mechanisms to get information. **Table 1** is a page from the Division's website requesting information from the public about possible violations and promising confidentiality. Ideally one would like to have information about the true origins of price-fixing cases prosecuted by the Antitrust Division. Unfortunately, due to stringent confidentiality restrictions about the source of information that triggered an investigation, this information is not available for the vast majority of cases the Division prosecutes (see footnote 4). Third, a criminal investigation could be for a current price-fixing matter or a past one where information has become available only recently.

The genesis of criminal investigations by the Antitrust Division can be myriad:

(a) One criminal investigation may reveal information about other criminal violations.[6]

[6] For example, the Antitrust Division's investigation of the lysine cartel involving Archer-Daniels

(b) Information discovered during the process of civil investigations (e.g., merger evaluation) may reveal information about cooperative pricing and market allocation schemes.[7]

(c) Information provided by other firm(s) in the market.[8]

(d) Signs of price wars (potentially signaling breakdown of collusive agreements) or rapid increase in

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Midlands and several Asian firms unearthed evidence on vitamin and related cartels leading to their prosecution including large multinationals like Hoffman-La Roche and Rhone-Poulenc. Bid-rigging in the construction industry appears pervasive and, in terms of investigative efforts, information revealed during one construction bid-rig often provide clues to other bid-rigs. Block and Feinstein (1986), for example, present evidence from the highway construction industry where the Antitrust Division prosecuted about 200 contractors on charges of bid-rigging. Bid-rigging and collusion in the construction industry seems pervasive – see van Bergeijk et al. (2006) for evidence from the Dutch industry.

[7] This area is rather complicated and obtaining information is very difficult for several reasons. First, the Antitrust Division provides NO public log of information about the origins of criminal investigations. (Even though I worked at the Antitrust Division for several years, obtaining this information proved very hard as even internally the Division does not have a mechanism for storing this information. Anecdotal information is more common.) In very selected high profile cases some information has become available, but the inner workings of the criminal investigations are closely guarded due to litigation and other factors. Second, because of the protections afforded to targets of a criminal investigation, the Division must make a call fairly early on about whether to proceed with a civil or criminal investigation. And, there is also the issue of double-jeopardy whereby if a firm has filed for merger clearance, that information is not expected to be used for obtaining criminal prosecutions. Given this, even if the transition from a civil to criminal case results in a criminal prosecution, the publicly filed indictment and supporting papers are very unlikely to reveal how the matter originated as a civil investigation. When civil investigation staffs at the Antitrust Division do discover evidence of criminal violations, they transition the matter to criminal investigation status without tainting either investigation. Given these complexities and confidentiality issues, finding examples in this area proved very difficult.

Nevertheless, I was able to come up with the following related examples available in the public domain. First, was the Division's successful challenge of the UPM Kymmene-Bemis MACtac merger a few years back. It spawned a grand jury investigation into alleged price fixing. Second, was the Division's investigation of the proposed Formica-International Paper (Nevamar Division) merger – the Division announced plans to challenge it, and the parties broke up the deal the next day. It spawned a grand jury price fixing investigation against a competitor called WilsonArt which ended with a guilty plea on some of the charges. Third, was the FTC's "3 Tenors" case which came out of an HSR investigation of a proposed merger between Time Warner & EMI. The contracts that ultimately were challenged were discovered during the HSR investigation.

More generally, it is quite common for one investigation leading to another. For criminal to criminal, see footnote 6 above. For other types of investigations, for example, the Antitrust Division while evaluating the pending merger between First Data Inc. and Concord EFS Inc. discovered evidence on exclusivity contracts between Western Union Financial Services Inc. and retail outlets which prevent competitors from setting up money-transfer systems at those outlets. This lead the Division to start an investigation of Western Union and issue Civil Investigative Demands ("Western Union Gets DoJ CID," *Wall Street Journal*, February 5, 2004; "Exclusivity Pacts By Western Union At Stake in Probe," *Wall Street Journal*, February 9, 2004).

[8] For example, in 1999 a settlement was reached in a milk price-fixing case where Marigold Foods, Land O'Lakes, Geo Benz and Sons, and Marigold Venture along with Dairies Trade Association were the accused. Part of the origin of this investigation was information revealed by another firm in the market.

prices or complaints by consumers about rising prices and suspicion of cartel-like activities.[9]

(e) Information via the leniency program.[10]

(f) Information uncovered while studying bidding patterns.[11]

Next we turn to the various stages of investigation and the timeline:

(1) Once information becomes available, it's merits are considered. If initial information is weak and more information is needed to determine the seriousness of the issue, a preliminary investigation is opened. If the initial information is profound and compelling, the Antitrust Division may start a federal grand jury investigation immediately. Once information becomes available, it may take between 3-6 months on average to get to the grand jury investigation stage.

(2) The Assistant Attorney General – the head of the Antitrust Division – has to sign off on a grand jury investigation.[12] The grand jury comprises of a group of several individuals who become privy to the confidential information that forms part of the Division's case. The investigation begins with the Division

[9] These have occurred in myriad products such as school milk contracts, electricity, local construction projects, gasoline, cable television, natural gas, airline pricing, among others. For example, in 2001, at the height of California's energy crisis, the price of natural gas spiked about 700% as it crossed the state line on an El Paso Corporation pipeline. This increase in price prompted complaints by various groups leading to judicial investigation and eventual prosecution. El Paso Corp. was accused to have entered secret deals – recorded in phone and other conversations – to cut out competitors and drive up prices. Subsequently when El Paso Corp. gave up control of the flow of gas, prices plummeted. During the same time period, the California Independent System Operator found that prices in 2000 were 10 times higher than in 1999 and the electric companies had withheld power through bidding strategies. In 1999, the Nevada Grocery Retailers filed a complaint with the State Dairy Association accusing local and regional dairies with collusion. In 2000, the Colorado Attorney's General office initiated an investigation into gasoline price fixing after receiving numerous complaints from local businesses and individuals of suspected collusion.

[10] Examples include the Sotheby's and Christie's auction house conspiracy, and the vitamins cartel where Rhone-Poulenc collaborated with the Division to provide evidence against Hoffman La Roche and BASF.

[11] E.g., these have occurred in local or nation markets as part of government contracts and products have ranged from timber, military supplies, milk, petroleum, aluminum, construction projects and waste disposal.

[12] The grand jury is rooted in centuries of Anglo-American history and it's role is to determine possible criminal violations of the federal laws and to return indictments against culpable corporations and individuals where there is probable cause to believe that a violation has occurred. It's proceedings are also designed to protect citizens against unfounded criminal prosecutions.

issuing subpoenas for documents. Since the process is confidential, sometimes the grand jury deliberations may be the first time the defendant hears about the accusations leveled by the Antitrust Division. If, on completion of the grand jury hearings, there is ample evidence, the Antitrust Division prepares a draft indictment. The Assistant Attorney General of the Antitrust Division makes the final decision on whether or not to indict certain individuals. The actual grand jury may take some time. If an investigation has been approved by the AAG, but the grand jury has not convened as yet, it is listed as pending. Between the previous stage and this one, it may take about 6-9 months on average.

(3) If the grand jury returns an indictment, the case will go to court under the Speedy Trial Act for criminal investigations. Between the indictment and the case going to trial, the time lapse is typically about 3-4 months.

(4) The stages in court, for example, include: (a) determining guilt; (b) assessing the volume of commerce involved and assessing liabilities; and (c) sentencing – penalties, fine, jail terms. Once the case goes to court, on average it takes 1-2 weeks for the trial to be over. (In a very small number of cases, there is settlement – preceded by what is called information filing – leading to a consent decree.)

Overall, from when the information first becomes available to the end of the case, on average it takes between 18-24 months to collect all the evidence required and prosecute price-fixing cases. Of course, some cases get done faster and others take more time. We will return to this issue of timing when discussing our empirical specification.

3. Data

Our data on criminal investigations by the Antitrust Division are at two levels. First, are the data on the total number of criminal prosecutions. These data provide an overall picture of the enforcement. These data are annual and cover the post-war period 1948-2003. Including earlier years is not meaningful as the two world wars and the great depression significantly affected the conduct of antitrust. Second, to

consider the dynamic interrelationships, we look at more detailed data on the number of grand jury investigations, the number of firms and individuals prosecuted, and the monetary fines imposed on firms and individuals. Unfortunately, these more detailed data were only available starting 1969. Finally, we also use data on civil antitrust enforcement related to merger and monopolization cases, among others. All of the above data are from the Antitrust Division's historical statistics. The other data used in our analysis are aggregate U.S. data on GDP and corporate profits from the Federal Reserve Bank of St. Louis data archives, and data on the S&P 500 stock price index are from Shiller (1989), updated for the recent years. Data on the total number of mergers in the U.S. are from three sources; Nelson (1959) for the early years, the Federal Trade Commission's merger series for the period 1958-1977 and the Thompson's Financials M&A database for the period 1978-2003. Finally, data on the party of the president and composition of the House and Senate are from U.S. historical archives.

Figure 1(a) displays the data on the total number of criminal cases prosecuted. These data are the total number of criminal court cases filed by the Antitrust Division minus miscellaneous criminal cases filed by the Division related to obstruction of justice, false statements, mail fraud and perjury. This "correction" is important because the latter class of criminal cases have little to do with price-fixing and related violations which we are interested in. Figure 1(a) shows a fair amount of year-to-year variation and a marked elevation of the level of prosecutions starting the late-1970s/early-1980s. To gauge the relative intensity of criminal enforcement, **Figure 1(c)** displays the ratio of the number of criminal cases to the number of total antitrust cases. Like figure 1(a), these data show considerable short-run fluctuations and the relative intensity starts rising markedly after the late-1970s. Over the last 20-25 years, on average about 75% of the antitrust enforcement, in terms of the number of court cases initiated, has been criminal. This represents a significant ratcheting up of criminal enforcement. **Figure 1(b)** displays the total civil cases initiated to provide a perspective.

Next, we examine the more detailed data which, as we noted earlier, are available for the period

1969-2003. **Figure 2** plots the data on the number of grand jury investigations initiated; details about grand juries was presented in section 2. These data show short-run fluctuations and the level appear to be a bit higher during the 1980s and lower during the 1990s. **Figure 3** presents the number of individuals and corporations prosecuted. These data show a downward drift after the late-1970s/early-1980s. Finally, **Figure 4** and **Figure 5** display information on monetary fines paid by firms and individuals. These data reveal an interesting pattern: apart from relatively short-period in the late-1990s, the numbers are rather low. The spikes in the data in the latter periods are primarily driven by a few high-profile prosecutions that generated large fines, but the typical fines have been small. In contrast to the other antitrust data (figures 1-3), the data on fines (figures 4 and 5) pose a problem for econometric analysis as for the vast majority of years the data are reveal low fines with minor time-series fluctuations, and then, at the end, there are large spikes. We return to this issue when we discuss our econometric specification.

The picture that emerges from figures 1-5 is somewhat complex. Prior to the late-1970s and early-1980s, the number of prosecutions were lower but more individuals and corporations were charged per prosecution: i.e., per capita fines were lower. During the later years, the number of individuals and corporations charged per prosecution are lower, but fines are much higher. This indicates that the criminal enforcement strategy shifted to one of sending a clear deterrence signal via more severe monetary fines (as well as jail terms, an issue that we do not consider here).

4. Empirical Framework for Examining Dynamic Interrelationships

Given our discussion in section 2 regarding the process of criminal investigations, the information sources that lead to criminal investigations and timeline, it appears very difficult to determine which variables might be jointly-determined (endogenous) or pre-determined (exogenous). For example, prosecution of an individual or firm may reveal new information leading to follow-on prosecutions. Similarly, a grand jury investigation may lead to prosecution of firms and individuals for

the violation under scrutiny, but also generate new criminal cases. Finally, information gleaned during a civil investigation – merger or monopolization case – may lead to discovery of information about criminal violations with subsequent investigation and prosecution. This implies that variables related to total number of criminal cases filed in court, the number of grand jury investigations, the number of firms and individuals prosecuted, among others, are best treated as being jointly-determined (or endogenous).

Our primary objective is to examine the dynamic interrelationships between the different components of the criminal investigative process such as total number of criminal cases filed in court by the Antitrust Division, number of grand jury investigations, number of firms and individuals prosecuted, among others. Our main approach is to use the Vector Autoregressions (VAR) methodology to study the dynamic interrelationships. The VAR framework has proved useful in studying the historical dynamics of sets of jointly-determined variables; Hamilton (1994), Enders (1995), Brooks (2002) and Pagan (1995) present details about this methodology and the pros and cons. In contrast to univariate methods, VARs explicitly allow cross-variable dynamics. In VAR modeling, each system (jointly-determined) variable is modeled as a function of it's own lagged values, lagged values of the other jointly-determined variables and any exogenous variables that may be relevant. In terms of drawing inferences, the main point is as follows. Suppose we consider a one-standard-deviation increase in the number of grand jury investigations. The VAR modeling allows us to examine how this change leads to changes in the number of firms and individuals prosecuted, change in future criminal cases filed in court, and future changes in grand jury investigations. (One can think of this process as forecasting what will happen to the endogenous variables in the VAR system once a given variable experiences a change.) This process can be carried out for each of the jointly-determined variables in the system. In short, the VAR methodology allows us to examine the dynamic interrelations and the various feedback effects within the system. While VARs have been criticized (noted below), there is general agreement that this methodology can be used to describe historical dynamics and interrelationships in time-series data, forecasting time-paths of

variables of interest, and uncovering interesting observations that can be pursued in future research.

A limitation of VARs is that since the variables of interest are treated as jointly-dependent, the only equations that can be estimated are the reduced-form equations in which the jointly-determined variables are modeled as functions of lagged-values of the endogenous variables. This implies that the VAR framework does not permit a structural interpretation of the model's parameters. While this is a shortcoming, in our context it is not possible to write a structural model because our dataset does not contain detailed information that would allow us to model the decision-making process either of the firms that are engaging in price-fixing behavior or of the antitrust enforcement officials. Given this, we do not consider structural estimation. Since the VAR methodology has shortcomings, as alternative estimation strategies we also present single-equation and SUR estimates. As we note in section 6, the single-equation and SUR estimates allow us to examine the estimated coefficients of both the jointly-determined and pre-determined variables and compare our inferences with those obtained from the VAR estimation.

Vector Autoregression Framework

The Vector-Autoregression (VAR) system we employ is given by equation (1):

$$(1) \quad \mathbf{X_t} = \mathbf{A(L)X_{t-1}} + \mathbf{B(L)Z_{t-1}} + \boldsymbol{\varepsilon_t}$$

where **X** is the vector of jointly-determined (or endogenous) variables with **A** the corresponding matrix of coefficients, **L** is the lag operator, **Z** is a vector of pre-determined (or exogenous) variables with **B** the coefficient matrix, and **ε** consists of the white-noise error terms that may be correlated. By design, no contemporaneous jointly-determined variables enter the VAR system. Due to having lagged values, all the right-hand-side variables are pre-determined. To be correct technically, system (1) is a "near-VAR" as the model includes exogenous variables. A pure VAR only includes endogenous variables (see Enders

1995, Ch.5; and Hamilton 1994, Ch.11). For simplicity, we will refer to our system as a VAR.

We consider the following five variables as the components of the vector **X**, the jointly-determined variables: (1) number of civil court cases prosecuted (Civil); (2) number of grand jury investigations initiated (Grand Jury); (3) number of criminal court cases prosecuted (Criminal); (4) number of firms convicted ($Convict^{Firm}$); and (5) number of individuals convicted ($Convict^{Indiv}$). We discussed these variables in section 2 and none of them can be seriously argued to be exogenous. An omission are the monetary fines imposed on firms and individuals. While these fines are clearly important variables, their time-series data are problematic. These data are essentially flat for the vast majority of the sample period and only towards the end do they show significant variation (figures 4 and 5). Our attempts to incorporate these data into our VAR analysis revealed no meaningful insights and we do not discuss them further as part of our econometric analysis. But we return to a more general discussion in section 8.

While the VAR methodology treats the declared set of variables as jointly-determined, it is important to properly *order* the variables if information is available. That is, which variable (or effect) is more likely to come early in the process and which may come later. Ordering determines shocks to which variables will have contemporaneous effects versus lagged effects. If we knew the correct ordering but instead estimated the VAR system with an opposite ordering, then the contemporaneous and lagged effects will be all mixed up. Enders (1995, p.305-310) presents a discussion of this issue. The ordering we consider is the same as listed above with civil court cases first and firms and individuals convicted last. Our justification for this ordering is as follows. Given the taxonomy of a typical criminal investigation outlined in Section 2, information revelation comes first, followed by grand jury investigation, followed by the criminal prosecution followed by sentencing and conviction of firms and individuals. For example, for an investigation we do not expect sentencing of individuals and corporations to precede grand jury investigations. We order the civil investigations first as, based on our

discussion in Section 2, these investigations are viewed as one of the conduits for information about cooperative market conduct and subsequent criminal cases. Finally, we note that within the constructed VAR system, we are able to evaluate all the intertemporal feedback effects. For example, if there is an increase in criminal cases, we can see how this affects criminal prosecutions in the future as well as the contemporaneous and future effects on the other four jointly-determined variables in the VAR system – civil cases, grand jury investigations, and the number of firms and individuals prosecuted. This procedure is followed for each of the jointly-determined variables to obtain a detailed representation of the feedback effects; in other words, a complete picture of the dynamic interrelationships among the jointly-determined variables. In terms of the antitrust variables in the VAR system, the vector **X** is given by:

$$(2)\quad \mathbf{X_t} = \begin{bmatrix} \text{Civil}_t \\ \text{Grand Jury}_t \\ \text{Cri min al}_t \\ \text{Convict}_t^{\text{Firms}} \\ \text{Convict}_t^{\text{Indivs}} \end{bmatrix}$$

The VAR methodology allows us to examine two useful aspects of dynamic interrelationships: (1) The *impulse responses* allow us to trace the time-path of a one-standard-deviation shock to a jointly-determined variable on the entire set of jointly-determined variables in the vector **X**. For example, if there is a one-standard deviation increase in the number of grand jury investigations, the impulse-responses will trace it's effect on the number of grand jury investigations in future time periods as well as any effects on the other four jointly-determined variables: number of civil court cases prosecuted, the number of criminal court cases prosecuted, the number of firms convicted and the number of individuals convicted.

(2) The *forecast error variance decomposition* indicates the percentage of the intertemporal movements of a variable in the vector **X** resulting from it's own shock versus shocks emanating from the other variables in the vector **X**. For example, looking at two-period ahead forecasts, we could say that only 20% of the forecast error variance emanates from it's own shock and the remaining 80% from the other variables in vector **X**. The properties of these forecast errors can help uncover interesting dynamic interrelationships in the VAR system. We present additional details and interpretation of these procedures when we discuss the econometric results in Section 6.

Other Factors

Turning to the potential set of pre-determined variables to be included in vector **Z**, we consider some of the broad forces that may have shaped the intertemporal path of criminal enforcement.

1. Economic Conditions.

Economic conditions can be a conduit for information flows about collusive activity. In some instances information may flow into the Antitrust Division's investigative offices when cartels break down, and, in other instances, when they are formed with consequent increases in prices. However, as Levenstein and Suslow (2006) note, very few case studies have *"...informed our understanding on the relationship between cyclicality and cartel stability."* Most of the reliable evidence we have are from a handful of prominent cartels that have been discovered. The conventional view on the link between economic conditions and collusive agreements is summarized in Scherer (1980, p.206) who notes that:

> *"there is evidence that industries characterized by high overhead costs are particularly susceptible to pricing discipline breakdowns when a cyclical or secular decline in demand forces member firms to operate well below designed plant capacity."*

He goes on to give examples of industries like cement, mining, chemicals, steel and aluminum. According to this view, collusion is likely to break down during periods of low demand. Levenstein and Suslow (2006) review a number of studies and conclude note that cheating and negative external shocks

appear to be important contributors to cartel breakdowns.[13] Suslow (1988, 1991) found that demand conditions are a key determinant of cartel stability, with survival being directly proportional to economic activity. Baker (1989) found that cartels in the U.S. Steel industry were more likely to break down when demand is low. Examining cartels formed under the Webb-Pomerene Export Trade Act, Dick (1996) finds that stability was greater during periods of stable prices and growing demand. Slade (1990) concludes that low demand appears to be conducive to cartel breakdowns and price wars. Overall, the conclusion one can draw is that adverse economic conditions are ripe for cartel breakdowns.[14] And since cartel breakdowns are one of the channels via which the Antitrust Division may get information about collusive activity, this suggests including economic conditions in vector **Z**.

2. Political Factors.

Compared to the Carter administration, criminal prosecutions increased by 112% during the Reagan administration, and the upswing continued during the Bush (Sr.) administration. Since then the pace of prosecutions has tapered off, but there were dramatic increases in fines in the Clinton era. While the prosecutions under Bush (Jr.) administration has dropped off quite a bit, it is not clear whether this is due to lack of enforcement or whether companies have become more aware of large fines and the

[13] In terms of duration, Levenstein and Suslow note that the precise timing of the start and end of cartels is extremely hard to pin down, In terms of the evidence they compiled, cartels typically have lasted between 3 to 8 years. Of the cartels during the 1990s for which they have evidence, the average duration was about 5.4 years with a standard deviation of 4.7 years.

[14] We do not summarize the theoretical literature on price movements under collusive agreements. In part this is due to the difficulty of obtaining clear insights for our broad based empirical work. And in part this is due to the diverse and inconclusive set of theoretical results on the pro-versus-counter cyclical price movements: e.g., Rothemberg and Saloner (1986), Green and Porter (1984) and the ensuing literature. The significant differences across the papers in the modeling of demand shocks, perfect or imperfect monitoring, among other factors, make comparisons difficult. Slade (1990), for example, presents an insightful discussion of the problems of testing these oligopoly models. She points out that definitive tests that would allow us to distinguish between alternate game-theoretic models were not possible as the frequency of the data collected were often longer than the firms' response time. In addition, while the method of communicating and observability of choice variables form an important part of the dynamics of strategic interaction, controlling for these fundamentals in data would be quite difficult.

deterrence effect is working, or that cartels have devised more sophisticated mechanisms to avoid detection and have become harder to find. In terms of his antitrust philosophy, Bush noted (Financial Times, Feb. 17, 2000): "*My own personal view... is [that] ... antitrust law needs to be applied where there are clear cases of price-fixing."* He went on to suggest that antitrust enforcement should be restricted to price-fixing. From a historical antitrust perspective, this generally reflects a more extreme version of the stance on antitrust during the Reagan administration. Examining the potential political effect is also interesting because of the institutional structure of the Antitrust Division: The Assistant Attorney General who heads the Antitrust Division is appointed by the U.S. President, potentially setting the stage for shifts in enforcement with switches of the party in power. Therefore, we include political effects in the vector **Z**.

3. Regime Change

There have been several key administrative milestones related to changes in leniency laws and harsher fines to make criminal enforcement more effective and increase the deterrence value. Violations become felonies in the mid-1970s and the Corporate Leniency Program was launched in 1978 – which made it more attractive for companies and individuals to co-operate with the Antitrust Division in criminal investigations. Griffin (2003), Harrington (2006), Hunton and Williams (2003), Kobayashi (2001), Kolaski (2002), Klein (1999), Motta (2004, p.192-194) and Paul (2000) note the various facets and effectiveness of the program. But as acknowledged by the Antitrust Division itself (Griffin, 2003, and Kolaski, 2002), the U.S. leniency program was not effective till changes were made in the early-1990s. While these have been key factors in the success of enforcement in recent years, in the bigger picture of criminal enforcement these changes can be viewed as endogenous to the broader shifts in intellectual thinking about criminal enforcement and the political willingness to prosecute. The Chicago-School's economics and legal scholars took the view that the government's antitrust focus should be on cartels and certain types of mergers. Posner (1976) remarked that *"only explicit price fixing and very*

large horizontal mergers ... are worthy of serious concern." Bork (1978) notes that taking action against price-fixing have lead to potentially large gains in consumer welfare over the decades. He argued that the primary focus should be on horizontal price-fixing agreements between competitors which are per se anti-competitive. The overall impact of this change in thinking was as follows. First, civil antitrust matters related to vertical and conglomerate mergers, resale price maintenance, vertical restrictions, among others, that were looked down upon as anti-competitive and reducing welfare, were de-emphasized as greater weight was placed on the pro-competitive and efficiency aspects of mergers and business conduct. Second, the focus of enforcement shifted to areas where there was likely to be clearer harm to welfare: (i) price-fixing and related conspiracies; and (ii) horizontal mergers in relatively concentrated markets. This has been documented extensively in, for example, Baker (2002, 2003), Crandall and Winston (2003) and Kovacic and Shapiro (2000). Ghosal (2005) presents a detailed discussion of this issue including econometric analysis. The above considerations reasonably lead us to believe that the overall antitrust climate changed to emphasize the significant consumer welfare loss associated with price-fixing and related violations. Unfortunately, the precise impact of these effects are difficult to quantify and capture in an explicit variable. Given this, we implement an econometric approach to controlling for these effects: testing for structural-breaks in enforcement data. We return to a discussion of this in section 5 along with estimation of the structural break date.

4. Mergers

We include the total number of mergers (merger wave) in the U.S. One reason for including this variable relates to information flows. For example, mergers above a certain threshold valuation have to be filed for clearance (HSR filing). Based on our discussion in section 2, the examination of merger-specific information may serve as one of the conduits for information about collusive activity in markets. We do not include the total number of mergers as part of the endogenous set of variables in **X** as we do not expect price-fixing investigations to have any impact on the merger wave in the U.S.; this is expected

to be driven by broader forces related to technological changes, deregulation, movements in stock markets and other broader macroeconomic forces.

5. Funding

In general, increase in funding may lead to greater ability to investigate. It can be argued that the level of funding should be an endogenous variable as the Antitrust Division has to request funds from the legislature and requests for increase in funds may follow increase in investigations, potentially making funds endogenous. However, previous papers examining this issue (e.g., Ghosal and Gallo, 2002; Ghosal 2005) have found no evidence in the data that funds is endogenous. This may in part be explained by the fact that the level of funding is influenced by a wide combination of factors related to the complexity of cases, number of internal investigations, party of the President, composition of the House and the Senate, among others. In addition, utilization of economists and attorneys (whose salaries are the most significant component of the Antitrust Division's annual budget) vary considerably over work cycles. As noted in Ghosal (2005), this variation in utilization poses a problem of clearly linking antitrust investigations to the level of funding. Given these considerations, we do not include funds as an endogenous variable. We return to this issue when we discuss variations of our VAR system (1) as well as in section 6 when we present single-equation estimates.

In equation (1), the vector of pre-determined variables **Z**, therefore, consists of:

$$(3)\quad \mathbf{Z_t} = \begin{bmatrix} \text{EconomicConditions}_t \\ \text{Politics}_t \\ \text{Regime}_t \\ \text{Mergers}_t \\ \text{Funds}_t \end{bmatrix}$$

In section 6 we discuss econometric issues and the lag-structure of the variables in the VAR system (1).

5. Detecting Structural-Breaks in Criminal Enforcement

Figure 1(a) shows a distinct jump in the number of criminal cases prosecuted somewhere in the late-1970s to early-1980s. This jump in the level of the variable is symptomatic of a structural-break in the data. In section 4 we discussed the reasons for expecting a structural-break in criminal enforcement, namely shift in intellectual thinking that antitrust should focus on business conduct with clearer harm to welfare, changes related to criminal violations becoming felonies, leniency programs, among others. However, we don't know when these actually affected enforcement. Given this, the methodology we use tests for a structural-break in criminal enforcement at an unknown date because while we may know the approximate time-period during which a break may have occurred, ex-ante we cannot identify the precise break date (see Andrews, 1993; Hamilton, 1994, Ch.22; Stock, 1994; and Stock and Watson, 1996). The literature on structural breaks, which burgeoned in the 1990s, shows that not controlling for breaks in the data when they are present, results in biased coefficient estimates and standard errors, and misleading inferences. This literature also shows that merely detrending the data in a conventional way, when the true cause is a structural-break, in an inadequate way to address the problem. Later, in our presentation of additional results, we show that after controlling for structural-break in the data, long-run trends in criminal enforcement, either modeled as linear or quadratic, have no role to play.

Before we outline the tests, it is important to clarify what a detected structural-break date means. Let **CRIM** denote the total number of criminal cases prosecuted. Suppose $CRIM_t$ has time-series observations over t=0,...,T and the statistical tests reveal a structural-break in year 'τ'. This tells us that the mean of $CRIM_t$ series in the t=0,...,τ interval is different from the t=τ+1,...,T interval. Nothing may actually have happened in the year τ, but events in the τ+1 to T period result in a sample mean that is different from the preceding period.

Let $CRIM_t$ be the number of criminal cases prosecuted and τ the hypothesized unknown structural break date. The dummy variable $D(\tau)$ is defined as $D_t(\tau)=0$ for $t \leq \tau$ and $D_t(\tau)=1$ for $t>\tau$. A regression including the unknown structural break point is given by equation (4):

$$(4)\quad CRIM_t = c_0 + \sum_{k=1}^{n} \rho_k CRIM_{t-k} + \xi D_t(\tau) + \omega_t .$$

The specification is autoregressive of order-n where 'n' is determined optimally based on the number of lags that are significant to fully account for the variables own dynamics. Equation (4) allows for a change in the intercept before and after the hypothesized break point and under the null hypothesis of no structural break, $\xi=0$. Since the break date τ is unknown, we consider a series of break dates between two potential dates τ_0 and τ_1. For each hypothesized break date, we estimate the above equation and get a F-statistic from testing $\xi=0$ against the alternative of $\xi \neq 0$. We focus on the largest of the resulting F-statistics from the sequence and use the Quandt Likelihood Ratio (QLR) statistic to detect the break point. As noted in Stock and Watson (1996), the distribution of the QLR statistic depends on the number of restrictions being tested q (q=1 in the above equation), and the width of the end-points τ_0/T and τ_1/T, where T is the total sample size; τ_0 and τ_1 cannot be too close to the sample endpoints. Following Stock and Watson (1996), we consider a 15% trimming of the CRIM time series; i.e., $\tau_0=0.15T$ and $\tau_1=0.85T$. Given our full sample period of 1948-2003, this implies that we delete about 9 years from each end of the sample and test for a structural-break in criminal enforcement over the window 1957 to 1994.

We estimated equation (4) with lag lengths of up to four (n=4), but only two lags were significant. Estimating (4) and testing for all potential break dates between 1957 and 1994 revealed the highest F-statistic of 6.23 for the year 1979. The estimated F-statistics were compared with critical values of the Quandt Likelihood Ratio statistic with 15% trimming: 1%=7.78, 5%=5.86 and 10%=5.00. Thus

our highest F-statistic of 6.23 is significant at the 5% level. Given our sample period, this implies that 1948-1979 represents one regime with lower criminal prosecutions on average and 1980-2003 represents a new regime of higher prosecutions. Therefore, in our econometric specification, we enter a D(1979) dummy (=0 over 1948-1979 and =1 thereafter) to capture a new regime in criminal enforcement.

We also examined extended specifications for testing for structural-breaks. The estimated break date was the same as that obtained using equation (4). Ghosal (2005) presents a more detailed analysis of structural breaks in U.S. antitrust enforcement data.

We did not conduct extensive tests for structural-breaks on the other criminal enforcement variables in vector **X**. The reasons are as follows. First, looking at the data in figure 2 and figure 3, it is not apparent that there is indeed a clear break in the data; this is in sharp contrast to the data in figure 1(a). We had noted earlier that the data on fines (figures 4 and 5) are not a part of our vector of variables **X**. Second, our limited experiments with testing for breaks for the other variables did not reveal evidence of clear breaks in these data. An important problem of testing for breaks for these variables is that while the total criminal prosecutions series starts in 1948 and allows for thorough testing, the other variables such as grand jury investigations and the number of individuals and firms convicted are available only starting 1969. This significant reduction in the number of time-series observations creates problems for testing for structural breaks. Given this, we did not pursue this issue any further for the other criminal variables. In terms of the total number of civil cases initiated, using an equation similar to (4) but using the total number of civil cases revealed a structural break in the year 1972. Given our sample period, this implies that 1948-1972 represents one regime with higher civil cases on average, and 1973-2003 represents a new regime with lower cases. In our econometric specification, we enter a D(1972) dummy (=0 over 1948-1972 and =1 thereafter) to capture a new regime in civil enforcement. Ghosal (2005) presents a more detailed analysis of structural breaks in U.S. antitrust enforcement data.

6. VAR Estimation and Results

In our estimation of the VAR system given by equation (1):

(1) We use two-lags each of the jointly-determined variables in our system. There are a couple of reasons for this. First, additional lags were insignificant. Second, additional lags of the endogenous variables quickly erode degrees of freedom given the structure of the VAR system and the number of time-series observations we have available. Later we report our findings using only one-lag of each variable;

(2) For the political effect we use a dummy variable to represent the party of the President (=1 if Republican). Since each term is four years, and some Presidents served second-terms in office, there is a high degree of persistence in this variable. Given this we include only one-lag of the political variable;

(3) As estimated and discussed in section 5, the regime variable is the dummy variable for the total number of criminal cases initiated (=1 after 1979; and zero before), and we include only one-lag of this variable. As noted in section 5, the regime variable does not enter the equations for grand jury investigations, number of firms convicted and the number of individuals convicted.

To provide a glimpse of what one equation looks like in our VAR system given by equation (1), consider the equation for the criminal cases prosecuted which is the third-equation in the VAR system:

$$\begin{aligned}(5)\ \text{Criminal}_t = \alpha_{30} &+ \sum_{i=1}^{2}[\alpha_{1i}\text{Civil}_{t-i} + \alpha_{2i}\text{Grand Jury}_{t-i} + \alpha_{3i}\text{Criminal}_{t-i} + \alpha_{4i}\text{Convict}^{\text{Firms}}_{\text{t-i}} + \alpha_{5i}\text{Convict}^{\text{Indivs}}_{\text{t-i}}] \\ &+ \sum_{j=1}^{2}[\beta_{1j}\text{Economy}_{t-j} + \beta_{2j}\text{Merger}_{t-j} + \beta_{3j}\text{Funds}_{t-j}] \\ &+ \beta_{41}\text{Politics}_{t-1} + \beta_{51}\text{Regime(1979)}_{t-1} + \varepsilon_{3t}.\end{aligned}$$

The following is one way of interpreting equation (5). First, in terms of the jointly-determined (endogenous) variables, criminal prosecutions in period 't' are a function of *information flows* and *investigations* in preceding periods. As we discussed in section 2, there a myriad sources of information,

including past criminal prosecutions, prosecutions of firms and individuals, information revealed during civil investigations, among others. The lagged values of the endogenous variables in equation (5) capture these effects. Second, economic activity was a possible source of information about collusive behavior and lagged values of economic conditions capture this effect. Finally, political effects and regime (more or less emphasis on criminal prosecutions) drive the number of criminal cases. Given the parsimonious structure of the VAR system (1), the equations for all the five jointly-determined variables have an identical structure. The estimated coefficients, of course, are free to vary across the different equations.

Estimation of VAR systems requires an orthogonalization procedure for the errors. We choose the Choleski decomposition; for more on this see Enders (1995, Ch.5) and Hamilton (1994, Ch.11). Orthogonalized innovations have the property that they are uncorrelated across time and across innovations and allow us to examine the effects of pure shocks to a single variable in the VAR system and then trace it's effects on the other variables in the system. Since this is a well documented procedure, along with alternative decomposition strategies, we do not discuss it further. As is standard for VAR estimation, from our estimation results we present two sets of results. First, in **Table 2**, we present the *impulse-responses*. Instead of graphing the impulse responses, we present the numbers in table form to provide a closer look. Second, in **Table 3**, we present the *forecast error variance decompositions*.

Impulse responses (Table 2)

As we noted in section 4, impulse-responses trace the response of the endogenous variables in the VAR system to shocks to each of the variables. For example, if we consider a one-standard-deviation (one-s.d.) innovation in the number of grand jury investigations equation, the effect of this shock is traced through all the five endogenous variables in our system: civil cases, grand jury investigations, criminal cases, firms convicted and individuals convicted. Therefore, for a shock to each endogenous variable, we generate five impulse-responses; the variable's own future time path as well as the four other

endogenous variables. Below we interpret the numbers in table 3 and highlight some of the main findings.

First let us examine the results in panel E (last panel) of table 2, which traces the impulse-responses of a one-s.d. innovation in the number of individuals convicted. In section 4 we discussed the ordering of variables in our VAR system and the number of individuals convicted was ordered in the fifth place. What this implies is that when there is an increase in the number of individuals convicted, it will have *no contemporaneous effect* on the preceding four variables in the VAR system. Any effects on civil cases, grand jury investigations, criminal cases and firms prosecuted will be in future periods. Therefore, in panel E, the current period row has entries of "zero" for the preceding four variables. The main results from panel E are that if there is a one-s.d. innovation (increase) in the number of individuals prosecuted this year, the subsequent three years see: (1) an increase of about 2, 4 and 2 new criminal cases; (2) the number of firms convicted increases by about 1, 4 and 4; and (3) the number of individuals convicted increases by about 3, 4 and 2. One likely explanation of these results is that information uncovered during the prosecution of individuals this year, leads to discovery of other price-fixing agreements and future convictions of firms and individuals.

Similarly, the main results of interest from panel D are that a one-s.d. innovation in the number of firms convicted leads to: (1) a current increase of about 6 individuals convicted; (2) future increases in the number of firms convicted (about 5, 4 and 6); (3) future increases in number of individuals convicted (about 4, 2 and 1); and (4) future increases in the total criminal cases filed in court (about 2, 2 and 3). From panel C, a one-s.d. innovation in the number of antitrust criminal cases initiated by the Department of Justice, leads to increases in future criminal cases initiated and prosecutions of firms and individuals. In panel B, for a one-s.d. innovation in the number of grand jury investigations, the main effect appears to be an increase in current and future increase in the number of firms prosecuted. Finally, panel A contains the results of a one-s.d. innovation in the number of civil antitrust cases initiated. As the table

shows, this leads to current as well as future increases in the number of criminal cases filed in court and firms and individuals convicted.

The main results from table 2 can be summarized as follows:

(1) There is noticeable dynamic interplay between the criminal variables. A one-s.d. innovation (increase) in grand jury investigations, criminal cases initiated, and number of individuals and firms convicted generates changes in most of the endogenous variables in future periods. A broad conclusion one can draw is that information unearthed during a given criminal investigation and prosecution reveals information about other conspiracies leading to future investigations and prosecutions;

(2) A one-s.d. innovation in civil court cases initiated leads to future increases in the criminal cases filed in court and firms and individuals convicted. The estimated quantitative effects are meaningful. An inference that can be drawn is that information gleaned during civil investigations, such as mergers or monopolization cases, serves to reveal information about collusive behavior in markets leading to criminal investigations and prosecutions.

Forecast error variance decompositions (Table 3)

Variance decompositions provide information about the relative fraction of the future movements in an endogenous variable that emanate from the variable's own past shock (change) versus changes due to shocks to the other endogenous variables. In other words, if we were to examine the k-period ahead forecast error variance of a given endogenous variable, the variance decompositions inform us of the extent to which this arises from past shocks to the variable itself versus the other endogenous variables.

Examining the results in panel E (table 3), we find that for the one-year ahead forecast, 25.5% of the error variance of the number of individuals convicted is explained by shocks emanating from past individuals convicted, 39.5% arises from shocks to the number of firms convicted and 22% from past shocks to civil cases. Shocks to grand jury investigations and criminal cases filed in court account for

about 3% and 10% respectively. Thus, shocks to the number of firms convicted emerges as the single most important variable in forecasting the future number of individuals convicted. As we look at longer forecast horizons up to four-years ahead, shocks to firms and individuals convicted account for the majority of the forecast error variance at close to 70%. This finding is consistent with those in panel D of table 2 where we found that a one-s.d. shock to the number of firms convicted generated large increase in the number of individuals prosecuted.

In panel D, we find that past shocks to the number of firms convicted emerges as the dominant force in explaining future conviction of firms. Past shocks to civil cases initiated and grand jury investigations emerge as the two other main factors but their contributions are not large. For the number of criminal cases in panel C, we find that in the longer-horizons, say the four-year ahead forecast, 44% of the error variance decomposition is accounted for by past shocks to the variable itself, but past shocks to civil cases and the number of firms and individuals convicted make meaningful contributions. For panel B, for grand jury investigations, apart from the variable's own past shocks, the number of firms convicted appears as the main contributor to the error variance decomposition.

Overall, the results in table 3 reveal a rich interaction between the variables, especially as we look at the longer forecast horizons. One interesting theme that emerges from panels B-E of table 3 is that civil investigations are a consistent and important contributor to the forecast error variance of the various criminal investigation and prosecution variables. This was evident also in the results in panel A of table 2 which revealed that a one-s.d. shock to civil cases filed lead to quantitatively meaningful increases in the criminal prosecution variables. Of the four criminal enforcement variables, the importance of which variables contribute the most varies depending on the specific variables under consideration.

Some checks of robustness

The first check we considered relates to the ordering of the variables. In our VAR system (1), the

ordering of the jointly-determined variables was as follows: #1 civil cases, #2 grand jury investigations, #3 criminal cases, #4 firms convicted, and #5 individuals convicted. In section 4 we noted that the ordering of variables is important in VAR estimation. If the prior information does not permit an appropriate ordering, then it is important to alter which variable is ordered first and which last. But based on our discussion in section 2, the criminal investigation process and prosecutions follow a distinct sequence based on which we choose the ordering noted above. Based on the information in section 2, it would make no sense to, for example, order individuals convicted first and civil cases last. This would be contradictory of the investigations process and sequence. The variations of the ordering we experimented with involved switching the order of (a) equations #1 and #2 and (b) equations #4 and #5. For these alternative ordering schemes there were no meaningful differences in our inferences. The second check relates to lag lengths of the endogenous variables. In our estimation of system (1), we used two-lags of each jointly-determined variable. We did not experiment with adding third-lags as this would severely constrict the degrees of freedom. Reducing the number of lags to one was problematic as many of the second-lags were statistically significant. However, dropping the second-lags substantially increase the degrees of freedom. For a look at the results, we did re-estimate system (1) with one-lag for each of the endogenous variables. While there were some differences in the estimated quantitative effects, our overall inferences remained intact. (These results are available on request.)

7. Single-Equation and SUR Estimation

Given our discussion in section 2 of the process of criminal investigations and the various sources of information that may lead to criminal cases, the empirical finding of the interrelationships between the set of criminal investigation variables – grand jury investigations, total criminal cases filed in court, number of firms convicted and number of individuals convicted – is not surprising. While we had indicated in section 2 that one of the sources of information may be civil investigations, the finding of a

rather strong linkage between civil and criminal investigations is more intriguing. To get a closer look at this relationship, in this section we present some single-equation estimates for the criminal cases and two-equation Seemingly Unrelated Regression (SUR) estimates using civil and criminal cases. There is an additional advantage of examining single-equation estimates. The VAR analysis does not allow us to examine impulse responses for variables that are not endogenous. For example, we are not able to generate the quantitative responses for fluctuations in economic activity. And, as we discussed in section 2, fluctuations in economic activity could be an important link in the criminal investigative process.

One important difference from the VAR analysis of the preceding section is that here we use a longer time-period 1948-2003 for which data on criminal cases filed are available. This implies that we will omit using data on grand jury investigations and number of firms and individuals convicted from the estimated specification; as noted in section 4, these data are available only starting 1969. While this is a shortcoming, the longer time-series allows us to take a closer look at the linkages between criminal and civil investigations and also the role of economic fluctuations on criminal cases.

The specification for single-equation estimation is derived using the quadratic cost-minimization subject to adjustment and disequilibrium framework. The details are presented in Appendix A. We note one econometric issue before presenting the specification. To a greater or lesser extent, the levels of several of the explanatory variables are non-stationary, such as the Antitrust Division's funding, the total number of mergers in the U.S. and GDP. We formally tested for non-stationarity using the Augmented Dickey-Fuller and Phillips-Perron (1988) unit root tests; these tests have a null hypothesis of difference-stationary. Using conventional significance levels, these tests could not reject the null that these variables are difference stationary. Given this, we entered the Antitrust Division's funds, GDP and the merger wave variables in first-differences.[15] The specification we estimate is given by equation (6):

[15] We did not first-difference the data for the VAR analysis as this is the recommended strategy in general:

$$(6)\quad \mathrm{CRIM}_t = c_0 + \sum_{j=1}^{2}[\theta_j \Delta\mathrm{MERG}_{t-j} + \gamma_j \Delta\mathrm{ECON}_{t-j} + \zeta_j \mathrm{CIVIL}_{t-j} + \rho_j \mathrm{CRIM}_{t-j}] + \delta\Delta\mathrm{FUND}_{t-1}$$
$$+ \alpha\mathrm{PRES}_{t-1} + \xi\mathrm{D}(1979) + \psi\mathrm{D}(1979)\mathrm{PRES}_{t-1} + \varepsilon_t$$

where, Δ represents first-difference and, as discussed in Appendix A, the error term ε_t is a moving-average process. To check whether the error term required a higher-order MA(.) specification, as would result from a richer lagged structure (in equations A.3 and A.4 in Appendix A), we implemented a Lagrange-Multiplier test for an MA(2) error structure. The test statistics are reported at the bottom of Table 4. For the specification in column A, we cannot reject a MA(2) structure.

As noted in **Table 4**, except for the coefficients related to the constant, PRES_{t-1}, D(1979) and D(1979)*PRES_{t-1}, the reported numbers are the coefficient estimates multiplied by one-standard-deviation of the respective variable. Since there is considerable variation in the size of the estimated coefficients, and means and standard deviations of the variables, the estimates multiplied by one-s.d. give us a ready look at the implied quantitative effect. The key findings from the results presented in column A are:

1. Civil Antitrust Enforcement: The number of total criminal cases filed increases after an increase in the number of civil court cases. The quantitative effect is an increase of about 5-6 cases prosecuted. Criminal cases also increase after an increase in the total number of mergers in the economy. The quantitative effect is an increase of about 6 cases. These two results are rather significant in the sense that an increase in civil enforcement and a greater number of mergers evaluated by the division do not appear to distract the Division into ignoring criminal investigations. Quite the contrary, our results point to *complementarities* between civil enforcement and merger control on the one hand and criminal

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see Enders (1995, Ch.5), Hamilton (1994, Ch.11), Pagan (1995) and Sims (1980).

enforcement on the other. One plausible interpretation of these results is that civil investigations and merger evaluation unearth information related to price-fixing and related conduct leading to investigations and an increase in criminal prosecutions.

2. Economic Activity: Criminal prosecutions by the Antitrust Division appear strongly counter-cyclical, with the number of prosecutions increasing about two-years after an economic downturn. The combined quantitative effect shows an increase of 7 to 8 cases prosecuted; this is a meaningful quantitative effect given the sample mean number of criminal cases prosecuted of about 35. We experimented using alternative measure of economic conditions such as stock price indices and corporate profits – our overall conclusions were similar to those with GDP. Can this result shed light on collusive practices? Given the broad nature of our criminal prosecutions data, one can only make rough inferences. One plausible explanation of our counter-cyclical result is that collusive agreements tend to break down during economic downturns and subsequently information flows into the investigative offices of the Antitrust Division resulting in investigations and prosecutions. This ties in with some of the literature cited in section 4 which support the view of cartel breakdown during downturns.

3. Structural-Break: The estimate on the structural-break dummy D(1979) shows an increase of about 37 cases per year after the break. As was discussed in section 4, the interpretation of the identified structural break-date is important: nothing actually has to have happened in 1979, but that the mean of the criminal cases series over the 1980-2003 period is (statistically) significantly greater than the mean of the series over 1948-1979. Our motivation for searching for the potential break-year and including the structural-break dummy was the shift in intellectual thinking towards greater emphasis on business conduct like price-fixing that resulted in incontrovertible loss of welfare and several administrative changes.

4. Political Effect: The coefficient on the D(1979)*PRES interaction term indicates that post-structural-break, Republican administrations have systematically initiated about 12 more criminal prosecutions per year than Democrats. Correspondingly, the coefficient on the PRES variable is insignificant implying that

pre-structural-break, there was no difference between Republicans and Democrats in their propensities towards criminal enforcement. One explanation of this finding is that Republicans, by focusing on criminal enforcement, attempt to target business conduct with clearer loss of welfare such as price-fixing.

We close by noting some of the other results. First, an increase in the Antitrust Division's funding appears to have a negative effect on the number of criminal cases initiated. While the result is a bit odd, several previous studies have produced mixed effects of the Divisions funding on case activity. The late-1970s and early-1980s simultaneously saw dramatic increases in criminal prosecutions and significant cuts in the Division's budget. This feature alone is likely to be driving the estimated negative relationship between funding and criminal enforcement. Omitting the funding variable from our estimated regressions did not change the other results. Second, in column B we re-estimate the specification in column A by augmenting it with a linear trend. The justification for adding a trend is as follows. As we look at figure 1(a), in a conventional sense one might argue that the time-series in criminal cases is simply positively trended over the sample period. If so, controlling for the trend may be important as omission of this might render our inference suspect. As we see from the estimates in column B of table 4, the trend variable itself is insignificant and does not alter any of our conclusions from column A. We also re-estimated with a quadratic trend and our inferences do not change. Third, since various appointments to the House and Senate committees and sub-committees and funding decisions are dependent on which party has majority, these may be important political influences exerted on the Antitrust Division's activities. The results reported in column C show that both these political variables are insignificant and do not add to our understanding of the intertemporal changes in criminal enforcement.

Seemingly Unrelated Regressions (SUR)

Since we do not have a structural model from which we can get cross-equation restrictions to estimate a simultaneous equations system, we instead estimated a Seemingly Unrelated Regressions

(SUR) model which allows for error correlation across equations. In particular, we estimated a two-equation SUR for criminal and civil cases. In the event that there is cross-equation error dynamics, SUR may provide superior inferences compared to those from a single-equation estimation. The equation for the total number of civil cases is similar to equation (6). The differences are that the structural-break dummy for civil cases is D(1972), as 1972 was the estimated break date (see section 4). Thus, the last two variables in equation (6) become: D(1972) and D(1972)$Pres_{t-1}$. The SUR results are in **Table 5**. Examining column A from table 4 with the column on criminal cases from table 5, we note that while there are marginal quantitative and qualitative differences, the inferences from column A of table 4 remain intact. The inferences related to (i) the role of civil investigations on criminal cases and (ii) the link between cyclical fluctuations and criminal cases initiated are virtually identical.

8. Concluding Remarks

Due to the stringent confidentiality restrictions imposed by the Department of Justice on the true origins of criminal investigations, we have precious little knowledge about the genesis of criminal investigations. In this paper we used broader publicly available data to search for (historical) dynamic interrelationships between the different facets of criminal enforcement as well as between criminal and civil enforcement. Some of our key findings are: (1) increase in the number of grand jury investigations lead to increases in the number of criminal cases in general and prosecution of firms in particular, with lags of about two years; (2) increase in the number of antitrust criminal cases initiated by the Antitrust Division leads to increases in future criminal cases, and prosecutions of firms and individuals; (3) increase in the number of firms convicted leads to future increases in the number of grand jury investigations and the number of firms and individuals convicted; (4) increase in the number of individuals convicted leads to increase in the number of firms and individuals convicted in future periods; and (5) criminal prosecutions increase a year or two after increases in civil antitrust enforcement

(merger and monopolization cases). For all of the above results, the estimated quantitative effects are meaningful. Results (1)-(4) above point to significant dynamic interrelationships and information-spillovers in the process of criminal investigations. An inference that can be drawn is that a given investigation and prosecution generates information about related conspiracies, leading to future investigations and prosecutions. More interestingly, in some ways, result (5) indicates a strong relationship between civil and criminal investigations, with increase in civil investigations and merger evaluations leading to increase in future criminal investigations and prosecutions. This points to complementarities between the civil and criminal investigative processes; information gleaned during civil investigation provide clues to collusive activity in markets. Future research using more detailed datasets and case-specific information may be able to shed additional light on these investigative interrelationships.

Our analysis also revealed that criminal enforcement follows a distinct counter-cyclical pattern with the number of criminal cases prosecuted increasing about two years after an economic downturn. We tie this finding to the literature which suggests cartel instability during economic downturns.

We end with two concluding remarks. First, the result that merger and civil antitrust investigations are good predictors of future criminal prosecutions, implies information spillovers. One implication is that firms who are engaged in price-fixing agreements should be very careful about applying for merger clearance as the antitrust merger investigation may lead to information about price-fixing activities and subsequent prosecution of firms and individuals. Discovery of price-fixing agreements may also serve as an important reason for the merger to be blocked. Second, price-fixing agreements are covert and very difficult to unearth. Therefore, antitrust authorities, as part of their current criminal as well as civil investigations, should make a concerted effort to glean whatever information they can about collusive activity in the markets.

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Appendix A: Deriving the Single-Equation Specification

We begin by presenting some notation. Let $CRIM_t$=number of criminal antitrust cases filed in court; $VIOL_t$=number of (unobserved) criminal violations; POL_t=political party of the president with P=1 if Republican, else 0; REG_t=regime with R=1 if new regime, else 0; $FUND_t$=funding allocated to the Antitrust Division; $MERG_t$=total number of mergers in the U.S.; $ECON_t$=aggregate economic conditions; and CIVIL=the total number of civil (monopolization, mergers, restraints of trade) antitrust court cases.

Consider the standard partial-adjustment equation:

$$\text{(A.1)}\quad CRIM_t - CRIM_{t-1} = \lambda(CRIM_t^* - CRIM_{t-1}),$$

where $CRIM_t$ is the actual number of court cases, $CRIM_t^*$ is the desired number of cases. The actual change in the number of criminal cases is a fraction λ ($0 \le \lambda \le 1$) of the desired change, with λ being a function of the adjustment and disequilibrium costs.[16] One can think of adjustment and disequilibrium costs arising for the Antitrust Division for the following reasons. First, the Division faces monetary and non-monetary (attorneys, economics, support staff) constraints to undertake criminal as well as civil (mergers, monopolization, restraints of trade) investigations. The number of criminal investigations the Division pursues, and consequently the number of prosecutions, may end up being less than the desired number due to such constraints. Second, consider a situation where the economy has numerous price-fixing conspiracies that result in higher prices, but the Division is not vigorously pursing criminal investigations.[17] The rise in prices often lead consumers to complain to their congressmen and senators with calls for greater action and investigations.[18] At the other end of the spectrum, suppose there is excessive activity by the Division in terms of prosecuting companies for price-fixing and related behavior. Producer groups may lobby the legislators to have the Division back off. Since being out of equilibrium in the intensity of enforcement implies greater scrutiny, the Antitrust Division would like to take corrective action if the current level of enforcement is too little or too much. Thus, in our context, we assume that the Antitrust Division pursues criminal investigations and prosecutions subject to minimizing these two costs and makes a sequence of actual $CRIM_t$ decisions designed to meet the target $CRIM_t^*$ which is a function of relevant driving variables.

Next, we model the desired $CRIM_t^*$ as a function of the relevant driving variables. Let $CRIM_t^*$ be specified as:

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[16] The partial-adjustment equation is derived from a quadratic cost-minimizing framework. The theoretical and empirical underpinnings of the framework where one considers a decision-maker's objective to minimize the expected present value of a quadratic loss function subject to adjustment and disequilibrium costs are well documented in Gould (1968), Kennan (1979) and Treadway (1971).

[17] This could arise either because the Division is pre-occupied with other types of investigations, uninformed and unaware of these violations or that it's current stance is one of less focus on criminal matters.

[18] Some of the markets where these have occurred include, for example, retail gasoline, cable TV, airline, building contracts, school milk and lunch contracts, government procurement contracts, among others.

$$(A.2)\ CRIM_t^* = a_1 VIOL_{t-1} + a_2 POL_{t-1} + a_3 REG_{t-1} + a_4 FUND_{t-1} + a_5 MERG_{t-1} + a_6 ECON_{t-1} + a_7 CIVIL_{t-1} + u_t$$

First, in section 2 we described the process of investigations and prosecutions. Given this, we assume that the relevant factors take time to impact the number of investigations and prosecutions and only use lagged values. Second, the motivation for equation (A.2) is as follows. $CRIM_t^*$ is driven by the lagged number of (unobserved) violations, VIOL, assuming that it takes time for information about possible violations to flow into the Antitrust Division; a_1 is expected to be positive. The Division's willingness to investigate and initiate new prosecutions depends on the prevailing political stance, POL. As we noted in section 4, Republican administrations appear to place greater emphasis on price-fixing and related violations; a_2 is expected to be positive. Under a new regime, REG, that favors intensified antitrust enforcement in areas of clear welfare loss such as price-fixing, we expect a_3 to be positive. The new regime effects following the emphasis placed by the Chicago school scholars on price-fixing as well as various administrative changes were discussed in section 4. The ability to initiate new investigations is expected to be dependent on the level of funding, FUNDS; a_4 is expected to be positive. The total number of mergers in the U.S., MERG, incorporates multiple effects. For example: (a) an increase in the number of mergers to be evaluated may give rise to the possibility that significant amounts of monetary and non-monetary resources may be diverted to evaluate them, potentially taking resources away from pursuing criminal and other types of cases; and (b) information discovered by the Antitrust Division during merger evaluations may unearth price-fixing and related violations and this may lead to increased criminal cases. Given the conflicting directional effects, the sign of a_5 is ambiguous. The economic activity variable, ECON, is linked to the literature on cartel stability discussed in section 4. Given the mixed results on the formation and stability of collusive agreements over economic expansions and contractions, the sign of a_6 is ambiguous. Finally, the civil enforcement variable, CIVIL, potentially captures multiple effects: (a) a greater emphasis on civil enforcement may take away resources and focus from criminal matters; and (b) greater number of civil investigations, such as monopolization and restraints of trade cases and mergers, may lead to discovery of information related to criminal violations (see section 2). Given the divergent effects, the sign of a_7 is ambiguous. The error term is assumed to be iid: $u_t \sim (0,\sigma_u^2)$.

Finally, we specify the equation for the (unobserved) violations as:

$$(A.3)\ VIOL_t = v_0 + b_1 POL_{t-1} + b_2 REG_{t-1} + b_3 CRIM_{t-1} + b_4 MERG_{t-1} + b_5 ECON_{t-1} + e_t.$$

We assume that every period has some given number of (unobserved) criminal violations v_0. Regarding the factors that might influence the intertemporal variation in violations, we assume that these effects take time and only use lagged values. A Republican administration or a new regime (REG) that places greater emphasis on criminal prosecutions would imply potentially lesser violations as firms perceive a higher probability of prosecution; b_1 and b_2 are expected to be negative. If the Antitrust Division is vigorously prosecuting criminal cases, CRIM, then potential violations are likely to be lower due to the greater likelihood of detection and prosecution; $b_3<0$. In periods characterized by greater mergers (MERG), potential violators may be more inclined to engage in anti-competitive behavior with the view that the Division is pre-occupied with evaluating mergers; $b_4>0$. The economic activity variable, ECON, controls for the link between economic conditions and criminal violations. Given our discussion in section 4, the direction of the relationship (sign of b_5) is ambiguous. The error term is assumed to be iid: $u_t \sim (0,\sigma_e^2)$.

We use equation (A.3) to replace V_{t-1} in (A.2) and then use the resulting expression to replace $CRIM_t^*$ in (A.1). The final estimating equation is of the general form:

$$\text{(A.4)}\ CRIM_t = c_0 + \sum_{j=1}^{2}[\alpha_j PRES_{t-j} + \beta_j REG_{t-j} + \delta_j MERG_{t-j} + \gamma_j ECON_{t-j} + \zeta_j CIVIL_{t-j} + \psi_j CRIM_{t-j}] + \theta FUND_{t-1} + \varepsilon_t,$$

where $\varepsilon_t=(u_t+a_1e_{t-1})$, and f, g, h, i, j and k are the lag lengths. Given the structure of equations (A.1), (A.2) and (A.3), the lags f=g=i=j=m=2 and k=h=1. The coefficients in equation (A.4) are typically combinations of the coefficients in equations (A.1), (A.2) and (A.3). Given our assumptions for the error terms u_t and e_t, and assuming zero covariance between u_t and e_t, ε_t is a linear combination of two iid errors: $\varepsilon_t \sim iid(0, \sigma_u^2+a_1^2\sigma_e^2)$, which is similar to a MA(1) process.

We end this section with two comments:
(1) We use a similar justification to derive the specification for the civil cases; and
(2) Following our analysis in section 5, for the criminal cases equation, the regime variable is a dummy D(1979) (=0 over 1948-1979 and =1 thereafter) to capture a new regime in criminal enforcement. And, for the civil cases equation the regime dummy is D(1972) dummy (=0 over 1948-1972; and =1 thereafter) to capture a new regime in civil enforcement.

Table 1. Antitrust Division's Request for Information About Price-Fixing and Other Violations
Source: http://www.usdoj.gov/atr/contact/newcase.htm

Report Possible Antitrust Violations
Antitrust Division

How to Report a Possible Violation
Information from the public is vital to the work of the Antitrust Division. Your phone calls, letters, and e-mail messages are often the first indication of an antitrust violation and may provide the initial evidence to begin an investigation. If you have information about a possible antitrust violation or potential anticompetitive activity, whether civil or criminal, please contact the Division (contact information included). We will review your complaint and refer it to one of our offices for investigation, if appropriate.

Confidentiality
Our confidentiality policy applies to all complaints received by the Antitrust Division.

Types of Antitrust Violations
For details about different types of antitrust violations, refer to:
Antitrust Enforcement and the Consumer.
Price Fixing, Bid Rigging and Market Allocation Schemes: What They Are and What to Look For.

Leniency Policies
Individuals or companies who (a) believe they may have been involved in criminal antitrust violations and (b) cooperate with the Antitrust Division may avoid prosecution if they meet the conditions of our individual or corporate leniency (amnesty) policies.

*In the accompanying Antitrust Division's primer on price-fixing and related violations, it notes:
What You Can Do
Antitrust violations are serious crimes that can cost a company hundreds of millions of dollars in fines and can send an executive to jail for up to three years. These conspiracies are by their nature secret and difficult to detect. The Antitrust Division needs your help in uncovering them and bringing them to our attention. If you think you have a possible violation or just want more information about what we do, contact the New Case Unit of the Antitrust Division (contact information provided).

See the Antitrust Division's primer on criminal violations details the specifics of price-fixing and related violations: http://www.usdoj.gov/atr/public/guidelines/primer ncu.htm.

Table 2. VAR Impulse Responses
Estimated system: equation (1).
Sample period: 1969-2003.

A. Response to Shock in Civil Cases

Timing	Civil	Grand Jury	Criminal	Firms	Individuals
Current-year	4.46	-1.75	1.29	4.61	4.86
One-year ahead	0.60	0.44	2.21	2.85	2.49
Two-year ahead	-1.85	-1.29	4.28	3.24	0.80
Three-year ahead	-0.86	-0.15	1.40	3.71	-0.39

B. Response to Shock in Grand Jury Investigations

Timing	Civil	Grand Jury	Criminal	Firms	Individuals
Current-year	0.00	4.07	-1.95	2.10	-1.79
One-year ahead	0.26	0.56	-0.83	-0.88	0.89
Two-year ahead	2.14	-0.52	1.43	5.22	0.65
Three-year ahead	0.94	0.39	1.81	3.86	1.63

C. Response to Shock in Criminal Cases

Timing	Civil	Grand Jury	Criminal	Firms	Individuals
Current-year	0.00	0.00	7.12	0.33	3.26
One-year ahead	-0.80	0.07	2.25	3.95	1.82
Two-year ahead	-2.87	-0.39	1.09	0.55	1.01
Three-year ahead	-1.23	0.48	-0.79	0.00	-0.89

D. Response to Shock in Firms Convicted

Timing	Civil	Grand Jury	Criminal	Firms	Individuals
Current-year	0.00	0.00	0.00	11.35	6.51
One-year ahead	0.36	1.95	2.32	5.50	4.54
Two-year ahead	-1.04	1.55	2.15	4.66	1.75
Three-year ahead	-0.98	0.17	2.49	5.63	1.53

E. Response to Shock in Individuals Convicted

Timing	Civil	Grand Jury	Criminal	Firms	Individuals
Current-year	0.00	0.00	0.00	0.00	5.23
One-year ahead	-1.06	0.26	1.96	1.66	2.81
Two-year ahead	-2.43	0.36	3.71	4.30	3.55
Three-year ahead	-1.82	1.12	1.60	3.83	2.49

1. A "shock" is a one-standard-deviation innovation in the relevant variable. In panel D, for example, it is a one-s.d. innovation (increase) in the number of firms convicted that causes current and future changes in the system variables: it causes the number of individuals convicted to increase by about 6 in the current year; looking at one-year ahead, the same one-s.d. shock leads to the number of new criminal cases filed in court to increase by about 2, another 5 firms convicted and 4 individuals convicted. To conserve space, we only present the effects up to three years ahead.
2. Variable definitions: Civil=number of civil antitrust cases filed in court; Grand Jury=number of grand jury investigations initiated; Criminal=number of criminal antitrust cases filed in court; Firms=number of firms convicted; Individuals=number of individuals convicted.

Table 3. VAR Forecast Error Variance Decomposition
Estimated system: equation (1).
Sample period: 1969-2003.

A. For Civil Cases					
Forecast	Civil	Grand Jury	Criminal	Firms	Individuals
One-year ahead	100.00	0.00	0.00	0.00	0.00
Two-year ahead	91.14	0.31	2.86	0.60	5.10
Three-year ahead	52.14	10.24	19.51	2.67	15.44
Four-year ahead	46.22	10.47	19.64	4.11	19.56
B. For Grand Jury Investigations					
Forecast	Civil	Grand Jury	Criminal	Firms	Individuals
One-year ahead	15.60	84.40	0.00	0.00	0.00
Two-year ahead	13.55	70.27	0.02	15.89	0.27
Three-year ahead	17.18	59.84	0.54	21.75	0.69
Four-year ahead	16.29	57.01	1.26	20.63	4.80
C. For Criminal Cases					
Forecast	Civil	Grand Jury	Criminal	Firms	Individuals
One-year ahead	2.96	6.78	90.25	0.00	0.00
Two-year ahead	8.63	5.92	73.31	7.08	5.06
Three-year ahead	21.47	5.65	49.06	8.62	15.20
Four-year ahead	20.55	7.54	44.04	12.42	15.45
D. For Firms Convicted					
Forecast	Civil	Grand Jury	Criminal	Firms	Individuals
One-year ahead	13.77	2.86	0.07	83.31	0.00
Two-year ahead	13.86	2.45	7.42	74.98	1.29
Three-year ahead	13.75	11.17	5.53	62.25	7.31
Four-year ahead	14.69	12.96	4.39	58.14	9.83
E. For People Convicted					
Forecast	Civil	Grand Jury	Criminal	Firms	Individuals
One-year ahead	22.03	2.99	9.93	39.51	25.55
Two-year ahead	20.43	2.73	9.56	43.11	24.17
Three-year ahead	18.60	2.70	9.14	40.32	29.24
Four-year ahead	17.40	4.03	8.96	38.87	30.74

1. For variable definitions see table 2.
2. The table is to be read as follows. Panel C, for example, shows that for the one-year ahead forecast, about 90% of the variable's forecast error variance is explained by past shocks to the number of criminal cases initiated (i.e., the variable's, own dynamics). But as we look at the three-year ahead forecast, about 21% is explained by past shocks to civil cases and another 28% is explained by past shocks to the number of firms and individuals convicted. At the three-year ahead forecast, only 49% of the error variance if explained by it's own dynamics. Thus, at the three-year ahead forecast, other variables play a significant role in explaining fluctuations in the number of criminal cases initiated. To conserve space, we only present the forecasts up to four years ahead.

Table 4. Single-Equation Estimation Results
Estimated specification: equation (6)
Sample period: 1948-2003.

	A	B	C
Constant	5.76 (0.360)	6.02 (0.319)	11.10* (0.069)
$CRIM_{t-1}$	10.14* (0.001)	10.14* (0.001)	8.58* (0.001)
$CRIM_{t-2}$	-3.04 (0.141)	-3.07 (0.134)	3.85* (0.085)
$CIVIL_{t-1}$	0.75 (0.641)	1.53 (0.626)	-0.42 (0.811)
$CIVIL_{t-2}$	5.11* (0.001)	9.85* (0.001)	4.67* (0.001)
$\Delta MERGERS_{t-1}$	4.02* (0.031)	3.79* (0.029)	3.39* (0.019)
$\Delta MERGERS_{t-2}$	2.30 (0.103)	2.31 (0.139)	2.87* (0.074)
ΔGDP_{t-1}	-2.69* (0.099)	-2.37 (0.223)	-2.14 (0.239)
ΔGDP_{t-2}	-5.04* (0.004)	-4.85* (0.024)	-4.86* (0.009)
$\Delta FUNDS_{t-1}$	1.77 (0.312)	2.30 (0.261)	1.73 (0.274)
$\Delta FUNDS_{t-2}$	-4.58* (0.001)	-4.39* (0.005)	-4.12* (0.008)
D(1979)	36.95* (0.001)	39.70* (0.001)	42.09* (0.001)
$PRES_{t-1}$	-0.69 (0.798)	-0.10 (0.971)	-0.13 (0.962)
$D(1979)\times PRES_{t-1}$	12.45* (0.019)	12.58* (0.017)	9.79* (0.077)
TREND	–	-0.11 (0.663)	–
$HOUSE_{t-1}$	–	–	-7.85 (0.261)
$SENATE_{t-1}$	–	–	-1.53 (0.805)
Adjusted-R^2	0.8336	0.8299	0.8390
LM: $\chi^2(2)$	0.0183	–	–
LM: $\chi^2(1)$	0.0507	–	–

Notes:

1. A Δ indicates first-difference. Except for the Constant, $PRES_{t-1}$, D(1979) and $D(1979)\times PRES_{t-1}$ coefficients, the reported numbers are the coefficient estimates multiplied by one-standard-deviation of the respective variable. This is done because there is considerable variation in the size of the means and standard deviations across the variables. Multiplied by one-s.d. gives us a direct glimpse at the quantitative effect.
2. The bottom rows LM:$\chi^2(2)$ and LM:$\chi^2(1)$ present the *p-values* from the LM-test. Given the results in column A, the specifications in columns B and C were estimated with a MA(2) error structure.
3. *p-values* (two-tailed), using the Newey-West (1987) heteroscedasticity and serial correlation consistent standard errors, are in parentheses. An asterisk * indicates statistical significance at least at the 10% level.

Table 5. Two-Equation Seemingly Unrelated Regression Results Sample period: 1948-2003.		
	Criminal Cases	**Civil Cases**
Constant	5.78 (0.399)	13.39* (0.022)
$CRIM_{t-1}$	9.91* (0.001)	2.07 (0.340)
$CRIM_{t-2}$	-2.72 (0.342)	-3.95* (0.073)
$CIVIL_{t-1}$	0.64 (0.761)	5.96 (0.001)
$CIVIL_{t-2}$	5.05* (0.014)	1.96 (0.233)
$\Delta MERGERS_{t-1}$	3.85* (0.019)	1.55 (0.223)
$\Delta MERGERS_{t-2}$	2.36 (0.172)	0.05 (0.969)
ΔGDP_{t-1}	-2.69* (0.085)	0.81 (0.529)
ΔGDP_{t-2}	-5.02* (0.003)	-0.92 (0.512)
$\Delta FUNDS_{t-1}$	1.71 (0.266)	2.88* (0.026)
$\Delta FUNDS_{t-2}$	-4.53* (0.003)	-0.29 (0.831)
$D(\tau)$	36.38* (0.001)	-4.06 (0.425)
$PRES_{t-1}$	-0.44 (0.901)	9.83* (0.003)
$D(\tau) \times PRES_{t-1}$	11.62* (0.088)	-8.65* (0.092)

1. The two equations are equation (6) for criminal cases and a similar specification for civil cases. (See discussion in section 6.)

2. The symbol τ denotes the structural-break year for the two types of cases: τ=1979 for the criminal cases; and τ=1972 for the civil cases. (See discussion in section 4.)

Figure 1(a). Total Criminal Antitrust Cases Filed: 1948-2003

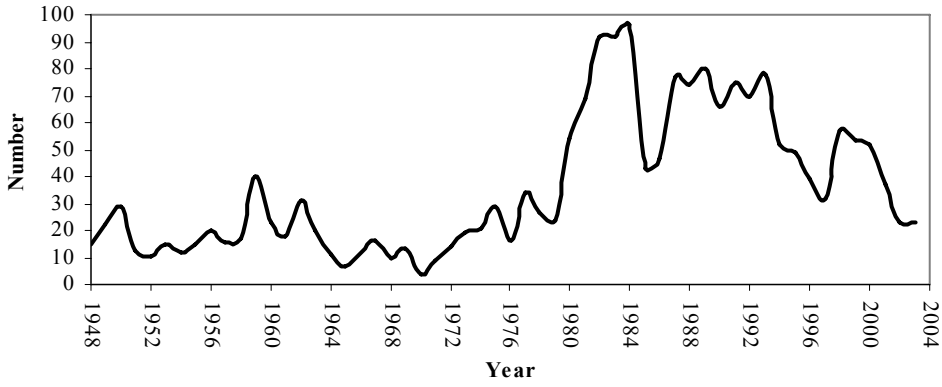

Figure 1(b). Total Civil Antitrust Cases Filed: 1948-2003

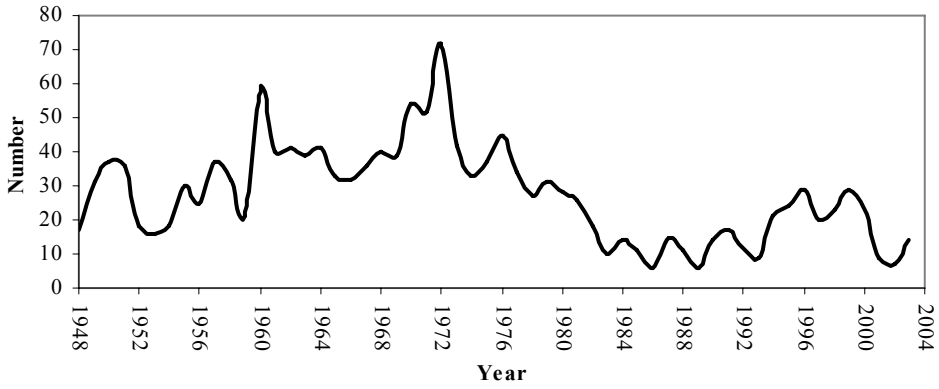

Figure 1(c). Ratio of Criminal Cases to Total Cases: 1948-2003

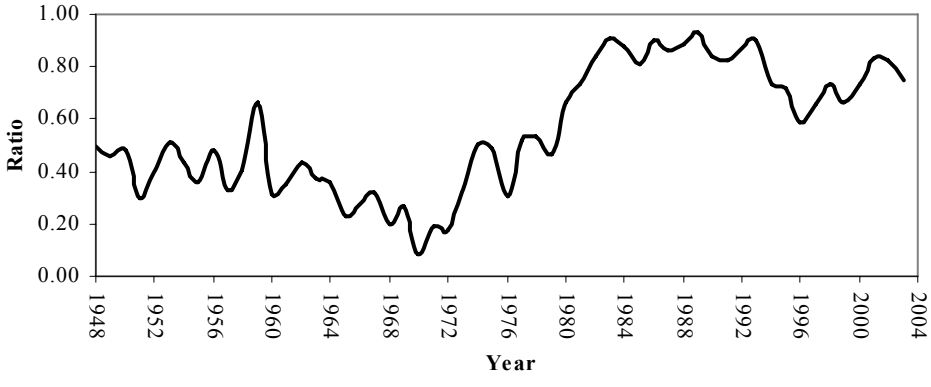

Figure 2. Grand Jury Investigations Initiated: 1969-2003

Figure 3. Corporations and Individuals Convicted: 1969-2003

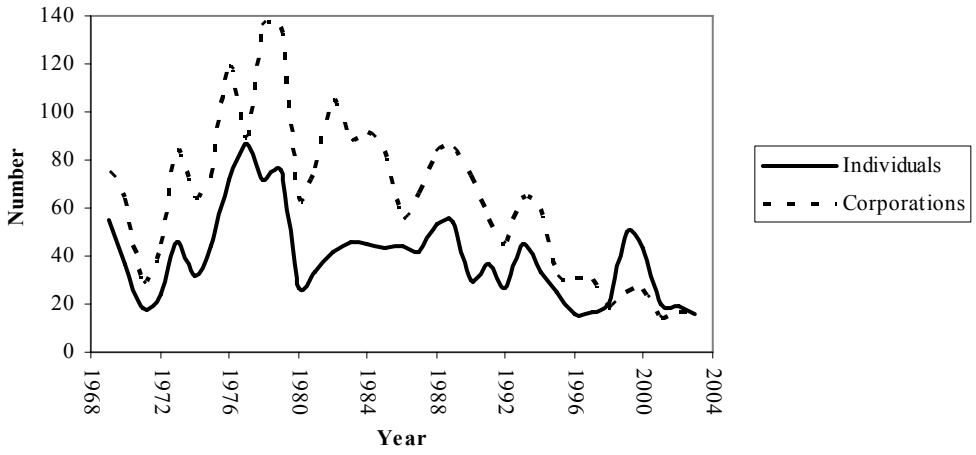

Figure 4. Fine Per Corporation: 1969-2003

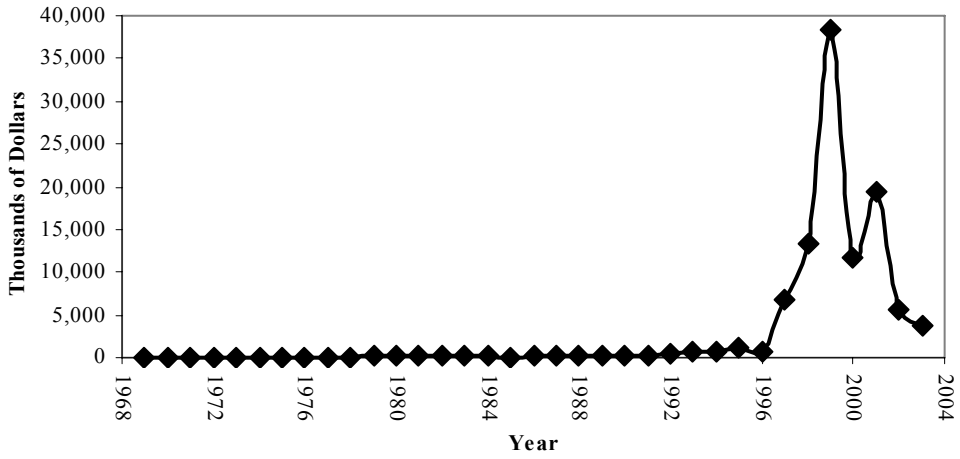

Figure 5. Fine Per Individual: 1969-2003