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Who is Selling You Chiquilitros of Gasoline? Evidence from a Public Disclosure Policy*

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Abstract:

This paper estimates the impacts of disclosing information online and through the newspapers of gas stations that violate fuel supplying standards in Mexico. Using data from inspection histories, it finds that disclosing information online decreases the probability that any gas station would be found in violation in subsequent periods. Gas stations exposed in the newspapers are estimated to decrease their sales at the month of the newspaper publication. This effect fades with time and is not significant for subsequent months. The paper shows that public disclosure mechanisms can complement enforcement effort in contexts where institutions are weak.

Keywords: Public disclosure, Corruption, Enforcement, Inspections, Violations.

JEL Classification: K42, K32, L51.

Resumen:

Este artículo estima los impactos de difundir información al público en Internet y en los periódicos sobre gasolineras que violan las regulaciones federales de despacho de gasolina en México. Utilizando datos sobre el historial de inspecciones, encontramos que difundir el historial de inspecciones en Internet reduce la probabilidad de que cualquier gasolinera viole regulaciones en los periodos siguientes a la difusión de la información. Adicionalmente, aquellas gasolineras expuestas en los periódicos registran disminuciones en sus niveles de ventas en el mes en que el reporte periodístico es publicado. Este efecto disminuye en el tiempo y es sólo significativo en el mes en que el reporte es publicado. El artículo muestra que los programas de difusión de información pública pueden inducir el cumplimiento de la ley en contextos donde las instituciones son débiles.

Palabras Clave: Difusión de información al público, Corrupción, Cumplimiento de la ley, Inspecciones, Violaciones.

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1. Introduction

Every year, the Mexican Consumer Protection Agency, PROFECO, inspects all gas stations in Mexico to ensure they supply gasoline according to federal standards. These inspections often reveal that gas stations sell *chiquilitros* (little liters) of gasoline, i.e. liters that are less than a true liter. The selling of *chiquilitros* is detected when inspectors find differences between the actual volume dispensed and the volume registered in the pump's register. Cheating is achieved by altering the mechanical and electronic components of the gasoline dispensers.

Despite constant monitoring and sanctioning of gas stations, cheating practices are rife: 30% of inspections conducted during the first half of 2006 detected violations. Sanctions have not been enough to deter violations mainly because they are not always imposed and when they are, they are small relative to the potential gains from cheating. During 2006, more than 900 inspections detected violations but only in 278 of those cases did the courts impose fines.¹ In Mexico City, fines imposed on gas stations caught selling *chiquilitros* represented 37% of the gas station owners' annual estimated gains from cheating.

In August of 2006, in an attempt to increase its regulatory powers, PROFECO started disclosing the inspection histories of all gas stations on its website, where the outcomes of the most recent inspections are rated using a traffic color system indicating the severity of the violation. Following PROFECO's launch of its website tool, several local newspapers in various cities started publishing the agency's online lists of gas stations classified as violators.

¹ Every time a gas station is found in violation, PROFECO starts an administrative legal procedure against the gas station that usually gets resolved in the courts only after long legal battles.

This paper estimates how disclosing the inspection histories of gas stations, via PROFECO's website and newspaper publications, impacts the probability that those businesses might continue to violate regulations. It also evaluates whether or not gas stations reported in the newspapers suffer a decline in their sales for the month the reports are published, as well as during the following months. Public disclosure in the context of the Mexican gasoline market is of particular importance since it is a highly regulated market by PEMEX, the national oil company. In the Mexican gasoline market, all gas stations are franchises of PEMEX: they have to display PEMEX logos and cannot freely set their prices.² The paper shows that consumers do use the information disclosed in the newspapers to discriminate across the range of gas stations.

Policies that mandate disclosure of information have been applied in different markets and most of the literature shows that making information accessible to the public has positive impacts on social welfare (Cohen and Konar, 1997; Ferraz and Finan, 2008; Garcia, Sterner and Afsah, 2007; Hamilton, 1999; Jin and Leslie, 2003; Khanna, Quimiu and Bojilova, 1998; Scorse, 2010). However, in some cases, information disclosure can lead to welfare losses (Dranove et al. (2003)). Information released as a result of public disclosure policies has also been criticized for being ineffective at persuading consumers (Magat and Viscusi, 1992; Weil et al., 2006), which brings into question the cost effectiveness of policies that disclose information to the public.

An unanswered question in the literature is, therefore: do consumers respond to the disclosure of a firm's information by third parties and, if they do, what is the magnitude of the response? Two obstacles have limited the empirical work in this area: 1) obtaining detailed micro-data on sales, profits or revenues at the firm-level is difficult and 2) analyzing consumer

² Gasoline prices are set by the government and are adjusted according to fiscal needs. There is some price variation across municipalities. Municipalities that share a border with a US city adjust their price on a weekly basis according to the average gasoline price registered the previous week in the contiguous US city. The rest of the municipalities fall under the same price zone and the price in those municipalities is adjusted on a monthly basis.

reaction to information is challenging because markets usually adjust to information disclosed via price or quality.

This paper makes four contributions to the existing literature on information disclosure. First, by using a unique dataset with monthly gasoline sales at the gas station level and by focusing on a market where firms cannot freely adjust their prices, it identifies changes in gasoline demand as a result of changes in quality, induced by disclosure of information about a firm's product quality, avoiding price endogeneity. Second, in contrast with past studies that analyze the impact of information disclosure on inspection outcomes, it considers the joint determination of violations and inspections.³ Third, it evaluates the impact of two sources of information disclosure, the Internet and newspapers. Finally, it is the first study in a developing country that analyzes public disclosure mechanisms using detailed firm level data on inspections, violations, volume sold and gas stations characteristics.

To identify the impacts of the launching of the website, I utilize the fact that the website launch was sudden and not anticipated by gas station owners, and test for changes in the probability of violating regulations before and after the website started. The effects of newspaper reports are identified by exploiting the variation in the timing of the publication of the first report in different municipalities. I show that once municipality time-invariant characteristics are controlled for, the timing at which the first report is published in a given municipality is uncorrelated with time-varying characteristics of the gasoline market in the municipality, and can be considered for the most part as an exogenous source of variation.

To estimate the impacts of the website and newspaper reports on the probability of violating regulations, I estimate a bivariate probit model with sample selection, where the

³ For example, Jin and Leslie's (2003) study on the impact of disclosure of restaurant hygiene score cards in Los Angeles on restaurant hygiene does not address the effect that the number of inspections have on restaurant hygiene levels.

probability of violation and the probability of inspection are jointly estimated, taking into account that violations are only observed if an inspection occurred. This empirical strategy is motivated by a principal agent model of compliance that I develop based on Becker's seminal work on the economics of crime (Becker, 1968). The model shows that if, as a consequence of disclosing information on firm's behavior, the regulator increases the probability of inspection, disclosing information to the public will unambiguously decrease the probability of violating regulations.

To evaluate the impacts of newspaper reports on gasoline demand I estimate an OLS model with gas station fixed effects.

The findings show that the website has negative and significant impacts on the probability of violating regulations. The website is estimated to reduce the probability of violating regulations by 0.06, which represents a 37% decrease in the estimated probability of violation before the website went into effect. Other results are: larger gas stations are more likely to be found in violation, while belonging to a chain of gas stations and average years of schooling for area residents where gas stations are located are negatively associated with the probability of violation. I also find evidence of targeted enforcement by PROFECO: gas stations that were detected in violation in past inspections were more likely to be inspected in current periods, and gas stations located in the same geographic area as each other were more likely to be inspected during the same month.

Both the website and the newspaper effects are larger on gas stations that had poor compliance histories before the first newspaper report was released in a given municipality. For those gas stations, public disclosure via online and newspapers is estimated to have reduced the estimated probability of violating regulations by 39% and 49%, for each source. The effect of

newspaper reports affect equally all violators located in the municipalities where the reports were published, regardless of whether or not a particular gas station was named in the reports. Thus, gas stations with poor compliance histories may have preemptively improved their behavior to avoid potential market losses from negative news exposure.

Results of the impact of newspaper reports on gasoline sales show that gas stations that were named in the newspapers lost between \$498 and \$539 per report in profits. This amount represents a decline of between 2.2% and 2.4% of monthly sales at gas stations and a 15% increase in the average fine imposed on violators. The economic losses were temporary: only significant at the month the reports were released. In subsequent months, the effect fades and is not significant. It is possible that newspapers induced improvements in behavior for violators because their reports led to an increase in the costs of noncompliance with regulations, albeit they were temporary.

Overall this paper shows that public disclosure mechanisms, in a context where fines are limited and regulatory agencies are weak in terms of their capacity for fining violators, can improve behavior and serve as a complementary mechanism for regulating firms.

The rest of the paper proceeds as follows: Section 2 reviews the literature. Section 3 reviews PROFECO's information disclosure program. Section 4 presents the theoretical model of violations. Section 5 presents the data, data sources and descriptive statistics. Section 6 discusses the sources of identification and the empirical strategy for estimating the impact of the website and newspaper reports on the probability of violating regulations. Section 7 shows that newspaper reports have a similar impact on gas stations with a history of noncompliance prior to the release of the first newspaper report, regardless of whether or not they had appeared in the news. Section 8 estimates the impact of newspaper reports on gasoline demand. In Section 9 I

conduct robustness checks on the estimation of the impact that the website and newspaper reports have on the probability of violation. Finally, Section 10 concludes this paper.

2. Literature Review

Empirical evidence shows contradicting welfare effects of public disclosure policies. Jin and Leslie (2003) show that disclosing hygiene grading cards in restaurants of Los Angeles improved hygiene levels and reduced the incidence of food borne related hospitalizations. Ferraz and Finan (2008) find that politicians whose corruption practices were revealed to the public were less likely to be re-elected. According to their findings the probability of being re-elected decreases with the corruption level disclosed and with the number of radio stations in the municipality. Konar and Cohen (1997) show that companies that were reported in the media after the disclosure of the Toxic Release Inventory (TRI) in the US, a database that discloses companies' emissions to the environment, had significant reductions on their stock prices. Dranove et al. (2003) shows that the adoption of mandatory coronary artery bypass graft (CABG) report cards in New York and Pennsylvania lowered social welfare.

Critics of information disclosure policies argue that information available to the public may have little persuasion effects as can be costly to collect, difficult to process and to interpret by consumers (Weil, et. al., 2006). The literature on persuasion suggests that agents are more likely to react to disclosed information if they hold weak priors about a given situation and also if they trust the agent that discloses the information (government, media, firms, other consumers, etc.) (DellaVigna and Gentzkow, 2010).

Research on the impacts of newspaper reports on consumer demand shows that it has temporary effects on demand (Beach et. al., 2008; Graff and Neidell, 2009 and Kiesel, 2010). Beach et al. (2008) study the impact of newspaper coverage on avian influenza in Italy on the demand of poultry from 2004 to 2006 and find that newspaper reports on avian influenza significantly decreased poultry demand but this impact was temporary and vanished by the 5th week after the publication. Kiesel (2010) analyzes the impact of newspaper coverage on organic products on organic milk sales in California. She finds that newspaper coverage increased the demand of organic milk and had a short-lived effect that dissipated with time. Graff and Neidell (2010) estimate the impact of smog warnings in Southern California on outdoor recreation demand. Their results show that the first day the warnings were issued and disseminated through the media, demand for outdoor recreation decreased significantly, however, warnings issued in consecutive days did not have significant impacts on demand.

3. PROFECO's Information Disclosure Policy

Since 2005, the Mexican government has taken several measures to prevent gasoline retailers from defrauding the consumer. In 2005, PROFECO's inspection policies were changed. The new rules, NOM-005-SCFI-2005, incorporated more accurate gasoline sampling techniques to detect the selling of *chiquilitros* and mandated the verification of the electronic components of the dispensers.⁴ In August of 2006, PROFECO announced to the media its new website tool where consumers and interested parties in general could access the ratings and the inspection histories of each gas station since 2005. For gas station retailers this announcement was an unexpected

⁴ The old version of the regulation NOM-005-SCFI-2005 only considered the verification of the mechanic components of the dispensers.

move, according to a PROFECO official I interviewed. Several attempts to block the access to the website by hackers after it went live also confirm that the website launch was sudden and unanticipated by gas station owners (El Universal, 2006). In the empirical analysis I use this exogenous change in the regulation to estimate the new regulations' impact on the probability of cheating.

Every year PROFECO determines the calendar of inspections. The agency's goal is to inspect every gas station at least once a year; ratings are generally updated every month. If a gas station has been inspected during the previous month, the rating is changed to reflect the most recent inspection outcome. If no inspection has occurred in a gas station during the previous 180 days the rating is discarded and that gas station appears without one. This last rule induces exogenous within-city variation of exposure to ratings, since length of exposure to a given rating is based on the timing of when the inspections occur, which is random for each gas station. This source of variation is exploited in the empirical analysis to compare gas stations that were caught in violation and were named in a newspaper report, and those gas stations found in violation but not mentioned in the news.

PROFECO's ratings are assigned according to the severity of the violation detected. Red ratings are given when any of the following violations are detected: pumps that dispense less than 0.985 liters per alleged liter sold, price alterations, broken or altered security seals, adulterating the gasoline content (gasoline mixed with other substances), modifications of the electronic and mechanical components of the dispensers, or refusal on the part of the gas station manager to be inspected.⁵

⁵ Dispensing less than 0.985 liters per liter and rejection of inspection comprised 90% of red violations.

Yellow ratings are assigned when pumps are found to dispense between 0.985 and 0.995 liters per liter sold,⁶ pump leaks are detected or the gas station has pumps out of service, and also when dispensers do not satisfy minimum technology standards according to Federal standards (NOM-005-SCFI-2005).⁷ Green indicates that the inspection did not find any anomalies. Gas stations that have not been recently inspected are given no rating. More than 50% of the violations detected by PROFECO’s inspectors involve the selling of *chiquilitros*, or differences between volume dispensed and volume sold as registered in the pumps register.

4. Model

In this Section I extend Becker’s enforcement crime model (Becker, 1968) to analytically derive the effects of information disclosure on compliance rates and enforcement. There is a principal (the regulator) and an agent (the gas station) that interact in a single period. The regulator’s objective function is to maximize social welfare comprised by the net gains from committing a violation minus the cost of inspecting and sanctioning violations. The gas station’s objective is to maximize its expected utility from committing a violation. I start by describing the problem of the gas station. A particular gas station will engage in illegal activities if the gains it obtains by doing so are higher than its expected losses:

$$EU = pU(y - f(\bar{f}, r)) + (1 - p)U(y) > 0 \tag{1}$$

⁶ Notice that yellow ratings also consider the selling of *chiquilitros*.

⁷ The most common reason for assigning a yellow rating in my panel was dispensing between 0.985 and 0.995 liters per liter sold.

where p and $U(\cdot)$ denote the probability of being caught and the firm's utility function, while y and f denote the gains from not complying with federal regulations and the penalty if caught selling *chiquilitros*, respectively. We assume the penalty f is a function of two exogenous variables: the fine set by the government \bar{f} and an information parameter r , which measures how demand changes as a reaction to information disclosure (by switching from one gas station to another gas station).

A disclosure policy increases the values of the parameter r . How the penalty changes as a result of information disclosure, i.e. $\frac{\partial f}{\partial r}$, will depend on consumer's transaction costs from accessing and reacting to disclosed information; for example, website accessibility, newspaper diffusion and number of competitors around.

The gas station will sell *chiquilitros* ($V = 1$) if $EU > 0$. Following Becker (1968), assuming a positive marginal utility of income, either increasing the probability of detection p or the penalty level f both have a negative effect on the probability of violation:

$$\frac{\partial EU}{\partial p} = U(y - f) - U(y) < 0 \quad (2)$$

$$\frac{\partial EU}{\partial f} = -pU'(y - f) < 0 \quad (3)$$

Notice also that marginal increases in the probability of detection decrease the marginal effectiveness of the fine, $V_{fp} < 0$, which reflects the fact that the probability of detection and penalties are substitutes: increasing either one can lower the expected gains from committing an offense, a common assumption in deterrence models.

The problem for the government is to maximize social welfare which is given by the net social gains from illegal activities minus the cost from deterring violators:

$$S.W = G(V) - H(V) - C(p) \quad (4)$$

where $G(V) - H(V)$ denote the gains to offenders minus the harm to consumers from offenses V and $C(p)$ denotes enforcement costs. Following Becker (1968), we also assume: $G' > 0$, $H' > 0$, $G'' < 0$, $H'' > 0$, $C_p > 0$ and $C_{pp} > 0$. For ease of exposition I assume that the penalty $f(\bar{f}, r)$ is exogenously fixed and that the government's decision variable is the probability of detection p . This is not an unreasonable assumption given that when gas stations are caught in violation, the fines are set by the courts, which are independent of PROFECO.

The first order condition is given by:

$$\frac{\partial S.W}{\partial p} = V_p(G' - H') - C_p = 0 \quad (5)$$

From equation (5) we obtain the optimal probability of detection and the number of offenses in equilibrium: p^* and $V^* = V(p, f, y)$.

If reports from the media covering gas station ratings become publicly available, the effect on the probability of being out of compliance for those gas stations is given by:

$$\frac{\partial V}{\partial r} = \frac{df}{dr} \left(V_p \frac{\partial p}{\partial f} + V_f \right) \quad (6)$$

Equation (6) summarizes the impacts of public disclosure on the probability of committing an offense. First, public disclosure decreases the probability of violation via an increase in the penalty, which is given by the term V_f . Second, it alters the optimal probability of detection (represented by the term $\frac{\partial p}{\partial f}$), since regulators could, in principle, substitute between penalties f and inspections p . Both effects are weighted by the transaction costs, $\frac{\partial f}{\partial r}$. If transaction costs are high, i.e. $\frac{\partial f}{\partial r} \cong 0$, disclosing information has no effect on reducing violations.

How regulators react to information disclosure, given by the term $\frac{\partial p}{\partial f}$, will determine if the policy is effective at deterring violators. If regulators increase the probability of detection (increase inspections) as a result of public disclosure, then the probability of committing an offense will unambiguously decrease, given transaction costs are not zero.

To analyze why the probability of finding violators changes as a result of information disclosure I derive an expression for $\frac{\partial p}{\partial f}$ by totally differentiating expression (5) and solving out for $\frac{d p}{d f}$:

$$\frac{d p}{d f} = \frac{V_p V_f (H'' - G'') + V_{fp} (H' - G')}{V_p^2 [G'' - H''] + V_{pp} [G' - H'] - C_{pp}} \quad (7)$$

First, I discuss how the marginal social losses, H' , compare to the marginal gains to violators, G' . Becker assumes that the government only has incentives to prosecute violators if the marginal social damages are greater than the marginal gains to violators: $H' > G'$. In the case analyzed in this paper, where gas stations cheat by selling *chiquilitros*, it is likely that $H' > G'$. Even though the losses from cheating are directly transferred to gas stations, which would make $H' = G'$,

social damages are likely to be greater than marginal gains to gas station owners since consumers do not know the amount they are cheated on and, therefore, cannot optimally decide where to buy gasoline. Additionally, they may experience disutility from being cheated on. For instance, if cheating involved selling bad quality gasoline, the difference between marginal social harm and marginal private gains would be higher than the case where cheating involves selling less quantity. This is because a car can be severely damaged and bad quality gasoline can cause more emissions.

Second, equation (7) shows that increasing the penalty has two opposite effects on the probability of detection. The first effect, given by the first expression in the numerator, $V_p V_f (H'' - G'') > 0$, tells us that the government can reduce the probability of detection if there is an increase in the penalty and keep the same level of deterrence. The second effect, given by the second term in the numerator, $V_{fp} (H' - G') < 0$, induces regulators to increase the probability of detection when the penalty increases, since increasing the penalty decreases the marginal effectiveness of the probability of being caught, given $V_{fp} < 0$.

The results can be summarized in the following way: if transaction costs are relatively low ($\frac{df}{dr} \neq 0$) and the regulators increase the probability of detection as a result of disclosing information, then the probability of committing an offense will unambiguously decrease as a result of disclosing information to the public.

Albeit the simplicity of the model, its implications suggests that it is important to control for the probability of detection (inspections) and for transaction costs if we want to empirically study the impacts of disclosing information on the probability of violating regulations. The former determines the sign of the effect and the later the magnitude of the effect.

In the next Section I describe the data and the empirical strategy followed.

5. Data

The dataset is a monthly panel for the period 2006-2008 with data on the number of inspections, number of inspections that detected violations, monthly retailer gasoline purchases at PEMEX (which is a proxy for sales),⁸ gasoline price, total number of pumps, storage capacity, chain,⁹ population and average years of schooling in the census block where the gas station is located. The sample has 96,588 observations comprising 2,683 gas stations studied over 36 months. Additionally, using geostatistical software, I created three variables to capture spatial externality effects: the number of competitors (gas stations) located within a radius of 1km from each gas station, percentage of competitors within 1km of (Euclidian) distance that were listed in a newspaper at a given month, and percentage of competitors located within a radius of 1km that were inspected in a given month. I focus my analysis on the 48 largest municipalities in Mexico, representing all states in the country. These municipalities had 46% of the total population and 63% of the total urban population in 2000 (Census, 2000). Table 1 in Appendix A presents summary statistics.¹⁰

In the sample, every gas station was inspected on average 1.4 times a year: 22% of the inspections found a violation, 36% of those inspections detected a severe violation and 56% of gas stations were found in violation at least once from 2006 to 2008. On average, 10% of gas stations in a municipality were inspected each month.

Newspaper reports were compiled from the websites of local newspapers from each of the 48 municipalities. A total of 31 municipalities had at least one report published in a

⁸ Using monthly purchases per gas station has the additional advantage that each purchase is measured in complete liters and not in *chiquilitros*.

⁹ In some cases multiple franchises belong to a single chain or owner. In my sample, 30% of gas stations belong to chains.

¹⁰ Due to imperfect spatial matching and missing values from the census data, the variables from the census have fewer observations.

newspaper during the study's time frame. Reports from newspapers with no website engines or with no search utilities are not included in the sample.¹¹ Newspaper reports vary in terms of the information provided, day of the week of publication and the journal's section where they appeared. All of them had the characteristic of only reporting violators, either by listing their ratings or by mentioning that those gas stations listed in the report had been found in violation by PROFECO's inspectors and consequently reported on PROFECO's website. In the reports, violators were identified by either listing their PEMEX ID, which is displayed at the gas station, or by the address of the gas station. In some cases the reports explicitly mentioned the ratings assigned by PROFECO (red or yellow), and in some others they only reported certain gas stations as being found in violation while providing a list with the types of violations detected by PROFECO.

In this paper I consider the total effect of newspaper publications without distinguishing between types of reports, as I am interested in the overall response to information disclosure. A total of 49 reports were recorded for the period 2006-2008, with 138 gas stations reported. Of those gas stations, 119 had one single report, 17 were reported twice and two had three reports.

6. The Effects of Media Disclosure on Violations

To estimate the impact of information disclosure via the website on the probability of violating regulations, I exploit the fact that the website launch was sudden and unanticipated for gas station owners, and thereby induced an exogenous change in regulation. The fact that the policy was sudden and not anticipated is important since gas stations could not change their behavior

¹¹ Focusing on newspapers with website engines induces selection in terms of newspaper coverage, as small papers are unlikely to have website engines. However, it is more likely that consumers and gas station owners react to information from large newspapers than from small newspapers, those with circulation rates of less than 2,000. The range of circulation rates of the newspapers recorded in my sample is 2,140 to 292,618.

before the policy went into effect and, therefore, we can measure the complete effect of the policy.

Figure 1 in Appendix B presents graphical evidence of the website's impact on the percentage of inspections that detected violations. The vertical line indicates the time at which the website was introduced. Although Figure 1 shows a decline in the average percentage of inspections finding violations after the introduction of the website,¹² it may be misleading to attribute the improvement in inspection outcomes solely to the presence of the website, given that violations are only observed if an inspection occurred. Changes in the number of inspections may also influence the probability of violations occurring, as Figure 2 shows. Figure 2 plots the number of inspections conducted before and after the website's launch. The influence of inspections on the probability of violating regulations was particularly important in the Summer of 2007 (see Figures 1 and 2) when the number of inspections registered a peak and the percentage of inspections that detected violations declined sharply.

Identification of the impact due to newspaper reports comes from variation in timing at which newspapers in different municipalities published the first report about local gas stations listed with red or yellow ratings on PROFECO's website. I focus on the first newspaper publication for two reasons. First, in most of the municipalities, only one newspaper report was published.¹³ Second, once the first newspaper report is released in a municipality, gas stations may correct their behavior in response to the possibility of being exposed in future reports.

To illustrate the relationship between violations, inspections and the time at which the first newspaper report was published, I created two more figures. Figures 3 and 4 plot the

¹² Estimates of changes in the level of the percentage of inspections before and after the website are statistically significant at the 1% level, confirming the apparent changes in levels shown in Figure 1 are significant. The website however did not significantly change the trend in the percentage of inspections that detected violations.

¹³ This is due to the fact that most of the municipalities had seen their first newspaper report published by the end of my panel.

percentage of inspections that found violations, and the number of inspections one year before and one year after the first time a local newspaper published a report as indicated by the vertical line, respectively.¹⁴ The graphs show a decline in the trends of the rates of inspections and violations after the newspapers published the first report.

Across municipalities, there is significant variation in the timing of the publication of the first newspaper report. Figure 5 plots the histogram of the first news reports published from 2006 to 2008 for the 48 municipalities considered in this study. Most of the reports appeared in the summer of 2008, probably as a late response to the dissemination of the information on the website. Another cluster of newspaper reports was registered around the time the website was launched. The publication of the first newspaper report is correlated with the percentage of violators that are detected in the municipality, as shown in Figure 3.

In order to address the potential endogeneity of timing of the first newspaper report's publication, I estimate a duration model on the probability that a newspaper in a given municipality released a report for the first time as a function of time-varying gasoline market characteristics in those municipalities and as a function of a set of time-invariant municipality variables. The unit of observation is a municipality in a given month. Market characteristics include percentage of gas stations in violation, percentage of gas stations inspected, total gasoline sales and number of complaints against gas stations in the municipality.¹⁵ Results of the Cox proportional hazard model are presented in Table 2.¹⁶ Column (1) of Table 2 shows the results of the duration model without municipality controls. Results of the duration model in

¹⁴ The horizontal axes of the graphs were normalized so that the time of the first newspaper publication is at zero. The graphs span a one-year window around the first time a newspaper published a report in a given municipality.

¹⁵ Municipality characteristics include population, total number of gas stations, percentage of gas stations that belong to a chain, number of households with a TV, number of households with access to piped water, electricity and sewage, total number of pumps and gasoline storage capacity, average years of schooling and number of households with a PC.

¹⁶ The Cox proportional hazard model is more flexible than other duration models since it does not require a parametric assumption about the time-dependence of the probability density function.

column (1) indicate that the probability of publishing the first report in a municipality, given that there has been no publication in previous periods, is correlated with time-varying characteristics of the gasoline market, such as the percentage of gas stations found to be in violation, the number of consumer complaints to gas stations and the number of total sales. An increase in the percentage of gas stations in the municipality found in violation in a given month increases the risk of a publication of a news report by 9%. Column (2) includes municipality time-invariant characteristics. When controlling for municipality characteristics, none of the time-varying market characteristics variables are significant, suggesting that most of the observable correlations between the first time newspapers published a report and the gasoline market characteristics can be explained by time-invariant municipality characteristics. The timing of the first report's publication can be considered for the most part a source of exogenous variation, once one controls for municipality characteristics that do not vary over time.

From the discussion in the preceding paragraph and the implications of the model presented in Section 4 it follows that, in order to estimate the impact of the website and newspaper publications on the probability of violating regulations, one needs to control for the probability of being inspected in a given month and to control for municipality fixed effects. According to the model presented in Section 4 if, as a result of disclosing information, PROFECO had increased its inspections the information disclosure policy should have unambiguously reduced the probability of committing a violation.

The model I estimate for finding how PROFECO's policy affected inspections and violations is a bivariate probit model with sample selection,¹⁷ where the probability of inspecting a gas station in a given month is jointly estimated with the probability of finding a violation.

¹⁷ I focus on the probability of violating regulations, rather than on the number of violations, because most of the gas stations are inspected only once a year, which induces a large number of zeros on both the number of inspections and the number of

Let $Inspec^* = X'_{it}\beta_1 + \varepsilon_{1it}$ represent the benefit to the regulator of inspecting gas station i , where X is a vector of explanatory variables, which includes gas station characteristics and municipality fixed effects. Although the latent variable $Inspec^*$ is not directly observable, the indicator function $Inspec$ is observable:

$$Inspec = \begin{cases} 1 & \text{if } Inspec^* > 0, \\ 0 & \text{if } Inspec^* \leq 0. \end{cases} \quad (8)$$

Let $Viol^* = X'_{it}\beta_2 + \varepsilon_{2it}$ denote the benefit gas station i obtains from violating regulations (e.g., tampering with the pumps). The latent variable $Viol^*$ is not observable but the indicator function $Viol$ is:

$$Viol = \begin{cases} 1 & \text{if } Viol^* > 0, \\ 0 & \text{if } Viol^* \leq 0. \end{cases} \quad (9)$$

The error terms ε_{1it} and ε_{2it} are assumed to have a bivariate normal distribution with correlation $Corr(\varepsilon_{1it}, \varepsilon_{2it}) = \rho$.

In a standard bivariate probit, four probabilities are estimated:

1. $Prob(Inspec = 1, Viol = 1)$
2. $Prob(Inspec = 1, Viol = 0)$
3. $Prob(Inspec = 0, Viol = 1)$
4. $Prob(Inspec = 0, Viol = 0)$

inspections that found violations. This is also the reason a bivariate probit was preferred over a standard Heckman model with selection, since the truncated variable in this case is dichotomous.

In the presence of a truncated sample, only probabilities 1 and 2 are observed. Probabilities 3 and 4 are indistinguishable from each other. The focus of this paper is to estimate how disclosing information affects the unconditional probability of committing a violation $Prob(Viol = 1)$. A standard bivariate probit would only allow us to estimate the conditional probability of committing a violation, $Prob(Viol = 1|Inspec = 1)$. Estimating how public disclosure affects the conditional probability of committing a violation is misleading since it is possible to observe reductions in the conditional probability $Prob(Viol = 1|Inspec = 1)$ without changing the unconditional probability $Prob(Viol = 1)$. One way this could happen is if PROFECO changed its inspection strategy and focused only on those gas stations with a higher probability of being caught in violation.

A bivariate probit with sample selection adjusts the likelihood function to correct the potential bias caused by not observing violations when there are no inspections which allows us to obtain estimates of the unconditional probability $Prob(Viol = 1)$.

For estimating a bivariate probit with sample selection, the likelihood function is constructed with three probabilities: $Prob(Inspec = 0)$, $Prob(Inspec = 1, Viol = 1)$ and $Prob(Inspec = 1, Viol = 0)$.

The specification I estimate for the inspection and the violation equations is given by:

$$Prob(Insp_{it}) = \tau + \gamma_1 violast_{it} + \gamma_2 website_t + \gamma_3 news_{mt} + \gamma_4 comp_{it} + Z'\beta + \varepsilon_{1it} \quad (10)$$

$$Prob(Viol_{it}) = \tau + \theta_1 violast_{it} + \theta_2 website_t + \theta_3 news_{mt} + Z'\delta + \varepsilon_{2it} \quad (11)$$

in which $Insp_{it}$ is a dummy variable that indicates if gas station i was inspected at month t , $Viol_{it}$ is a dummy variable that takes a value of one if an inspection of gas station i at month t discovered a violation (only observed if an inspection occurred during that month), τ is a trend variable (which controls for increasing detection of violations over time), and $violast$ is a dummy variable that takes a value of one if in the previous inspection gas station i was found in violation. This variable captures the influence of past enforcement on the current probability of violating regulations. Z is a set of covariates that includes gas stations characteristics such as number of pumps, storage capacity, population and average years of schooling at the census tract, a chain dummy and the number of competitors within 1km of distance. The variables Z and $violast$ control for the most important factors PROFECO inspectors take into account for inspecting gas stations.¹⁸ The variable $website$ is a dummy variable that takes a value of one for observations that occurred after August of 2006, when the website was introduced. $news$ is a dummy variable that takes a value of one for the month in which a newspaper published a report for the first time in municipality m ; this dummy variable stays on until the end of the panel. The vector Z also includes interactions between $website$ and schooling and $website$ and the chain dummy.

The identifying assumption for estimating the effect of newspapers is that, conditioned by gas station characteristics and municipality fixed effects, the timing of the first newspaper publication is uncorrelated with either ε_{1it} or ε_{2it} , the unobservables that affect the probability of inspection and violation, respectively. As is the case with a standard Heckman model with sample selection, the model requires an exclusion restriction, a variable that is correlated with the

¹⁸ According to an interview I had with PROFECO's inspections coordinator in June of 2010 the main factors that PROFECO takes into account for deciding who to inspect are the size of the market (number of gas stations in a city) and past behavior.

probability of inspection and uncorrelated with ε_{2it} . I use the percentage of gas stations around gas station i that are inspected in month t , denoted by the variable *comp* in equation (10). The larger the percentage of gas stations around gas station i that is inspected in month t , the higher the probability that gas station i is inspected. In order for the variable percentage of inspected neighboring gas stations to work as a valid exclusion restriction we need to assume that the only way it affects the probability of violation is via the probability of inspection. Hence, we assume gas stations do not change their status from violation to non-violation once they observe neighboring gas stations are being inspected. This assumption is not unreasonable given PROFECO's inspection policy, which targets geographic areas, rather than specific gas stations. The geographic clustering of inspections responds to PROFECO's limited resources for inspecting gas stations and to their needs to reduce inspection costs; therefore, this clustering is unlikely to be correlated with unobservables that influence the probability of violating regulations.

Table 3 presents results from the estimation of the bivariate probit model with sample selection for the probability of inspection (columns (1) to (3)) and the probability of violation (columns (4) to (6)). Three models are presented in Table 3: a reduced model (columns (1) and (4)); a base model with municipality fixed effects, gas station and socioeconomic characteristics and time trend (columns (2) and (5)); and a model that adds to the base model interaction terms of *website* and the chain dummy and *website* and schooling (columns (3) and (6)). Estimated marginal effects of the control variables on the probability of violation are presented in Table 4.¹⁹ The last row of Table 4 shows the estimated unconditional probability of violation before the website started operating for each model.

¹⁹ Marginal effects of the dummy variables are calculated as the difference between the estimated unconditional probability of violation when the dummy takes a value of one and the estimated unconditional probability of violation when the dummy takes a value of zero, and they are evaluated at the mean of each variable.

First, I discuss the estimation results of the probability of inspection presented in columns (1) to (3) of Table 3. The estimates of the website dummy and ρ , the correlation coefficient of the error terms in the equations of the probability of violation and the probability of inspection, are significant and positive for all models, which validates the econometric approach to jointly estimating the inspection and violation equations. Estimates in Table 3 show evidence of two types of PROFECO's inspection targeting strategies. First, the coefficient of the dummy of violation in the previous inspection is positive and significant, which indicates that violators are inspected more frequently. Second, inspections are geographically clustered as evidenced by the significant and positive coefficient of the *competitors inspected* variable, possibly in order to decrease inspection costs. Other significant variables that are correlated with inspections are *population* and *storage capacity*. Gas stations located in more populated areas are less likely to be inspected and larger gas stations are more likely to be inspected.

The interaction terms (column (3)) indicate that areas with more education levels were inspected more often before the website started operating. No significant evidence of a reduction in the level of inspections in areas with more schooling levels was found (see coefficient *Schooling*Website* in column (3)).

The marginal effects of the explanatory variables on the probability of violation show that the website has significant and negative effects on the probability of violating regulations. The website reduces the unconditional probability of violating regulations by 0.062 (see column (2) of Table 4), which represents 37% of the estimated probability of violating regulations before the website started operating. Also, gas stations that are detected in violation in the previous inspection are more likely to be in violation in the current period. This result suggests that previous inspections and the sanctions imposed as a result of those inspections were not

sufficient to deter violations. It also indicates that inspections that followed an inspection that disclosed violations are random and unexpected by the gas station owner, who is caught by surprise and found in violation. I find that gas stations with larger storage capacity were more likely to be found in violation, possibly reflecting larger gains from cheating. Reputation effects seem to have a strong impact on chains: belonging to a chain is associated with a 0.027 reduction in the likelihood of violating regulations. Gas stations located in areas where the surrounding population has an additional year of schooling are less likely to violate regulations by 0.006.

I also find evidence of differentiated effects of the website: it has stronger effects on gas stations that do not belong to chains and that are located in areas with less educated people (see column (3) in Table 4)). The estimate of the newspaper dummy, although negative, does not show significant effects on the probability of violating regulations. However, evidence from public disclosure programs suggest that disclosure policies are particularly effective for firms that, before the policy went into effect, were in poor compliance status (Garcia, Sterner and Afsah, 2007; Hamilton, 1999; Scorse, 2010).

To assess if public disclosure of a gas station's inspection outcome on the website and in the newspapers had greater effects on gas stations with a history of noncompliance versus those with good histories, first I present graphical evidence for the impact of newspaper publications on violation rates; this evidence focuses on the set of gas stations that, before the first newspaper published a report in a municipality, was found in violation in at least one inspection. Hereafter, I will also refer to this set of gas stations as the set of violators. Figures 6 and 7 plot the percentage of inspections that detected violations and the number of inspections before and after a newspaper report was published, respectively. Figure 6 shows that, in the set of violators, the

first newspaper report induced a sharp decline in the percentage of inspections that detected violations, which can be partly associated with the decline in inspections depicted in Figure 7.

To estimate the effects of media disclosure on the probability of violating regulations in the set of violators, I follow the same econometric strategy and estimate a bivariate probit model with sample selection. Tables 5 and 6 present the results of the estimations and the marginal effects of the variables on the probability of violation, respectively. I estimate two models: the first one uses only the sample of violators (columns (1) and (3) in Table 5 and column (1) in Table 6) and the second one uses the whole sample and interacts a dummy *violator*, that takes a value of one if a gas station belongs to the set of violators (was caught in violation before a newspaper first published a report), and zero otherwise, with the *newspaper* and *website* dummies (columns (2) and (4) in Table 5 and column (2) in Table 6). Since we are focusing on violators, we omit the variable *Violation in last inspection*.²⁰

Results of both models are qualitatively similar, which indicates that focusing on the subsample of violators correctly captures the direction of the effects of public disclosure on the set of violators.

Overall, the effects of the explanatory variables on the probability of inspection are similar to the ones obtained in Table 3: gas stations located in the same geographic location are more likely to be inspected during the same month and the number of inspections increased after the website was launched. Contrary to the findings obtained in Table 3, the probability of inspection significantly decreased when newspapers started publishing reports.

The effects of most of the control variables on the probability of violation are qualitatively similar to the ones obtained in Table 4: larger gas stations are more likely to violate

²⁰ Also, convergence was not achieved in the estimates of Table 6 when using the complete sample and including the variable *Violation in last inspection*.

regulations, while belonging to a chain and being located in areas with more educated people are both associated with a lower likelihood of violation.

However, I find evidence of differentiated effects of the website and the newspaper dummies for violators and non-violators. Column (1) of Table 6 shows that violators reduced the probability of committing violations by 0.18 and 0.22 after the website started operating and the newspapers published reports, respectively. These numbers represent 39% and 49% of the estimated probability of committing violations before the newspapers started publishing reports. Column (2) shows the effects of public disclosure using the complete sample and thus allows us to observe the effects of the website and newspapers for violators and non-violators. Results of column (2) indicate that the website and the newspaper reports only have negative impacts on the probability of violation for violators. The effect of newspapers on non-violators (*Newspaper dummy* coefficient in column (2)) is positive, possibly indicating that non-violators may have anticipated that no other report would be published which increased their incentives to violate regulations. Interestingly, non-violators seem to not have changed their behavior as a result of the website, an indicative that the website effects are more permanent than newspaper effects since it can be accessed by consumers at any time.

Also worth discussing is a main difference regarding the estimates obtained without distinguishing across violation status: The correlation coefficient ρ is not significant and that the Wald test of independence of equations cannot be statistically rejected. Although in principle this would suggest conducting separate estimations for the probabilities of inspection and violation, results of separate regressions (not reported here) are similar to the ones presented in Tables 5 and 6 and, given that the number of inspections seem to have decreased after the first newspaper

report had been published, controlling for the probability of inspection in the violation equation is necessary.

The reason newspaper reports induce changes in behavior only for those gas stations with a history of noncompliance may be explained by the fact that persistent violators are more likely to be reported in the news and to face bad publicity in the future, as they are inspected more frequently and exposed to bad ratings online for longer periods compared to gas stations with good behavior. It is also possible that violating gas stations become more aware of potential exposure to bad publicity once newspapers start publishing reports, whereas gas stations with good compliance histories underestimate the effects on their sales that media exposure can have.

Within the set of violators, there are gas stations that were not reported by the newspapers and gas stations that did appear in the news reports. In the next Section, I discuss why this is the case and evaluate if disclosure of information on the website and through newspaper reports have different effects on those two types of gas stations.

7. Heterogeneous Effects of Newspaper Reports on Gas Stations with a History of Noncompliance

Only 7.4% of gas stations that had been found in violation before a newspaper published a report were exposed in the news. There are two possible explanations for why some violators were exposed in the news and others were not: 1) at the moment the reporter consulted the web page some gas stations had ratings and others did not, a variation that is mostly exogenous due to PROFECO's rule for updating the ratings, which discards ratings from old inspections and 2) the reporter arbitrarily selected gas stations with red or yellow ratings on which to report. In order to

check if there was a systematic selection of gas stations for the news, Table 7 shows the coefficient estimates of a set of OLS regressions of gas station characteristics, before the first newspaper was published, on a dummy that takes a value of one for gas stations that were exposed in the newspapers in the first report.

Column (1) shows the basic OLS estimates and column (2) controls for municipality fixed effects. Column (1) of Table 7 reveals that gas stations that are exposed in the news do not systematically differ from gas stations that are not in the news, except in their average violation rates. Gas stations that are in the news are more likely to be found in violation before the newspaper published a report. However, controlling for municipality fixed effects removes most of the differences in violation rates between exposed gas stations and those not exposed, suggesting that within municipalities there was not a systematic selection of gas stations for the newspaper reports. Hence, selection of gas stations for the newspaper reports seem to be mainly driven by PROFECO's rule for updating the ratings.

To test if newspaper reports have differentiated effects for exposed and not-exposed gas stations with a history of noncompliance prior to the news reports, I follow the same procedure as in the previous sections and estimate a bivariate probit model with sample selection restricting the sample to the set of violators. The inspection and violation equations I estimate are given by

$$Prob(Insp_{it}) = \gamma_1 website_t + \gamma_2 news_{it} + \gamma_3 nonews_{it} + \gamma_4 comp_{it} + Z' \beta + \varepsilon_{1it} \quad (12)$$

$$Prob(Viol_{it}) = \theta_1 website_t + \theta_2 news_{it} + \theta_3 nonews_{it} + Z' \delta + \varepsilon_{2it} \quad (13)$$

in which *news* takes a value of one for gas stations that appeared in the first newspaper report in a given municipality and remains as one until the end of the panel, and *nonews* takes a value of one for gas stations located in municipalities where newspapers published reports about violating gas stations, but were not listed in the reports. The matrix Z denotes the set of covariates, including a dummy that indicates if a gas station was found in violation in the previous inspection and a trend variable.

Table 8 presents the marginal effects estimates on the probability of violation. The effects of the first newspaper report are negative and significant for both types of gas stations, those that are exposed and those that are not. Although gas stations that did not appear in the newspapers seem to have their probability of violating regulations reduced to a greater degree than those gas stations that appeared in the newspaper reports, the (χ^2) tests of equality of coefficients, $\gamma_3 = \gamma_4$, cannot be rejected in any of the specifications. The estimates suggest that gas station owners of those gas stations detected in violation prior to the first newspaper report reacted in a similar fashion to the threat of exposure in future reports, regardless of whether or not they were exposed in that first report, and thus improved their behavior. One possible explanation of this result is that violators anticipate potential market losses as a consequence of future news reports.

In the next Section I evaluate if gas stations that were reported in the newspapers suffered from a decline in their market shares as a consequence of bad publicity.

8. The Effects of Newspaper Reports on Gasoline Demand

In the previous sections it was shown that gas stations with a history of noncompliance prior to the first time a newspaper report was published in a municipality were less likely to violate

regulations after that first report was published. Moreover, newspaper reports had a similar impact on the set of violators, regardless of whether or not they were reported in the news, indicating that violators may have anticipated the potential losses in market shares as a consequence of bad publicity and thus corrected their behavior, possibly to avoid exposure in future newspapers reports.

To evaluate the impact of newspaper reports on monthly gasoline sales I estimate the following equation for sales of gas station i at month t :

$$Sales_{it} = \alpha_i + m\tau + \beta_1 percnews_{it} + \beta_2 violdummy_{it} + \sum_{j=0}^3 b_j \cdot news_{it-j} + \varepsilon_{it} \quad (14)$$

where $Sales_{it}$ indicates purchases (gasoline volume) of regular and premium gasoline to PEMEX from gas station i at month t (which is a proxy for gasoline sales), α_i denote gas station fixed effects, $m\tau$ is a vector of municipality by time fixed effects and ε_{it} is the disturbance term. The inclusion of municipality by time fixed effects captures changes over time in the gasoline market at the municipality level that may influence the demand of gasoline in a particular gas station, such as new market entrants and other market shocks. The variable $news_{it}$ represents the number of newspaper publications that reported gas station i in month t . I included three lags of the news variable in order to capture the duration of the impact of the newspaper release. The variable $percnews$ denotes the percentage of gas stations within 1km from gas station i that were reported in the news in month t . This variable intends to capture spatial externality effects of the publication of the newspaper reports. Suppose gas station i did not appear in the news at time t : the larger the percentage of competitors around gas station i that are reported in the news,

the more likely consumers will switch to gas station i for consuming gasoline. Since every time a gas station is found in violation altered pumps are shut down until the violations are corrected, I included the variable *violdummy*, which takes a value of one if gas station i was found in violation at time t , in order to control for the effect that this type of sanction has on sales.

The main identifying assumption in equation (14) is that the number of newspaper reports is not correlated with the error term ε_{it} . Since newspapers only reported violators and the probability of violating regulations may be correlated with monthly sales, identification of the parameters in equation (14) requires controlling for gas station characteristics that influence the probability of violating regulations. In Section 7, it was shown that the probability of violating regulations was correlated with storage capacity, belonging to a chain and years of schooling in the census block where gas stations are located. Thus, the inclusion of gas station fixed effects should control for time-invariant characteristics that influence the probability of violating regulations and also for those time-invariant characteristics that affect the likelihood of appearing in newspaper reports, such as location, gas station ownership and municipality characteristics.

Since only gas stations that are in violation were reported in the newspapers, I also estimate equation (14) using the sample of violators, i.e. those gas stations with a history of noncompliance prior to the first publication of a news report. In this sample, the control group, those gas stations that violated regulations but were not reported in the news, comprises a more comparable group to the treatment group than the control group that uses both violators and non-violators as is the case with the complete sample of gas stations. In Section 8 it was shown that, within the group of violators, gas stations that appeared in the first newspaper report were similar in their characteristics to gas stations that were not exposed in the newspaper reports (see Table

7). Restricting the sample to the group of violators eliminates potential biases that may remain after the inclusion of fixed effects.

Results of the estimates of equation (14) are shown in Table 9. According to these estimates, newspaper reports have negative and significant effects on gasoline sales. The impact on the complete sample are similar to the impact estimated on the sample of violators, which suggests that the inclusion of fixed effects controls for most of the characteristics that influence the number of times a given gas station is exposed in the news. Columns (2) and (4) of Table 9 present the results for the specifications that include lags of the number of newspaper reports. According to these results, the effect of newspaper publications decreases over time and is only significant for the month of the newspaper publication. There are two possible explanations for the temporary impact on sales. One is that consumers expect that, as a result of those stations having received negative news exposure, gas stations will have incentives to correct their behavior; consequently, consumers punish the named gas stations only for a short period of time, the period in which they correct their anomalies. A second explanation is that consumers may perceive that the net gains from going to other gas stations decrease over time, once they have started going to other gas stations and have internalized the costs of searching for alternative retailers.

Gas stations that are named by the newspapers sell between 12,100 and 13,160 liters less in the month of the report's publication, an amount equivalent to selling between 2.2% and 2.4% liters less per month.²¹ These estimates are the lower bounds of the impact of newspaper reports, since gas stations named in the news corrected their violations and consequently purchased more gasoline once they were reported in order to sell the *right* amount of gasoline. Considering that the average real price of gasoline for the period 2006-2009 was \$0.75 dollars per liter, the

²¹ In the sample of violators, gas stations sold on average 535.83 cubic meters per month prior to the publication of the news.

average commercial margin was 5%, and gas stations in the news corrected their behavior as a result of media exposure, gas stations named in the reports lost between \$498 and \$539 per newspaper report in profits for the month in which they were exposed.

To compare the decline in sales from negative press to the average fine a station would be liable for if caught, I use a set of gas stations in Mexico City for which I was able to obtain data on fines. Gas stations in Mexico City caught in violation in the period of study were fined on average \$3,620.²² The estimated loss per newspaper report for those gas stations is \$557. This amount represents 15% of the average fine.

The question still remains, why are gas stations correcting their violations as a consequence of newspapers publications if consumer reaction is temporary and represents only a fraction of the fine? One possible explanation is that gas stations may fear continuous media exposure will add to a growing negative reputation on the part of the business, in the eyes of the consumer; in this case, the impact of repeated newspaper reports would be greater and last for longer periods.

9. Robustness Checks

In this Section I perform robustness checks on the estimates of equations (10) and (11). One concern is that although the estimates control for the probability of being inspected, the decline in violation rates observed after the website's introduction may have been driven by the large increase in the number of inspections that started in the second quarter of 2007. A second concern is that results may be driven by a few outliers. For example, Figure 1 shows that before

²² The average fine was calculated for any type of violation. The amount of the fine depends on the severity of the violation. Fines are increase with the severity of the violation.

the website launch there was a large percentage of inspections that detected violations in April of 2006. Similarly, there is a large decline in violation rates after March of 2007. To test if the estimates are robust to the omission of outliers, I estimate a bivariate probit model with selection restricting the sample to those observations before April of 2007 and discard the observations of April 2006 and December 2012.

Table 10 presents marginal effects estimates of the website dummy for the probability of violation. The estimations exclude the dummy variable that indicates if the gas station was found in violation in the previous inspection, as when it was included the model did not converge. Also, it excludes the time trend as is not significant in any of the estimated models. Results in Table 10 show that estimates of the website are robust to the exclusion of outliers. Moreover, the magnitudes of the website's estimated effects are similar to the ones obtained when considering the full sample.

Another concern about using inspector's disclosed violations is that it may be a biased indicator of the "real" cheating if corruption of inspectors is present. To address this I estimated a fixed effects model using the number of consumer complaints filed against gas stations from 2006-2008. The results (not presented here) show that both the website and the newspaper dummies have a negative impact on the number of complaints, but the effects are not significant. Although coefficients are not significant, the sign of the coefficients indicates that both disclosure through the website and the newspapers tended to improve the behavior of gas stations.

10. Conclusions

This paper contributes to the literature on public disclosure. In particular, the paper studies the effects of disclosing information online and through the newspapers about Mexican gas stations that violate gasoline supply regulations. The first question this study intends to answer is whether gas stations improve their behavior as a result of PROFECO's policy of disclosing inspection outcomes online and through the newspapers. The second question addressed is if the gasoline demand in those gas stations that were reported in the newspapers declined at the month of the publication and during the following months. Additionally, the study explores whether public disclosure programs are more effective at improving behavior in gas stations that have a history of noncompliance versus those that are in full compliance with regulations.

The findings show that online disclosure and newspaper publication have differentiated effects on the probability of violating regulations. PROFECO's web page has significant and relatively large effects on the probability of violating regulations. In contrast, newspaper reports only have significant effects on those gas stations with a history of noncompliance before the newspapers started publishing reports.

According to our findings, disclosing information online decreases the probability of violating regulations by 37%. For gas stations that had a history of noncompliance before the newspapers started publishing reports, both newspaper and online disclosure decrease the probability of violating regulations by 39% and 49% each.

One of the reasons that gas stations may improve their behavior as a result of PROFECO's disclosure policy is that consumers decide where to consume gasoline according to the information disclosed by PROFECO. I find that consumers react to the information published

in the newspapers and consume less gasoline at those gas stations that are reported as violators. Newspaper reports have a negative and statistically significant impact on monthly gasoline sales. Gas stations reported in the newspapers are estimated to lose between \$498 and \$539 in profits in the month the newspaper report is published. This loss represents between 2.2% and 2.4% of their monthly sales. Although the effects on gasoline sales are not large and are only temporary, they seem to be effective at inducing compliance.

Results indicate that public disclosure mechanisms are an effective tool for improving compliance rates in contexts where regulatory agencies are weak and lack the resources to fine and prosecute violators.

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Appendix A

Table 1. Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Violation dummy	11098	0.222	0.416	0	1
Inspection dummy	96588	0.115	0.319	0	1
Years of schooling	86580	10.240	2.215	0	15.17
Population (1000)	86580	2.786	1.819	0	11.736
Storage capacity (100 m3)	96588	1.828	0.886	0.2	11
Number of pumps (10)	96588	1.695	0.836	0.2	6
Number of competitors within 1km	96588	1.861	1.835	0	10
News dummy municipality	96588	0.400	0.490	0	1
News dummy gas station	96588	0.019	0.136	0	1
Newspaper reports	96588	0.002	0.043	0	2
Website dummy	96588	0.778	0.416	0	1
Chain dummy	96588	0.296	0.456	0	1
Competitors inspected (%)	96588	0.080	0.213	0	1
Total Sales (m3)	96588	537.767	395.850	0	3755.758
Price Magna (real pesos/liter)	93905	5.665	0.206	4.880	7.105
Price Premium (real pesos/liter)	93905	6.807	0.249	5.379	7.601

Table 2. Duration Model on the probability of publishing the first report

Variables	(1)	(2)
Complaints	0.892** [0.045]	0.977 [0.062]
Percentage gas stations in violation	1.095** [0.043]	1.083 [0.053]
Percentage gas stations inspected	1.006 [0.012]	1.015 [0.010]
Sales	1.041*** [0.012]	0.986 [0.022]
Municipality characteristics	N	Y
Observations	1308	1308

Note: Hazard ratios reported from a Cox proportional hazards model on time to first publication. The unit of observation is a municipality. Standard Errors Clustered at the state level in brackets. ***p<0.01, **p<0.05 and *p<0.09.

Table 3. Media effects on the probability of inspection and violation

Variable	Prob(Inspec=1)			Prob(Viol=1)		
	(1)	(2)	(3)	(4)	(5)	(6)
Violation last inspection		0.098*** [0.022]	0.098*** [0.022]		0.415*** [0.054]	0.413*** [0.054]
Competitors inspected	0.73*** [0.04]	0.651*** [0.039]	0.651*** [0.039]			
Storage capacity		0.014** [0.006]	0.014** [0.007]		0.073*** [0.017]	0.073*** [0.018]
Pumps		0.007 [0.006]	0.007 [0.006]		0.037 [0.023]	0.037 [0.024]
Competitors		-0.006** [0.002]	-0.006** [0.002]		-0.006 [0.010]	-0.006 [0.010]
Website dummy	0.15* [0.08]	0.285*** [0.080]	0.457*** [0.175]	-0.226*** [0.072]	-0.302*** [0.080]	-1.558*** [0.428]
Newspaper dummy	0.09* [0.04]	-0.016 [0.055]	-0.015 [0.055]	-0.048 [0.055]	-0.041 [0.096]	-0.051 [0.095]
Chain dummy		-0.006 [0.017]	-0.054 [0.056]		-0.164*** [0.030]	-0.059 [0.165]
Chain dummy*Website			0.05 [0.051]			-0.11 [0.177]
Schooling		0.006 [0.004]	0.023** [0.010]		-0.034*** [0.009]	-0.150*** [0.040]
Schooling*Website			-0.017 [0.011]			0.120*** [0.039]
Population		-0.004*** [0.001]	-0.004*** [0.001]		-0.006 [(0.017]	-0.007 [0.017]
Constant	-1.43*** [0.08]	-1.819*** [0.073]	-1.983*** [0.159]	-1.116*** [0.130]	-1.495*** [0.288]	-0.277 [0.549]
ρ	0.38*** [0.09]	0.292*** [0.100]	0.251** [0.103]	0.38*** [0.09]	0.292*** [0.100]	0.251** [0.103]
Municipality FE	N	Y	Y	N	Y	Y
Time Trend	N	Y	Y	N	Y	Y
Number of obs.	96588	64574	64574	96588	64574	64574
Uncensored obs.	11098	7753	7753	11098	7753	7753
Wald test	20.01	4.44	5.93	20.01	4.44	5.93

Note: Estimates of bivariate probit with sample selection. Columns (1)-(3) show estimates of the probability of inspection. Columns (4)-(6) present estimates of the probability of violation. The exclusion restriction is *Competitors Inspected*. Clustered Std. Errors at the state level in brackets. ***p<0.01, **p<0.05 and *p<0.09. Test of independence of equations given by Wald test, distributed as a χ^2 .

Table 4. Marginal effects of the probability of violation

Variable	(1)	(2)	(3)
Violation last inspection		0.085***	0.085***
		[0.018]	[0.019]
Storage capacity		0.012***	0.013***
		[0.004]	[0.004]
Pumps		0.006	0.006
		[0.004]	[0.004]
Competitors		-0.001	-0.001
		[0.001]	[0.001]
Website dummy	-0.041***	-0.062***	-0.484***
	[0.015]	[0.023]	[0.168]
Newspaper dummy	-0.008	-0.007	-0.009
	[0.010]	[0.017]	[0.016]
Chain dummy		-0.027***	-0.01
		[0.007]	[0.028]
Chain dummy*Website			-0.018
			[0.029]
Schooling		-0.006**	-0.026***
		[0.002]	[0.009]
Schooling*Website			0.021***
			[0.008]
Population		-0.001	-0.001
		[0.003]	[0.003]
Municipality FE	N	Y	Y
Time Trend	N	Y	Y
Number of obs.	96588	64574	64574
Uncensored obs.	11098	7753	7753
Wald test	20.01	4.44	5.93
Pr(Violation=1)	0.13	0.16	0.17

Note: Marginal effects of the estimates of bivariate probit with sample selection of the probability of violation evaluated at the mean of each variable. The exclusion restriction is *Competitors Inspected*. Clustered Std. Errors at the state level in brackets. ***p<0.01, **p<0.05 and *p<0.09. Test of independence of equations given by Wald test, distributed as a χ^2 . Estimates of the unconditional probability of violating regulations before the website are presented in Pr(Violation=1).

Table 5. Media effects on the probability of inspection and violation for violators

Variables	Prob(Inspec=1)		Prob(Viol=1)	
	(1)	(2)	(1)	(2)
Storage capacity	0.005 [0.008]	0.011** [0.005]	0.079*** [0.022]	0.085*** [0.013]
Pumps	-0.006 [0.012]	0.006 [0.007]	-0.006 [0.039]	0.005 [0.022]
Competitors inspected	0.693*** [0.054]	0.682*** [0.040]		
Competitors	-0.009*** [0.003]	-0.004* [0.002]	-0.009 [0.009]	-0.005 [0.008]
Website dummy	0.167** [0.071]	0.250*** [0.065]	-0.473*** [0.066]	0.035 [0.107]
Newspaper dummy	-0.173*** [0.062]	-0.033 [0.052]	-0.647*** [0.119]	5.315*** [0.149]
Violator dummy		0.213*** [0.032]		6.681*** [0.133]
Violator*Newspaper		-0.105*** [0.024]		-5.957*** [0.128]
Violator*Website		-0.069* [0.039]		-0.556*** [0.114]
Chain dummy	0.008 [0.018]	-0.004 [0.014]	-0.131*** [0.041]	-0.155*** [0.033]
Schooling	0.005* [0.003]	0.007** [0.003]	-0.027*** [0.007]	-0.021*** [0.007]
Population	-0.002 [0.004]	-0.002 [0.001]	-0.014 [0.012]	-0.002 [0.011]
Constant	-1.584*** [0.041]	-1.764*** [0.037]	-0.119 [0.336]	-7.135*** [0.239]
ρ	0.084 [0.157]	0.193 [0.123]	0.084 [0.157]	0.193 [0.123]
Municipality FE	Y	Y	Y	Y
Time Trend	Y	Y	Y	Y
Number of obs.	35424	86580	35424	86580
Uncensored obs.	4519	10142	4519	10142
Wald test	0.29	2.47	0.29	2.47

Note: Estimates of bivariate probit with sample selection. Columns (1)-(3) show estimates of the probability of inspection. Columns (4)-(6) present estimates of the probability of violation. Estimates in columns (1) and (3) use the sample of violators. Columns (2) and (4) show estimates using the complete sample and interactions terms of a dummy for violators with website and newspaper dummies. The exclusion restriction is *Competitors Inspected*. Clustered Std. Errors at the state level in brackets. ***p<0.01, **p<0.05 and *p<0.09. Test of independence of equations given by Wald test.

Table 6. Marginal effects of the probability of violation for violators

Variables	(1)	(2)
Storage capacity	0.029***	0.0006**
	[0.008]	[0.0003]
Pumps	-0.002	0.00004
	[0.014]	[0.0001]
Competitors	-0.003	-0.00004
	[0.003]	[0.00007]
Website dummy	-0.180***	0.0002
	[0.032]	[0.0008]
Newspaper dummy	-0.222***	0.670***
	[0.045]	[0.083]
Violator dummy		0.875***
		[0.047]
Violator*Newspaper		-0.023**
		[0.009]
Violator*Website		-0.003**
		[0.001]
Chain dummy	-0.047***	-0.001**
	[0.017]	[0.0005]
Schooling	-0.010***	-0.0001
	[0.003]	[0.0001]
Population	-0.005	-0.00002
	[0.004]	[0.00009]
Municipality	Y	Y
Time	Y	Y
Number	35424	86580
Uncensored	4519	10142
Wald test	0.29	2.47
Pr(Violation=1)	0.446	0.16

Note: Marginal effects of the estimates of bivariate probit with sample selection of the probability of violation evaluated at the mean of each variable using the sample of violators. Estimates in column (1) use the sample of violators. Column (2) shows estimates using the complete sample and interactions terms of a dummy for violators with website and newspaper dummies. The exclusion restriction is *Competitors Inspected*. Clustered Std. Errors at the state level in brackets. ***p<0.01, **p<0.05 and *p<0.09. Test of independence of equations given by Wald test, distributed as a χ^2 . Estimates of the unconditional probability of violating regulations before a newspaper in a city started publishing the first report are presented in Pr(Violation=1).

Table 7. OLS estimates of gas station characteristics on newspaper dummy: sample of violators

Dependent Variable	(1)	(2)
Violation dummy	0.0627*	0.03
	[0.032]	[0.029]
Inspection dummy	0.006	0.008
	[0.0074]	[0.006]
Competitors inspected	-0.009	-0.002
	[0.0077]	[0.0077]
Pumps	-15.55	9.71
	[29.7]	[25.1]
Competitors	-0.036	0.121
	[0.20]	[0.21]
Storage capacity	-479.6	-38.01
	[367]	[308]
Schooling	-0.436	-0.444
	[0.27]	[0.28]
Population	-1278	1220
	[5919]	[5237]
Chain dummy	-0.059	-0.085
	[0.051]	[0.054]
Municipality FE	N	Y
Observations	1115	1115

Note: OLS estimates using the sample of violators. Every row represents a different estimation of the dependent variable on a dummy that takes a value of one if a gas station was reported in a newspaper. Clustered Std. Errors at the state level in brackets. ***p<0.01, **p<0.05 and *p<0.09.

Table 8. Marginal effects of newspaper publications on the probability of violation: sample of violators

Variable	(1)	(2)	(3)
Violation in last inspection		-0.029	-0.024
		[0.019]	[0.020]
Storage capacity		0.018*	0.020*
		[0.010]	[0.011]
Pumps		-0.009	-0.005
		[0.013]	[0.014]
Competitors		-0.009**	-0.006
		[0.004]	[0.004]
Website dummy	-0.166***	-0.139**	-0.132**
	[0.036]	[0.056]	[0.054]
Nonews	-0.140***	-0.115**	-0.132***
	[0.041]	[0.042]	[0.046]
News	-0.094***	-0.074**	-0.086**
	[0.033]	[0.036]	[0.034]
Chain dummy		-0.056**	-0.051**
		[0.023]	[0.023]
Schooling			-0.011**
			[0.005]
Population			-0.004
			[0.006]
Municipality FE	N	Y	Y
Time Trend	N	Y	Y
Number of obs.	40140	31519	28023
Uncensored obs.	5005	3890	3535
χ^2 test (News=No news)	0.7	0.86	1.08

Note: Marginal effects of newspaper publications on the probability of violation using the sample of violators evaluated at the mean. Standard Errors Clustered at the state level in brackets. ***p<0.01, **p<0.05 and *p<0.09. All regressions include time dummies. FE: fixed effects. Test of equality of coefficients News and No news given by χ^2 test.

Table 9. Effects of newspaper reports on total gasoline sales

Variable	Complete Sample		Sample of violators	
	(1)	(2)	(3)	(4)
Violation dummy		-4.462 [2.97]		-4.488* [2.58]
Competitors inspected		-9.729 [10.5]		5.9 [24.9]
News	-13.16** [5.18]	-12.30** [5.24]	-12.36* [6.44]	-12.10* [6.41]
News (t-1)		-1.064 [6.89]		-6.643 [6.15]
News (t-2)		4.322 [10.4]		-1.696 [8.79]
News (t-3)		6.719 [11.8]		3.354 [10.8]
Constant	539.3*** [0.033]	538.4*** [0.27]	547.4*** [0.16]	532.8*** [0.61]
Observations	96588	88539	40140	36795
R-squared	0.1	0.09	0.13	0.12

Note: OLS estimates of volume of sales sold by gas station. Standard Errors Clustered at the state level in brackets. ***p<0.01, **p<0.05 and *p<0.09. All estimations include municipality by time and gas station fixed effects.

Table 10. Marginal effects of the probability of violation excluding outliers

Variable	(1)	(2)	(3)
Storage capacity		0.061***	0.061***
		[0.013]	[0.012]
Pumps		0.031*	0.032*
		[0.017]	[0.017]
Competitors		0.002	0.002
		[0.005]	[0.005]
Website dummy	-0.022	-0.055**	-0.239***
	[0.022]	[0.024]	[0.090]
Newspaper dummy	-0.009	0.024	0.015
	[0.028]	[0.036]	[0.034]
Chain dummy		-0.016	-0.016
		[0.021]	[0.031]
Chain dummy*Website			0.0001
			[0.042]
Schooling		-0.015***	-0.025***
		[0.004]	[0.008]
Schooling*Website			0.0184*
			[0.009]
Population		-0.001	-0.001
		[0.006]	[0.006]
Municipality FE	N	Y	Y
Time Trend	N	N	N
Number of obs.	34879	31265	31265
Uncensored obs.	3514	3245	3245
Wald test	2.23	0.3	0.28
Pr(Violation=1)	0.205	0.342	0.34

Note: Marginal effects of the estimates of bivariate probit with sample selection of the probability of violation excluding outliers evaluated at the mean of each variable. The exclusion restriction is *Competitors Inspected*. Clustered Std. Errors at the state level in brackets. ***p<0.01, **p<0.05 and *p<0.09. Test of independence of equations given by Wald test, distributed as a χ^2 . Estimates of the unconditional probability of violating regulations before the website are presented in Pr(Violation=1)

Appendix B

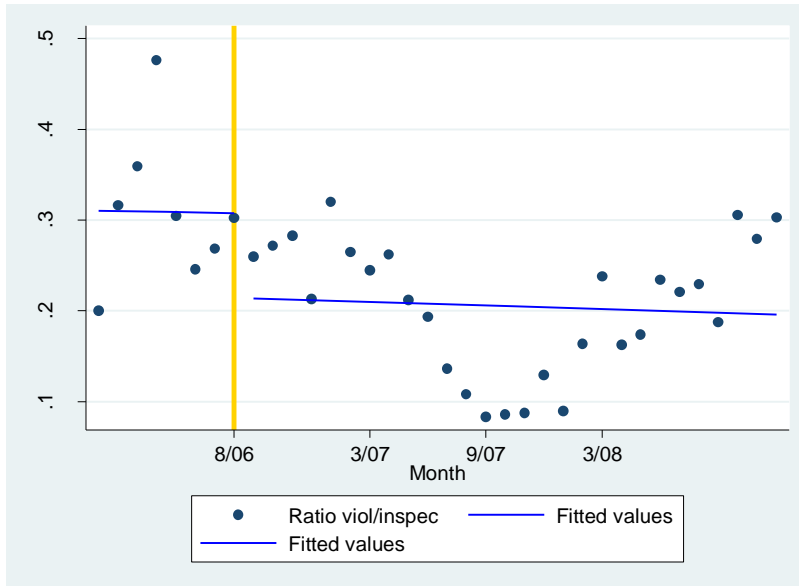


Figure 1: Ratio of violations to inspections before and after the website launch

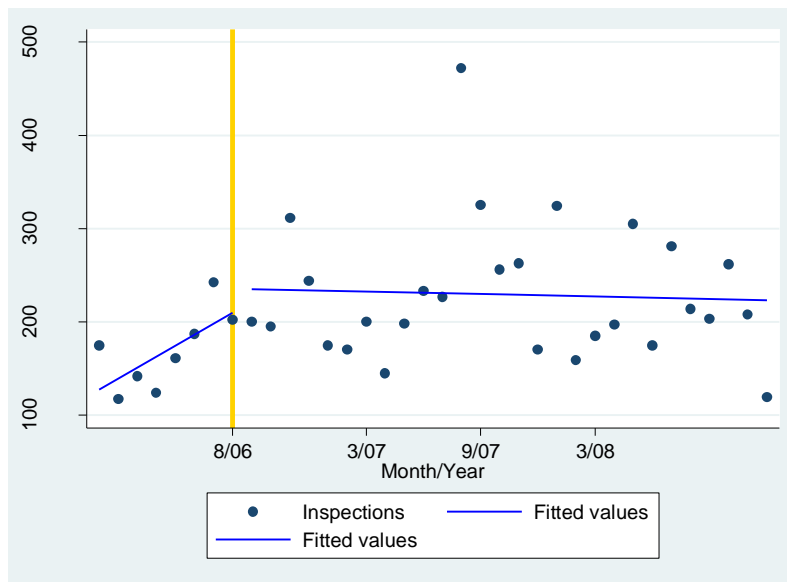


Figure 2: Inspections before and after the website launch

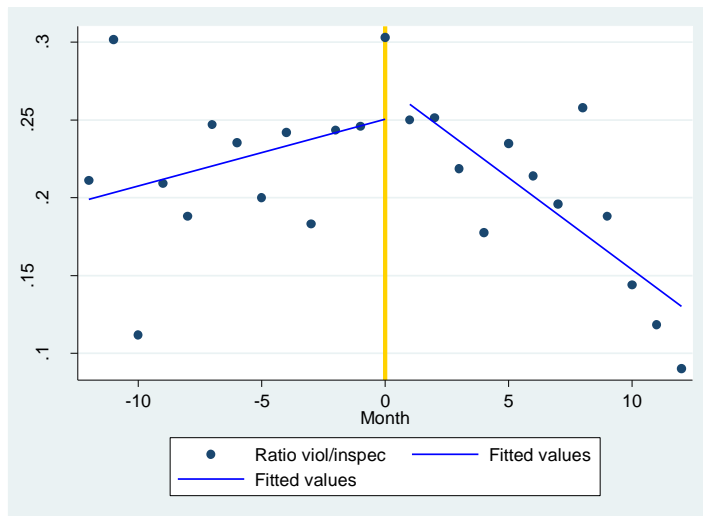


Figure 3: Ratio violations to inspections before and after the first newspaper report

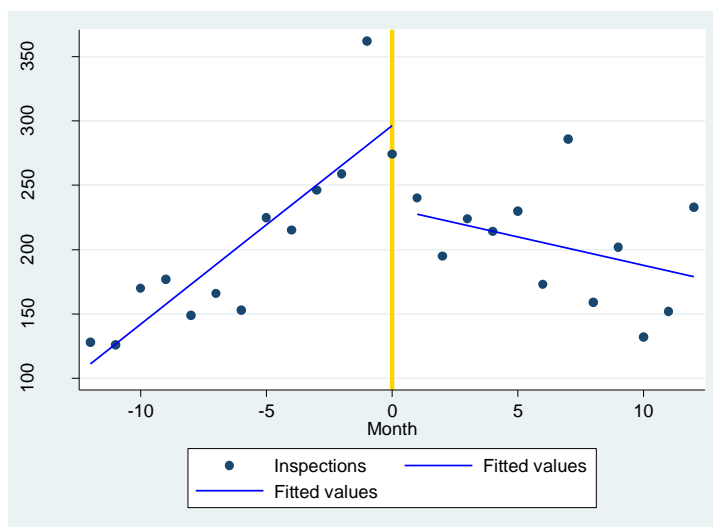


Figure 4: Inspections before and after the first newspaper report

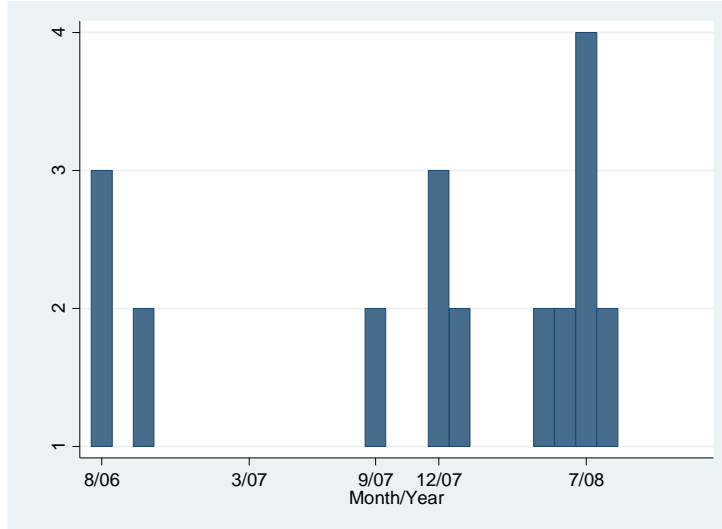


Figure 5: First newspaper report

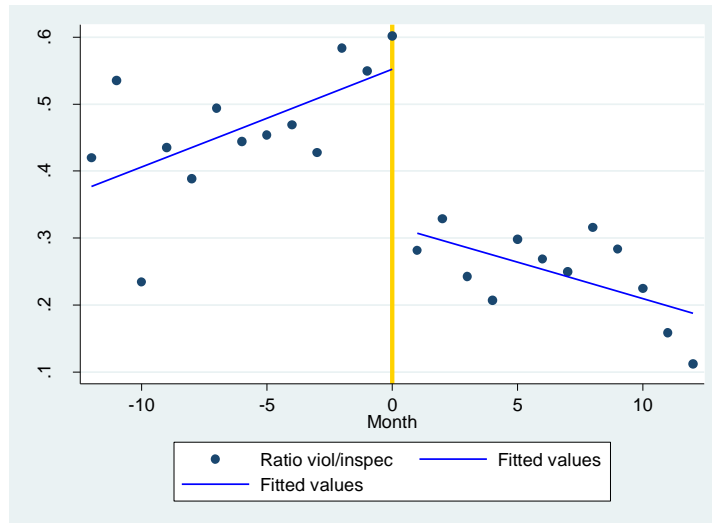


Figure 6: Ratio violations to inspections before and after the first newspaper report: sample of violators

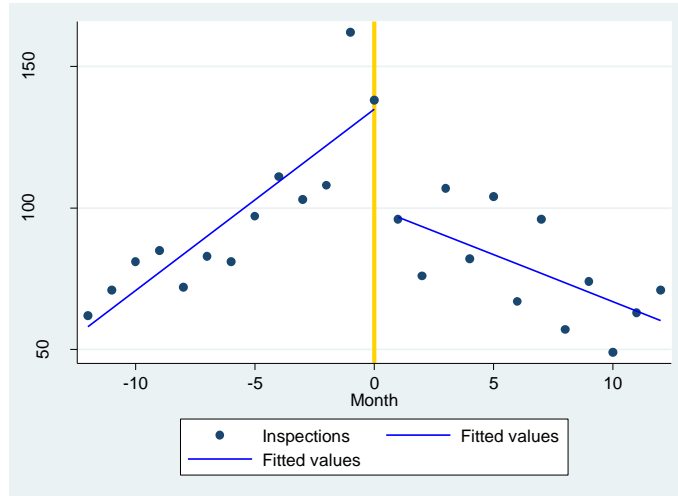


Figure 7: Inspections before and after the first newspaper report: sample of violators