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**Estimating The Value Of Antitrust Investigations:  
A Case Study in Agriculture**

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## 1. Introduction

Antitrust regulatory agencies broadly provide guidance to industry, conduct investigations and pursue sanctions. Since regulation is costly, the goal of our analysis is to enhance the understanding of the value of antitrust regulatory efforts, specifically investigative activities. We focus on the competitive impacts of competition investigations as i) this line of research is new and ii) the issue is of extreme importance for regulatory agencies whose investigations have not lead to prosecution and are thus considered to be “failures” by their critics. The outcome from an investigation does not typically result in a trial either because the initial allegation lacks merit or, as is often the case, there is a lack of sufficient evidence. One cannot simply assert that ‘failed’ investigations have no effect on competition in the market, especially when the targets were in fact engaged in anticompetitive behavior. The void of research by academicians in this area is primarily due to the lack of public information regarding the investigatory efforts by regulatory agencies, a limitation we are fortunate to have overcome.

Economics has long been and continues to be used to estimate the value of deterrence of crimes such as assault, robbery, burglary and other felonies (Becker 1968; Mathur 1978; Cameron 1988; Cornwell and Trumbull 1994; Cherry 1999; Corman and Macon 2000; Fernandez, Ley and Steel 2001; and Mustard 2003). Based on game theoretic *a priori* expectations, typical empirical deterrence measures used to describe crime rates have been the size of police budgets, numbers of prosecutions and size of penalties. Most, but not all, research finds that these deterrence mechanisms reduce crime rates.

Deterrence of anticompetitive behavior through the presence of an antitrust authority, litigation and or the execution of antitrust penalties has long been an important topic of debate by both academicians and antitrust authorities alike (Brei and Elzinga 1973; Feinberg 1980; Block, Nold and Sidak 1981; Besanko and Spulber 1989; Bosch and Eckard 1991; Sproul 1993; Baker 2003; Crandall and Winston 2003; Werden 2003; Harrington 2004a; Harrington 2004b, Harrington 2005; and Werden 2008). The most prevalent anticompetitive behavior analyzed in the literature is collusion and illegal monopolization through merger. Most, but not all, of the theoretical and empirical research along these lines has found that prosecution is a deterrence mechanism that has a negative effect on anticompetitive behavior.

We assert that the degree to which society suffers from market failure is significantly impacted by another, mostly unobserved, player in the game, the regulator. Though our study focuses on competition regulation in agriculture, it is applicable to all market regulation. Most market power estimates of the beef industry in 1990's have been shown to be relatively small given the high level of market concentration (Crespi and Sexton 2005). Though not specifically controlled for in an econometric way, empirical work of the beef industry has acknowledged the potential impact of litigation on market power estimates over time (Azzam and Park 1993).

### *1.1 Objectives*

Our research is structured around two key objectives: (i) develop a workable theoretic model of anticompetitive deterrence via investigation to predict competitive outcomes, then (ii) empirically test the impact on competition of a past investigation.

## *1.2 Agriculture Competition Regulation Background*

To achieve the objectives of this analysis, we conduct a unique case study of a USDA, Grain Inspection Packers and Stockyards (GIPSA) competition investigation.<sup>1</sup> The investigation of a buyer collaboration, in which multiple packer buyers hired a common bidding agent, at a local Wisconsin auction market was conducted in the years 1999 and 2000. The allegation was that the presence of a common bidding agent reduced competition. Typical of GIPSA competition investigations, the case was closed and did not result in litigation.<sup>2</sup> Later, Coatney, Shaffer and Menkhaus (2011) demonstrate that the common agent under investigation purchased roughly 75 percent of the animals for roughly 8 percent less than their rivals, which is result of reduced competition from rivals.

Though competition cases have since been investigated by GIPSA, no case has come to trial. It is well documented that GIPSA has struggled in regulating the competition provisions of the Act. In 1997, Dan Glickman, then Secretary of Agriculture, requested the Office of Inspector General (OIG) to evaluate the effectiveness of GIPSA in regulating and enforcing the competition provisions of the Packers and Stockyards Act of 1921 arising from 1) the significant increase in concentration due to mergers during the 1970 to 1980's in the livestock processing sector, 2) increased allegations by livestock producers of anticompetitive behavior by livestock buyers and 3)

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<sup>1</sup> GIPSA is responsible for the enforcement of the Packers and Stockyards Act of 1921 which covers unlawful acts of unfair, deceptive, discriminatory or monopolistic practices in the marketing of livestock, meat and poultry. For details see <http://archive.gipsa.usda.gov/pubs/psprogram.pdf>.

<sup>2</sup> The lead author of this research was the lead GIPSA investigator of the allegation, thus possessing intimate knowledge of the investigation. The case was closed before an econometric analysis could be conducted.

the results of a concentration study commissioned by GIPSA (USDA, OIG 1997). The primary finding of the 1997 OIG investigation was that GIPSA lacked the resources to adequately monitor anticompetitive behavior and provided recommendations to aid GIPSA. In response to the OIG's recommendations, the USDA restructured GIPSA in 1999, obtained additional funding and began investigating allegations of anticompetitive behavior (USDA, GAO 2000). Unsatisfied that GIPSA had adequately addressed OIG's recommendations; Senator Grassley requested that the General Accounting Office (GAO) also evaluate the progress of GIPSA's reorganization (US, GAO 2000). The 2000 GAO report again cited a serious need to increase GIPSA's monitoring and investigative capacity and also provided a set of recommendations.

Of the \$17,837,000 allocated to GIPSA in the 2001 GIPSA budget, GIPSA's budgetary expenditures toward competition investigations was \$3,431,000 (USDA, GIPSA 2009). In 2001, GIPSA conducted or initiated 52 investigations (USDA, GIPSA 2001). By 2005, GIPSA's budget increased to \$19,510,000 of which \$4,050,000 was dedicated to investigating competition investigations (USDA, GIPSA 2009). In 2006, GIPSA recorded 31 investigations (USDA, GIPSA 2006).<sup>3</sup> While GIPSA's total 2009 annual budget increased to \$22.4 million, budgetary expenditures toward competition investigations declined to a mere \$330,000 though the agency still recorded opening 31 and closing 16 investigations (USDA, GIPSA 2009). Only 1 competition investigation (recorded in 2009) resulted in an enforcement action of any kind since the 1999 restructure.

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<sup>3</sup> GIPSA did not report competition statistics in 2005 as the agency was under investigation by OIG for misreporting competition investigation numbers.

The ability of GIPSA to enforce the competition provisions of the Act continues to be heavily criticized by livestock producers and government officials. In 2005, Senator Harkin called for another round of audits of GIPSA (Harkin 2005). In 2006, both OIG and the GAO conducted audits. Both agencies found that GIPSA failed to effectively implement their earlier recommendations (USDA, OIG 2006; and US, GAO 2006). Most recently, the USDA has announced a joint collaboration with DOJ to address competition concerns of livestock producers.<sup>4</sup>

There is no doubt that GIPSA has struggled regulating an enormous livestock industry<sup>5</sup>, however, the criticisms of livestock producers and government officials are an over exaggeration to some degree. For instance, Senator Grassley stated in a letter to Secretary of Agriculture Vilsack in 2009, “GIPSA has struggled for years both with the DOJ and the Office of General Counsel (OGC) within the U.S. Department of Agriculture (USDA) to convince attorneys within both agencies to take on GIPSA cases aggressively for prosecution. This has resulted with producers having a low confidence level in GIPSA and subsequently deciding not to file complaints since "GIPSA wouldn't do anything with my complaint anyways" as one producer put it.” Grassley later states, “if more cases are prosecuted, even if lost, the Agency can once again start to gain its credibility back in the field, where it's most important.” (Grassley 2009).

The major weakness of Grassley’s argument is that the metric of successful regulation is unidimensional (prosecution) and presumes that most complaints lodged by

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<sup>4</sup> For details see [http://www.justice.gov/atr/public/press\\_releases/2009/248797.pdf](http://www.justice.gov/atr/public/press_releases/2009/248797.pdf).

<sup>5</sup> The annual volume of commerce regulated by GIPSA in 1999 was approximately \$68 billion growing in 2008 to approximately \$100 billion (USDA, GIPSA 2009).

industry participants violate the Act. It is only when an allegation is *likely* to violate the Act does, and should, an investigation ensue of which GIPSA has been active up to their limited resources. However, investigating even a clear violation of the Act such as collusion does not necessarily result in a sufficient finding of fact to prosecute.

Struggling to improve their regulatory effectiveness, GIPSA has developed performance measures of their regulatory activities by means of compliance audits (no violation found after investigation) and the efficiency of their investigations by means of the number of days an investigation is open before being closed (USDA, GIPSA 2009). However, neither of these measures demonstrates the impact their agency's activities have on the true measure of their effectiveness, the competitiveness of the market.

## **2. Theory**

Our central hypothesis is that the act of investigating *legitimate* violations of anticompetitive behavior results in immediate and persistent increases in competition, regardless of whether the case is litigated or successfully prosecuted. This hypothesis is derived from developing a deterrence game to include the probability of investigation along with the probability of penalties. The following parable of the “cop-in-the-median” highlights our game theoretic model.

Imagine driving to work on the same road day after day. The speed limit is posted at 55 miles per hour. If caught speeding, the penalty is increasing in the miles per hour over the speed limit. You have not seen a policeman along this stretch of road for a very long time, if ever. It is in your best interest to reduce the opportunity cost of driving



time, so the probability you are speeding on any given highway at any given moment is positive.

If you are willing to break the law, the decision you make is whether you will drive up to 5 miles an hour, or 5-plus miles an hour over the speed limit. Driving up to 5 miles an hour over the speed limit seems to be an unofficially accepted level of speeding. The reason being is that if you are observed in this range of speeding, the policeman's cost of writing a ticket is less than the low fine received. As such, the policeman will let drivers at low rates of speeding pass unhindered. However, if the policeman observes you driving 5-plus miles an hour over the speed limit will significantly increase the odds you will get a ticket and 10-plus miles an hour over is virtually a sure thing.

Now assume you routinely drive 10 plus miles an hour over the speed limit because of the value of your time and you estimate that the likelihood of being caught is basically nil (high number of highways to low number of cops). However, one day you see a policeman parked in the median. What is your reaction? Like most people, you immediately slow down as quickly as possible. The reason for your reaction is that you hope the radar has not locked on you yet and if it does, you will be caught either within the unofficial speed limit or at speed subject to a lower fine. For whatever reason, the policeman does not give you a ticket. Relieved, you continue down the road. It is important to note, that had you been driving the posted limit to begin with, you would have no reason to react to the presence of the policeman.

The next day, suspecting that the policeman may be targeting your stretch of road, you decide to drive within the unofficial acceptable level of speeding. If you see him you

are in the clear and you may even approach the speed limit just to be sure. If you don't see the cop anymore, in time you regain confidence to speed 10 plus miles an hour over the limit.

## 2.1 A General Model

The immediate and persistent impact on competition by an antitrust investigation can be compared to the impact of the “cop-in-the-median” on driver speeds. In the preceding parable, the game begins at an equilibrium level of illegal behavior. For our purposes, the reaction of the target to the event of being monitored by the regulator is focal. We ignore the speed of adjustment back to the equilibrium level as it is heavily dependent upon the behavioral aspects of the agent's probability updating mechanism. For the simplicity, we treat the regulator as a state of nature constrained in resources rather than a strategic player in the game. The risk neutral agent's game of chance is described generally as follows. In regime I the agent's day to day objective function is

$$\underset{0 < v}{Max} E[U] = R(l) + R(v) - \beta(p, \alpha)F(v) - k$$

where:

$R(\bullet)$  is the economic return to legal  $l$  and illegal  $v$  activity ;  $\beta(p, \alpha)F(v)$  is the expected cost of a fine given level of illegal activity;  $\beta(p, \alpha)$  is probability of being fined which is the joint probability of being monitored by regulator  $p\left(\frac{I}{L}\right)$  which is the ratio of the number of  $I$  investigators to the number of  $L$  locations and  $I < L$  , and the probability of sufficient evidence for conviction  $\alpha(t)$ . The probability of sufficient evidence is a function of the length of time  $t$  evidence is both produced by the agent and observable by

the regulator;  $F(v)$  is the fine structure given the level of violation; and  $k$  is the fixed cost of economic activity.

The properties of the model are as follows. If  $v = 0$  then  $U = R(l) - k$ , otherwise the agent chooses an optimal level of illegal activity to satisfy  $R'(v) = \beta(p, \alpha)F'(v)$

which is the additional marginal value to the additional marginal cost of illegal behavior.

The restriction for a global maximum of illegal behavior to obtain is that

$0 \leq R''(v^*) < \beta(p, \alpha)F''(v^*)$ . Therefore, there is an equilibrium positive level of day to

day crime as long as  $R(v^*) > \beta(p, \alpha)F(v^*)$ . The comparative statics assumed are that

$$\frac{\partial v^*}{\partial I} < 0, \frac{\partial v^*}{\partial L} > 0, \frac{\partial v^*}{\partial t} < 0.$$

Now let the regulator arrive on location of economic activity and begin monitoring the behavior of the target at  $t = 0$ . If the regulator observes a *sufficient* accumulative violation over time period  $\underline{t} \leq t$  it is assumed that they will prosecute and win with probability 1, therefore  $\beta(p, \alpha(t)) = 1 \quad \forall \quad \underline{t} \leq t$ . The fine structure is such that

$R(v(t)) - \beta(p, \alpha(t))F(v(t)) < 0 \quad \forall \quad \underline{t} \leq t$  and is known by the target<sup>6</sup>  $F(v(t)) = 0$  and

$\beta(p, \alpha(t)) = 0$ , if and only if,  $s < \underline{t}$ , the amount of time  $s$  it takes the target to discontinue

illegal behavior. Assuming  $\underline{t}$  is known by the target, the agent engaged in illegal activity

regime II objective stopping function is  $\arg \max_t = R(v(t)) - \beta(1, \alpha(t))F(v(t)) = \underline{t} - \varepsilon$ ,

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<sup>6</sup> GIPSA is an administrative law body and cannot pursue fines, but can impose Cease and Desist Orders which eliminates future earnings of criminal behavior. Also, because GIPSA maintains a memorandum of understanding with the Department of Justice and competition violations of the Packers and Stockyards Act are also violations of the Sherman Antitrust Act, GIPSA can *in effect* impose sanctions of treble damages by providing their evidence to the Department of Justice.

where  $\beta(1, \alpha(t)) = 1$  and  $F'(v(t)) > 0$  for  $\underline{t} \leq s$  and 0 otherwise. Therefore, the target optimally engages in crime before sufficient evidence can be collected then reverts to legal behavior. If the target is constrained by how fast they can react and  $\underline{t} \leq \underline{s}$ , then the target optimally stops ‘as soon as possible’. If the target is not engaged in illegal behavior, there is no value in changing their behavior.

### 3. Data

The data for our analysis contain two ingredients, a timeline of the known events of interest and price series for the target market and similarly situated auctions in the region.<sup>7</sup> The timeline is as follows: (1) the collaborators and their common agent were officially notified of GIPSA’s investigation into their buying practices during the week of June 24, 2000; (2) GIPSA officially closes the investigation during the week of November 3, 2001; and (3) the common agent was barred from buying by the auction company during the week of April 7, 2007 for an unrelated offense to the initial GIPSA investigation, after which the collaborators continued representing themselves at auction independently.

To quantify the effect of the investigation on auction prices, we utilize weighted average weekly prices collected from USDA, Agricultural Marketing Service (AMS) from the week of January 8, 2000 to the week of May 16, 2009. Individual auction data are not available from government sources prior to 2000, and missing observations in the

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<sup>7</sup> Due to a confidentiality agreement with the complainant auction company and the requirements of confidentiality by the then GIPSA’s lead investigator and now the lead author of this research, the names and locations of the principals and agents involved cannot be disclosed. The data as presented, however, are available upon request.

data series are due to non-reporting of the target market by AMS officials.<sup>8</sup> We collected price series for the target auction and 5 regional auctions, all within Wisconsin and less than 176 miles from the target market. A summary of the percentage price differentials between the target market v. regional markets and events are depicted in Figure 1.<sup>9</sup>

Summary statistics for these prices series are reported in Table 1. There are a total of 1,696 observations across the 6 auctions, with each auction representing between 12 and 20 percent of the entire sample. There are a total of 489 weeks during our sample frame, and missing observations are not systematic across auctions. For the 6 auctions, there are 34, 41, 42, 55, 44, and 37 percent of the possible observations missing, respectively. Table 1 includes two columns which report the number of price observations for two periods of interest, during the investigation and after the agent exited the auction. Within each auction, between 12 and 20 percent of the observations occur during the investigation and between 15 and 32 percent of the observations occur after the agent has exited. The last column shows that 2 of the non-target markets are within 75 miles, and all 5 are within 175 miles.

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<sup>8</sup> From conversations with AMS officials, their data contain only a sample of the transactions at any given auction on any given day

<sup>9</sup> The price differentials in Coatney et. al. (2011) depict a significantly lower price at the target market from October 4, 1999 through January 26, 2000. This was due to more comprehensive data provided by the auction company at the target market than what is publicly available for this analysis.

#### 4. Empirical Model and Results

To estimate the investigation effect, we utilize the fixed effects regression model

$$(1) \quad y_{it} = \eta_t + x'_{it}\beta + \tau w_{it} + c_i + u_{it}$$

where  $y_{it}$  is the weekly price at auction  $i = 1, \dots, 6$  in period  $t = 1, \dots, T$ ,  $\eta_t$  is a periodic intercept shifter effect,  $x_{it}$  is a vector of observable control variables, and  $w_{it}$  is a dummy variable equal to 1 if auction  $i$  is under investigation and zero otherwise. The target market is given by  $i = 1$ , so  $w_{it}$  takes on a value of 1 only when auction 1 is under investigation.  $c_i$  captures unobservable auction specific heterogeneity and is (potentially) correlated with the observable regressors, and  $u_{it}$  is an idiosyncratic error term.

Table 2 reports the parameter estimates for equation 1 using the fixed effects estimator. Auction fixed effects and periodic intercept shifters are included for all regressions. Column 1 reports the estimated investigation effect in the absence of control variables, and implies that prices are 55.9 cents/cwt higher on average. This result is statistically significant at conventional levels, and is robust to standard errors clustered at the auction level (Column 2). The within, between, and overall  $R^2$ s are quite high, and the auction level fixed effects account for 28 percent of the overall variation. The correlation of the fixed effects with the regressors is quite small at 0.102 (not reported in Table 2).

Column 3 of Table 2 reports the estimated investigation effect in the presence of a dummy variable controls for whether the investigatory target has exited the auction, and

implies that prices are 78.5 cents/cwt higher on average. Interestingly, the investigation has nearly the same effect as the agent exiting the market, which increases prices by 73.4 cents/cwt on average. These results are statistically significant at conventional levels, and are robust to standard errors clustered at the auction level (Column 2). The  $R^2$ s and the proportion of variance captured by the fixed effects is largely unchanged compared to Columns 1 and 2. The correlation of the fixed effects with the regressors remains low at 0.092 (not reported in Table 2).

Estimating equation 1 requires estimating 481 periodic intercept shifters, which severely limits the available degrees of freedom. To remove these shifters from the regression equation, we construct the difference equations

$$(2) \quad y_{1jt} \equiv y_{1t} - y_{jt}$$

for the  $j = 2, \dots, 5$  non-target markets. This yields the corresponding fixed effects regression model

$$(3) \quad y_{1jt} = x'_{1jt} \beta + \tau(w_{1t} - w_{jt}) + c_{1j} + u_{1j}$$

$y_{1jt}$  is the difference in price between the target market and market  $j = 2, \dots, 5$  in period  $t = 1, \dots, T$ , and  $x'_{1jt} \equiv x'_{1t} - x'_{jt}$ ,  $c_{1jt} \equiv c_{1t} - c_{jt}$ , and  $u_{1jt} \equiv u_{1t} - u_{jt}$  are the corresponding differences for the right hand side variables. Since  $w_{jt} = 0$  for all  $j \neq 1$ , this reduces to the standard fixed effects model

$$(4) \quad y_{it} = x'_{it} \beta + \tau w_{1t} + c_i + u_i$$

where  $i$  now denotes the 5 market pairs  $i = (1, 2), (1, 3), (1, 4), (1, 5)$ , and  $(1, 6)$ .

Table 3 reports the parameter estimates for equation 4 using the fixed effects estimator. Auction-pair fixed effects are included for all regressions. Column 1 reports the estimated investigation effect in the absence of control variables, and implies that prices are 57.6 cents/cwt higher on average. This result is statistically significant at conventional levels, and is robust to standard errors clustered at the auction-pair level (Column 2). The within, between, and overall  $R^2$ s have dropped considerably, which is not surprising given the number of variables that have been removed from the model. The auction-pair level fixed effects still account for a considerable amount of the overall variation (20 percent), and the correlation of the fixed effects with the regressors is still low at 0.041 (not reported in Table 3).

Column 3 of Table 3 reports the estimated investigation effect in the presence of a dummy variable controls for whether the investigatory target has exited the auction, and implies that prices are 78.7 cents/cwt higher on average. Interestingly, the investigation has nearly the same effect as the agent exiting the market, which increases prices by 70.9 cents/cwt on average. These results are statistically significant at conventional levels, and are robust to standard errors clustered at the auction level (Column 4). While the between  $R^2$  drops considerably after controlling for the agent's exit, both the within  $R^2$  and overall  $R^2$  are higher. The proportion of variance captured by the fixed effects account are largely unchanged compared to Columns 1 and 2, and the correlation of the fixed effects with the regressors remains low at 0.005 (not reported in Table 2).

In order to allow for a residual treatment effect after the investigation has officially closed, we amend the regression model to



$$(5) \quad y_{it} = x'_{it}\beta + \tau[w_{it} + z_{it}\delta_1 \exp(-\delta_2 s_t)] + c_i + u_i$$

where  $\delta_1, \delta_2 \geq 0$  are non-negative parameters that determine the exponential decay of the investigation effect  $\tau$ ,  $z_t$  is a dummy variable that takes on a value of 1 if the investigation is closed and the agent is still participating in the auction, and  $s_t$  is a normalized trend variable anchored to the period in which the investigation closed. Specifically, if  $\bar{t}$  represents the last week of the investigation and there are  $T_0 = T - \bar{t}$  weeks left in the sample, then  $s_t$  is defined by

$$(6) \quad s_t = \begin{cases} \frac{t - \bar{t}}{T_0} & \text{if } t > \bar{t} \\ 0 & \text{if } t \leq \bar{t} \end{cases},$$

and takes on values between 0 and 1.

To demonstrate how this model nests the previous model (equation 4), define by  $\underline{t}$  the period in which the investigation opens. Before the investigation ( $t < \underline{t}$ ), the investigation effect  $\tau[w_{it} + z_{it}\delta_1 \exp(-\delta_2 s_t)]$  reduces to the formulation in equation 4 since  $w_{it} = 0$  and  $z_{it} = 0$ . During investigation ( $\underline{t} \leq t \leq \bar{t}$ ), the effect again reduces to the previous formulation  $\tau$  since  $w_t = 1$  and  $z_t = 0$ . After investigation ( $t > \bar{t}$ ), the effect becomes  $\delta_1 \exp(-\delta_2 s_t)$  since  $w_t = 0$ ,  $z_t = 1$ . If  $\delta_1 = 0$  then the effect instantaneous adjust back to the pre-investigation level; however if  $\delta_1 \neq 0$  the effect will instantaneously drop/rise to  $\tau\delta_1$  and then slowly decay back to the pre-investigation level at a rate determined by  $\delta_2$ . Thus, formulating the investigation effect in this way preserves the

original spirit of the model, while also permitting a test of instantaneous versus gradual reversion of prices back to pre-investigation levels.

Table 4 reports the parameter estimates for equation 5 using nonlinear least squares with auction-pair fixed effects estimator. The instantaneous investigation effect is similar in magnitude and statistical significance to previous estimates at 84.4 cents/cwt, as is the effect of the agent's exit at 76.4 cents/cwt. The point estimate for  $\delta_1$  implies that the investigation effect drops to 54.7 cents/cwt as soon as the investigation ends and then decays back to the pre-investigation level at a rate determined by the estimate for  $\delta_2$ . Since the estimate for  $\delta_1$  is statistically significantly different from zero at conventional significance levels, this suggests the existence of a residual treatment effect. The parameter estimate for  $\delta_2$  is not statistically significant at conventional levels, however the p-value for the joint test that  $\delta_1 = \delta_2 = 0$  is 0.0519 and suggests rejection of the no-residual-effect hypothesis.

The positive point estimate for  $\tau$  provides evidence that welfare gains from investigation begin accruing immediately upon formal disclosure of the investigation. Importantly, sellers' revenues are increased by 76.4 cents/cwt for *each week* the investigation remains open. The similarity between the investigation effect and the agent's exit effect is striking, and is supported by a p-value of 0.8022 for the joint test that these estimates are equal. Interestingly, this finding suggests that opening the investigation had the same effect that the agent had on the market in the absence of investigation.

The estimates for the residual investigation effect suggest that a portion of the investigation effect persists after the investigation has closed. During the first week after the investigation closes, the residual effect instantaneously drops from  $\tau$  to  $\tau\delta_1$  and then decays exponentially according to  $\delta_1 \exp(-\delta_2(t-\bar{t})/T_0)$ . Using the formula

$$(7) \quad \lambda \tau \delta_1 = \tau \delta_1 \exp\left(-\delta_2 \frac{t-\bar{t}}{T_0}\right)$$

where  $\lambda$  is some fraction of the initial residual effect  $\tau\delta_1$  and  $t-\bar{t}$  is the number of weeks after the investigation. Solving for  $t$  yields

$$(8) \quad t-\bar{t} = -\frac{T_0}{\delta_2} \ln(\lambda).$$

Equation 8 provides an equation for measuring on how long it takes for the residual effect to equal a fraction  $\lambda$  of the initial residual effect. Table 5 provides these measures for values of  $\lambda$  from 0.9 to 0.1, and implies that residual effect declines 10 percent within 5 weeks, 50 percent within 32 weeks, etc. Interestingly, it takes over two year (106 weeks) for the effect to decline by 90 percent.

Since the residual effect will eventually decay to zero, the cumulative residual effect over time is given by

$$(9) \quad \int_0^{\infty} \tau \delta_1 \exp\left(-\delta_2 \frac{t}{T_0}\right) dt = \frac{\tau \delta_1 T_0}{\delta_2} = \$25.3 / \text{cwt},$$

which implies an additional \$25.3/cwt in sellers average revenue post investigation. To obtain the overall effect on average revenue, this is added to the gains that accrued during

the investigation. For an investigation lasting  $x$  weeks, the gains from the instantaneous investigation effect  $\tau x = \$0.844x / cwt$  are added to the above residual effect. This particular investigation lasted for 71 weeks, which implies a total gain in average revenue of

$$(10) \quad \tau x + \frac{\tau \delta_1 T_0}{\delta_2} = 0.844(71) + 25.3 = \$85.2 / cwt.$$

## 5. Conclusion

The results indicate that a subset of bidders at the target auction altered their bidding behavior during the time they knew of the government investigation into the buying practices of the collaboration of principals and their common bidding agent.

Unfortunately, from the available data it cannot be determined which bidders at the target auction significantly altered their bidding behavior. However, we can conclude as predicted from our game theoretic model, that at least a subset of bidders at the target auction was *knowingly* engaged in some form of anticompetitive behavior prior to learning about the investigation as there is no rational reason to bid higher than would be expected from fully competitive bidders. Furthermore, from interviews with the target auction company, the common agent continued to purchase the majority of the cattle as before the investigation, but at significantly higher prices. Therefore, the targets of the investigation necessarily increased their willingness to pay during the investigation period. Bolstered with the empirical results from Coatney, Shaffer and Menkhaus (2011) and combined with the impact of the removal of the common agent we can further conclude that the increase in competition when the investigation became common

knowledge was driven primarily by changes in the bidding behavior of the common agent.

In a similar situation, academic researchers observed a pricing strategy by a group of NASDAQ dealers (Christie and Schultz 1994a). The group of dealers refused to price the bid and ask prices in odd-eighths increments which indicated collusive pricing. Upon public announcement of the researchers' findings, the dealers immediately changed their pricing strategy and in subsequent work by the authors were unable to justify the change in behavior under a competitive assumption (Christie and Schultz 1994b). The immediate change in pricing behavior was later cited by the plaintiffs as evidence that the dealers were *knowingly* engaged in anticompetitive behavior (Barboza 1997). The defendants later settled out of court and new regulations by the Department of Justice and the Security and Exchange Commission were instituted.<sup>10</sup>

Finally, it is interesting to note that during the investigation and after the common agent exited the auction the significant increase in competition relative to the region. With no rational reason for the price differential to occur it could very well be the case that other auctions in the region were (are) suffering from a lack of competition. After our analysis was complete, we shared the results with the original complainant. His paraphrased reply was, "Well,...all auctions suffer from buyers working things out. They [buyers] get it done in many different ways. We just have to keep watch all the time."

Though no prosecution of anticompetitive behavior was levied against any buyer at the

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<sup>10</sup> U.S. Department of Justice Antitrust Division, *United States of American v. Alex Brown, et al.*, Stipulation and Order, 1996 <http://www.justice.gov/atr/cases/f0700/0741.htm> and U.S. Securities and Exchange Commission, Report Pursuant to Section 21(a) of the Securities and Exchange Act of 1934 Regarding the NASD and Nasdaq Stock Market, 1996, <http://www.sec.gov/litigation/investreport/nd21a-appx.txt>.

target market, we believe that the “cop-in-the-median” provided significant value to the public. As such, it would behoove regulatory agencies to identify their investigative efforts on the market when lobbying for funding.

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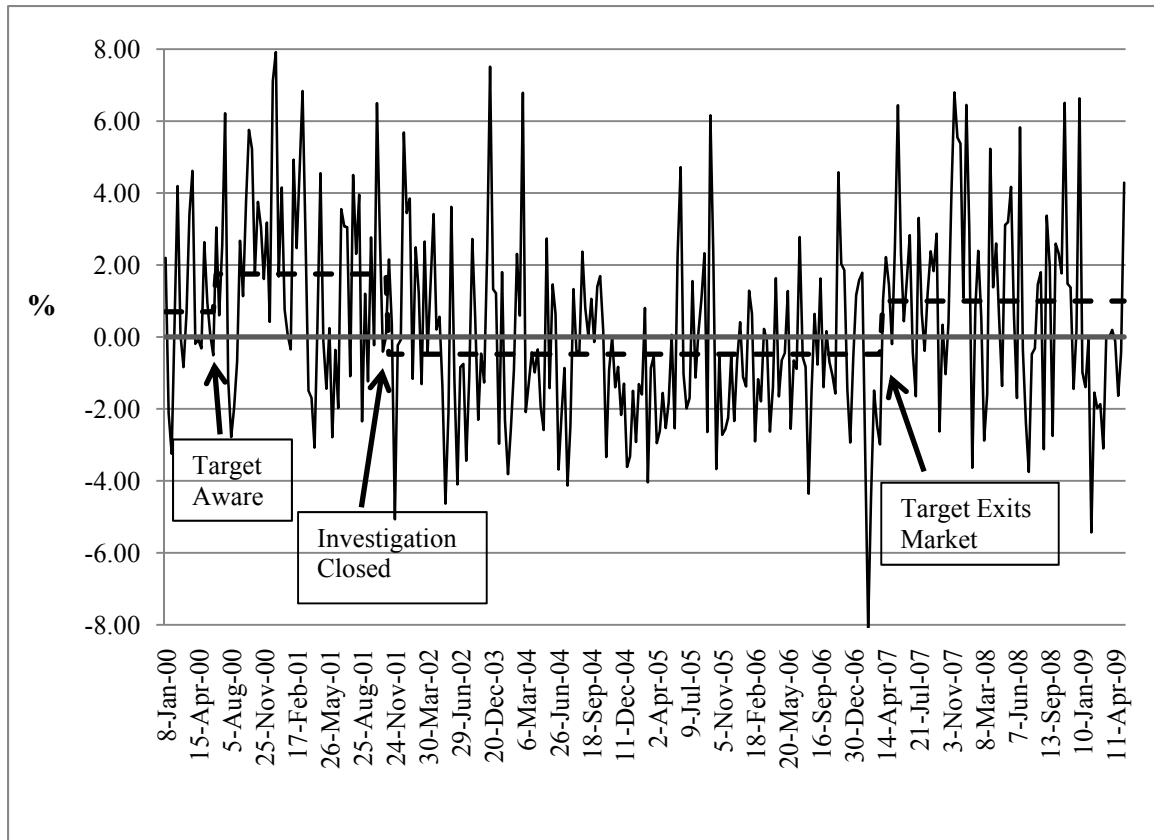
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Figure 1: Mean Percentage Price Differences – Target v. Regional Markets



**Table 1. Weekly Auction Prices**

<b>Auction</b>	<b>Mean (s.d.)</b>	<b>Total Obs</b>	<b>Obs During Investigation</b>	<b>Obs After Agent Exits</b>	<b>Distance from Target (miles)</b>
Auction 1*	45.93(6.054)	323	58	82	--
Auction 2	43.51(6.397)	290	58	44	176
Auction 3	47.81(6.322)	284	35	84	67
Auction 4	45.93(5.691)	218	31	69	54
Auction 5	44.58(5.956)	275	42	52	136
Auction 6	44.06(5.922)	306	39	72	152

Notes: Data collected from USDA, AMS for the period starting the week of January 8, 2000 and ending the week of May 16, 2009. \* denotes that Auction 1 is the target market.

**Table 2. Effect of Investigation on Auction Prices**

Dependent variable: <i>Weekly Auction Price</i>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
Investigation (Yes = 1)	0.559 (0.181)***	0.559 (0.192)**	0.785 (0.187)***	0.785 (0.153)***
Agent Exit (Yes = 1)			0.734 (0.164)***	0.734 (0.232)**
Within R-squared	0.9780	0.9780	0.9783	0.9783
Between R-squared	0.8877	0.8877	0.8720	0.8720
Overall R-squared	0.9695	0.9695	0.9697	0.9697
Std of Fixed Effects, $\sigma_c$	0.6666	0.6666	0.6732	0.6732
Std of Idiosyncratic Error, $\sigma_u$	1.0662	1.0662	1.0579	1.0579
Number of Observations	1696	1696	1696	1696
Auction Fixed Effects	Yes	Yes	Yes	Yes
Periodic Intercept Shifters	Yes	Yes	Yes	Yes
Standard Errors Clustered by Auction	No	Yes	No	Yes

Notes: Parameter estimates obtained using the fixed effects estimator. Conventional standard errors in parentheses unless otherwise noted. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels.

<b>Table 3. Effect of Investigation on Auction Prices</b>				
Dependent variable: <i>Weekly Auction Price Differences Relative to Target Market</i>				
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
Investigation (Yes = 1)	0.576 (0.122)***	0.576 (0.143)**	0.787 (0.124)***	0.787 (0.084)***
Agent Exit (Yes = 1)			0.709 (0.110)***	0.709 (0.259)**
Within R-squared	0.0233	0.0233	0.0649	0.0649
Between R-squared	0.2123	0.2123	0.0162	0.0162
Overall R-squared	0.0243	0.0243	0.0543	0.0543
Std of Fixed Effects, $\sigma_e$	0.7080	0.7080	0.7155	0.7155
Std of Idiosyncratic Error, $\sigma_u$	1.4319	1.4319	1.4018	1.4018
Number of Observations	944	944	944	944
Auction-pair Fixed Effects	Yes	Yes	Yes	Yes
Standard Errors Clustered by Auction-pairs	No	Yes	No	Yes

Notes: Parameter estimates obtained using the fixed effects estimator after differencing the data relative to the target market. Conventional standard errors in paranthesis unless otherwise noted. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels.

<b>Table 4. Instantaneous and Residual Effect of Investigation on Auction Prices</b>	
Dependent variable: <i>Weekly Auction Price Differences Relative to Target Market</i>	
Instantaneous Effect ( $\tau$ )	0.844 (0.169)***
Residual Effect ( $\delta_1$ )	0.648 (0.255)*
Residual Effect ( $\delta_2$ )	8.514 (17.165)
Agent Exit (Yes = 1)	0.764 (0.251)**
Overall R-squared	0.2363
Number of Observations	944
Auction-pair Fixed Effects	Y
Standard Errors Clustered by Auction-pairs	Y

Notes: Parameter estimates obtained using nonlinear least squares estimator after differencing the data relative to the target market. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels.



<b>Table 5. Exponential Decay of the Residual Investigation Effect</b>	
<b>Fraction of the Initial Residual Effect, <math>\lambda\delta_1</math></b>	<b>Weeks Since Investigation Closed, <math>t - t_{bar}</math></b>
0.9	4.875739155
0.8	10.3263518
0.7	16.50574676
0.6	23.63933472
0.5	32.07657848
0.4	42.40293027
0.3	55.71591319
0.2	74.47950875
0.1	106.5560872

Notes: Results for equation 8 in text using parameter estimates reported in Table 4. For this analysis,  $T_0$  is 394.