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REGULATION, COMPETITION AND FRAUD: EVIDENCE FROM RETAIL GAS STATIONS IN MEXICO

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Abstract

Mexican gas stations across the country buy and sell gasoline at regulated common prices. Therefore, authorities that set these prices do not take into account competition conditions of each market. In this paper we establish the effect of a regulated mark-up price as well as competition on the incentives that gas stations in Mexico have to dispense less amount of gasoline than what consumers pay for. The results of theoretical and empirical work indicate that a higher regulated mark-up price reduces the incentives of gas stations to cheat. Similarly, more intense competition among the retailers of a given market decreases the average shortage.

Keywords: gasoline pricing; regulation; competition; fraud

JEL: K4, L11

I. INTRODUCTION

The gasoline industry in Mexico is highly regulated. There is only one brand and no price competition exists. All retail stations buy and sell gasoline distributed by the state-owned oil company Petróleos Mexicanos (PEMEX) at fixed common prices. These prices are determined by the ministry of finance, Secretaría de Hacienda y Crédito Público (SHCP). In addition, the official consumer agency, Procuraduría Federal del Consumidor (PROFECO), inspects pumps at gas stations to verify that they meet official norms. Among other things, they verify that station pumps dispense the correct amount of gasoline and that the product meets the announced quality standards.[1]

In spite of PROFECO's inspecting efforts, many consumers believe that they do not get all the gas they pay for. According to PROFECO (2005), more than 60% of consumers believe retail gas stations do not dispense the correct amount of gasoline and almost 40% say they have had some problem with retail service. The problem that these consumers report more frequently (61.9%) is getting less amount of gasoline than what they pay for. In Mexico, this practice by retailers is called selling "incomplete liters".

The perception of consumers is not wrong. The results of PROFECO's periodic inspections indicate that dispensing incomplete liters is a common practice. Furthermore, the results of the field study "Programa del Consumidor Simulado" (PCS) show that there is at least one gas station dispensing less gasoline than what consumers pay for in 54.4% of municipalities included in the sample. According to this study, the maximum shortage represents 15% of the amount requested by consumers.

[1] There are two types of gasoline in Mexico: Magna (87 octanes) and Premium (93 octanes).

In the absence of price regulation, even if there is only one brand, it would be expected to find price variation in different gasoline stations across the country or at different places in the cities depending on particular local market conditions. The fact that gasoline prices are set by SHCP does not imply lack of incentives for gas stations to charge higher prices in certain markets and that they actually do it. However, gasoline stations in Mexico are unable to set prices openly.

Although in principle all gas stations charge the official price, it is important to understand that stations that sell incomplete liters actually charge a higher price. Prices of divisible goods are set in terms of standard measures of volume like liters or gallons. For instance, if a retail station in Mexico sells unleaded gasoline at 7.96 pesos per liter, the official price in February of 2010, but dispenses 900 milliliters instead, then the actual price is slightly above 8.84 pesos per liter. Consequently, the station is charging 88 cents over the price.

Since gas stations can charge a higher price indirectly by dispensing incomplete liters, one would expect to find a relation between the variables that affect the equilibrium price in a flexible price environment and the size of the fraud or overprice. For example, under a flexible price scheme, stations facing less competition tend to set higher prices than other stations that have more competitors. This is the way in which firms respond to market conditions. However, given that prices are fixed, Mexican stations that face less competition would have more incentive to increase prices by dispensing incomplete liters than other stations facing more competition.

This paper extends the model developed by Salop (1979) to study the incentives that gasoline stations have to sell incomplete liters. In addition, it uses information of the PCS published by PROFECO to test the predictions of the model. Among other things, the model predicts that gas stations have less incentive to sell incomplete liters if competition is more intense and the regulated mark-up price is higher. Finally, the results of empirical work are consistent with these predictions.

Next section reviews works related with illegal activity, as well as studies about gasoline markets. Sections III and IV are devoted to develop and analyze the theoretical model, respectively. Section V presents empirical work to test the predictions of the model. Finally, section VI concludes.

II. BACKGROUND

The problem of gas stations that dispense less gasoline than what consumers pay for has not been addressed directly in the economic literature. However, there is abundant work on three areas that are related to this problem. The first area includes economic studies about crime. The second area is conformed by theoretical work about competition and prices. Finally, the third area includes empirical literature about price competition in gasoline markets of the US and Canada.

Although in economic terms selling incomplete liters can be considered equivalent to increasing the price, it is not right from a moral perspective and it may be illegal.[2] This practice allows firms to obtain higher profits under certain circumstances but can result in punishment by the authorities and social discredit. Firms are supposed to evaluate the advantages related to overprice taking into account the cost of punishment and the probability of being caught.[3] If the expected cost of punishment is not sufficiently high, firms have economic incentives to overprice. However, as explained by Levitt and Dubner (2006), in addition to economic incentives there are moral and social incentives. Some firm owners or managers do not sell

[2] Aguilar (2006) explains that the allowed tolerance in Norm 005, which establishes the way in which PROFECO verifies gas station pumps, is 100 milliliters per 20 liters.

[3] The seminal paper by Becker (1968) explores these issues in detail.

incomplete liters because they consider it wrong or they fear social discredit in case they are caught.

In mainstream economic theory there is an inverse relation between price and the number of firms in the market. The extension of Cournot's model in Tirole (1988) is useful to explore the whole range between monopoly and perfect competition. In this model, considering that all firms have the same cost structure, each additional entrant generates a lower equilibrium price.[4] Another line of argument that supports the negative relation between prices and competition is the possibility of collusion. Bain (1951) says that having a small number of firms in the industry facilitates collusion. In this sense, Geithman, Marvel and Weiss (1981) say that there can be a critical number of firms for collusion and that this number depends on particular conditions of each industry.

There are several papers that relate gasoline prices with the characteristics of the product and local market conditions. Among others, it is possible to highlight the empirical work of Marvel (1978), Barron et al. (2004), Barron et al. (2008) and Sen (2003). The results in these papers are consistent with mainstream economic theory. That is, they find an inverse relationship between prices and competition.

Marvel (1978) studies the relationship between average gasoline prices in 22 US metropolitan areas and the Herfindahl index to determine whether firms collude in these markets. Among other things, Marvel finds that average prices are higher in markets where the concentration index is higher. Similarly, Barron et al. (2004) study the aggregate price level and

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[4] Stiglitz (1987) develops a model that relates prices and competition taking into account consumer search costs. The results of his work are opposed to mainstream economic theory.

price dispersion in 4 geographic areas. They find that an increase in the density of sellers reduces not only the aggregate price level but also the price dispersion.

Barron et al. (2008) use field experiment data collected in 54 gasoline stations that modified prices exogenously. They identify the effect of competition (that is, the number of alternative retailers) over the price elasticity in each of the gas stations that participated in the experiment. The results of the experiment indicate that gasoline stations face a more elastic demand when they have more competitors. It is important to notice that, holding everything else constant, the mark-up of a firm is inversely related to the price elasticity of demand. It follows that more competition leads to lower prices.

Sen (2003) compares the effect of oil international price changes and concentration in the local market over the retail prices of gasoline in Canada. According to the results of this analysis, oil international prices explain retail prices more than concentration in the local market. However, the evidence shows a positive relationship between gasoline prices and market concentration.

III. The Model

The model developed by Salop (1979) can be extended to study the incentives that gasoline stations in Mexico have to cheat. In order to achieve this purpose, it is important to take into account the characteristics of the gasoline market in this country. First, PEMEX supplies gasoline to all the retailers in Mexico. Second, there are common fixed buy and sell prices for gasoline in almost every place in the country.[5] Hence, it is assumed that all stations buy gasoline at the same marginal cost $c > 0$ and, afterwards, sell it at the official common price $p > c$.

Although the official price of gasoline is not controlled by retailers, it is important to keep in mind that they can overprice by dispensing incomplete liters. Each retailer decides to do it or not depending on its incentives and scrupulosity. It is assumed that retailer i sets overprice e_i which consumers are unable to identify with certainty. Hence, $p + e_i$ is the actual price consumers pay at this station.[6]

Following Salop (1979), there exist n firms selling identical goods (gasoline) located symmetrically along a circle with perimeter z. The size of this circle represents the size of the market. Figure 1 shows the "circular city" and firm i located at 0. This firm competes directly with firms $i-1$ and $i+1$ located at distance z/n to the left and right hand side, respectively, from the firm i.

FIGURE 1.- Firm i, its nearest competitors and the size of the city

INSERT FIGURE 1

Consumers are distributed uniformly on the perimeter of the circle and have perfectly inelastic unit demands. That is, every point around the circle represents a consumer willing to pay

[5] The exceptions to this rule are towns in the border with the US where prices are fixed taking into account prices at the other side of the border.

[6] Although e_i is called an overprice, this variable may be either positive, negative or zero.

any amount of money to have one unit of the good. In addition, consumers pay transportation cost $t > 0$ times the distance to the retailer they choose to buy from.[7]

In general, consumers compare retail gasoline stations and decide where to buy under uncertainty. For example, in the US and Canada there is uncertainty about the price of gasoline in different stations and there are search cost associated with this fact. In contrast, gasoline stations in Mexico have a fixed well known price but there is uncertainty about the amount of gasoline that consumers actually get in each station and, consequently, about the effective price. It is important to say that price flexibility does not eliminate all the incentives that retailers may have to cheat. Consumers' complaints about cheating gas stations do occur in countries where retail gasoline prices are flexible.

Although consumers ignore the exact amount of gasoline that retailers dispense, in order to make a decision they must have some expectation about the probability of being cheated and the amount of this overprice in the relevant stations. Furthermore, it is reasonable to assume expectations not distant from reality. In other words, consumers must have some ability to discover cheating gas stations and act accordingly. Otherwise, cheating would have no limits.

Assume that retailers do not cheat all the time. In particular, suppose that with probability q_i consumers pay e_i at station i and that they do not pay it otherwise. For instance, if $q_i = 1/2$ the gas station i cheats consumers half of the times but dispenses the full amount of gas the other half.

The expected overprice at retail station i is $q_i \cdot e_i$. Despite the consumer ignores whether he or she will receive the correct amount of gasoline at a given station and occasion, it will be

[7] Transportation costs must include the cost of time, money and nuisance that consumers incur when they move from one place to another.

assumed that the expected overprice at each station is known by consumers. This assumption allows consumers to compare retailers and make a rational decision.

The consumer chooses the best retail station ex-ante, considering that some or all stations may overprice. In other words, the consumer may buy in certain station expecting overprice because it can cost more to buy in other stations that are far away although the expected overprice may be lower.[8]

IV. ANALYSIS

In the circular city, as explained by Tirole (1988), each firm competes directly with two adjacent firms. The total expected cost for a consumer located at x in the interval $\left(0, z/n\right)$ who decides to buy gasoline at the retail station i is

$$q_i \cdot e_i + p + x \cdot t \,. \tag{1}$$

Similarly, the expected cost of buying at station $i+1$ for the same consumer is

$$q_{i+1} \cdot e_{i+1} + p + \left(\frac{z}{n} - x\right) \cdot t \,. \tag{2}$$

It follows that the consumer who is indifferent between these two stations is located at

$$x_c = \frac{z}{2n} + \frac{q_{i+1} \cdot e_{i+1} - q_i \cdot e_i}{2t} \,. \tag{3}$$

Equation (3) says that the market shares of the two stations are equal as long as their expected overprices are the same. In this case, consumers buy at the closest retail service station.

[8] In a different context, Png and Reitman (1994) find that consumers in California are willing to pay up to 6% more in term of prices in order to avoid waiting time in congested retail stations that price lower.

However, each retailer may try to get a larger share of the market reducing the expected overprice.

Suppose that all the direct and indirect rival retailers of firm i choose to overprice e_o with probability q_o. The demand of firm i as a function of these variables and its own is

$$D_i(q_i, e_i, q_o, e_o) = \frac{z}{n} + \frac{q_o \cdot e_o - q_i \cdot e_i}{t}. \quad (4)$$

The stations choose how much and how frequently they overprice in order to maximize expected profits, taking as given the decisions of their rivals. That is, station i chooses e_i and q_i to maximize

$$E\pi_i = (q_i \cdot e_i + p - c) \cdot D_i(q_i, e_i, q_o, e_o) = (q_i \cdot e_i + p - c) \cdot \left(\frac{z}{n} + \frac{q_o \cdot e_o - q_i \cdot e_i}{t} \right). \quad (5)$$

The implicit assumption of equation (5) is that retail stations are risk neutral. That is, they maximize expected profits. The first order conditions are

$$\frac{\partial \pi_i}{\partial q_i} = (q_i \cdot e_i + p - c) \cdot \left(\frac{-e_i}{t} \right) + \left(\frac{z}{n} + \frac{q_o \cdot e_o - q_i \cdot e_i}{t} \right) \cdot e_i = 0 \quad (6)$$

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Although this optimization problem does not have unique solutions for e_i and q_i independently, there is a unique solution for the expected overprice $q_i \cdot e_i$. The symmetric equilibrium of this game is found setting firm's i expected overprice equal to its rivals overprices (*i.e.*, $q_i^* \cdot e_i^* = q_o \cdot e_o$). In other words, the expected overprice $q_o \cdot e_o$ is chosen to eliminate the incentives of any of the firms to modify it unilaterally. In this case, the equilibrium expected overprice $q_o \cdot e_o$ is

$$q_o \cdot e_o = \frac{t \cdot z}{n} - (p - c). \tag{8}$$

The equation above says that the equilibrium expected overprice depends on transportation costs, the number of firms, the size of the market, the official price and the marginal cost. Although the expected overprice is referred as a positive number, equation (8) allows it to be either positive or negative. For instance, if the first term in the right hand side is smaller than the official markup, then the overprice is negative. However, it is not difficult to see from equation (5) that expected profits are always positive.

Figure 2 shows the distribution of gasoline shortage in the PCS sample. According to the data collected in this sample, the probability that a retailer dispenses the correct amount of gasoline is about 63% while the probability that it dispenses short of the amount is about 37%.[9] Although it is common to find retailers dispensing short of the amount and out of the allowed tolerance, the shortage tends to be relatively small. Most of the times, the shortage is bellow 10%.

FIGURE 2.- Distribution of gasoline shortage in the PCS sample

INSERT FIGURE 2

Firms can increase (or decrease) the expected overprice either by dispensing incomplete liters more frequently or dispensing shorter (or larger) "liters" according to market conditions. Although it is relatively simple to determine the direction in which the equilibrium expected

[9] There is only one case out of 394 where the retailer dispenses more gasoline than what the simulated consumer pays for.

overprice changes in response to a change in one of the exogenous variables, it is important to highlight the effect of a change in the official mark-up (that is, the difference between the official price and marginal cost), as well as a change in the number of firms. Among other things, the model predicts that retail gas stations have less incentive to sell incomplete liters if the official mark-up is larger and if competition is more intense.

These results are easy to understand noting that the equilibrium market price in the absence of price regulation would be equal to the sum of expected overprice, $q_o \cdot e_o$, and the official price, p, as shown in the following equation.

$$q_o \cdot e_o + p = \frac{t \cdot z}{n} + c. \qquad (9)$$

Since the official price is not controlled by the firms, they have incentives to adjust their expected overprices according to the local market conditions that they face. If more competition leads to lower prices but firms are not able to modify the official price, they would have incentives to reduce the expected overprice or even to make it negative. Similarly, if the authority changes the official price and everything else remains unchanged, firms would have incentives to adjust the expected overprice in opposite direction to the change in the official price.

The data suggests that competition in most Mexican markets is not sufficiently intense to generate a negative overprice. As mentioned before, in only one out of 394 tests the retailer dispenses more gasoline than the amount paid. However, a reasonable explanation for this asymmetry is the following. The authority in Mexico actually regulates both retail and wholesale prices which implies that all gas stations have the same markup. This markup is low in comparison to those in the US where prices are not regulated. The regulated markup in Mexico was 5.92 and 6.5% during the period in which the PCS was conducted. According to the data of 43 US cities in Borenstein and Shepard (1996), the average retail margin was about 15% of the price during the 1986-1991 period. Similarly, the data of 48 states of the US in Deltas (2008) implies an average retail margin of 16% during the 1988-2002 period.

V. Empirical Analysis

The PCS data can be used to evaluate two of the main results of the theoretical model. It is important to explain that the PCS is conducted by PROFECO to test specifically whether retail stations dispense the amount of gasoline that consumers pay for. When PROFECO conducts the PCS, retailers are not aware that they are being tested. However, law prevents the authority to use the results of these tests to sanction retailers. That is, this information is produced for statistical purposes only. In addition to the PCS, PROFECO verifies retail gasoline stations periodically. These verifications may result in sanctions to retailers but inspectors have to identify themselves with the retail station personal before they start the procedure.

The PCS dataset includes 394 tests in 17 states of the country conducted between May of 2005 and July of 2006. There are 103 municipalities in the sample. Thus, on average each municipality is tested 3.8 times. There are some retail gas stations with more than one test. However, it is not possible to know whether the same gas pump is chosen when this occurs. Table 1 shows the distribution of tests and municipalities in the different regions of the country. Note that most of the tests are conducted in the central region of the country but the south region includes more municipalities. Finally, there is little information from the north of the country both in terms of tests and municipalities.[10]

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[10] The states that are included in the north region are Coahuila, Durango and Nuevo León; the states in the central region are Guanajuato, México, Michoacán, Morelos, Querétaro, San Luis Potosí, Sinaloa and Zacatecas; the states

TABLE 1. Distribution of tests and municipalities

INSERT TABLE 1

The PCS information is used to build two databases. In the first database, the unit of observation is the test. In the second database, the unit of observation is the municipality. It will become clear later that each of the databases is convenient to test empirically one of the main predictions of the theoretical model. However, the two databases can generate different results. For instance, if the unit of observation is the test, then 36.5% of the times retail gasoline stations dispense incomplete liters. However, if the unit of observation is the municipality, then in 54.4% of them there is at least one gasoline station dispensing incomplete liters. Similarly, the maximum shortage in a test is 15% but the maximum average shortage in a municipality is 8.3%. Finally, it is important to say that the shortage is not correlated with the number of tests conducted in the municipality.

a) The official mark-up price

One of the main results of the theoretical model is that retailers' incentives to cheat are inversely related with the official mark-up price (i.e., the difference between the official price and marginal cost). In order to test this proposition empirically there should be a change in the mark-up price at some point in time. Fortunately, in January of 2006 PEMEX, PROFECO and the

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in the south region are Guerrero, Hidalgo, Oaxaca, Puebla and Tlaxcala. The VMC includes information of Distrito Federal (DF) and 10 municipalities of the state of México that are part of the Metropolitan Area of Mexico City.

Mexican taxing agency, Servicio de Administración Tributaria (SAT), announce a joint effort to verify and evaluate gasoline retail services (see PEMEX, 2006). As a consequence of this announcement, PEMEX signs a new contract with retailers increasing the mark-up price from 5.92 to 6.5%. Although in principle this event allows testing the prediction of the model, it is important to take into account that the contract contains other clauses that may affect retailers' decisions but their effect cannot be separated from this change in the mark-up price.

The dataset that considers the test as unit of observation contains the identification number of the retail gasoline station, the difference between the amount of gasoline requested by the simulated consumer and the amount dispensed by the retailer, as well as the date in which the test is performed. Fortunately, tests are performed both before and after the signature of the new contract.

FIGURE 3.- Distribution of gasoline shortage in the PCS sample before and after the new contract.

INSERT FIGURE 3

Figure 3 shows the distribution of gasoline shortage in the PCS sample before and after the announcement of the new contract. Although it is possible that some of the retailers had not signed the new contract by the time in which they were tested, we observe a difference in the distribution of gasoline shortage of the tests performed before and after the announcement. Most of the difference is observed in the probability that retailers dispense the correct amount of gasoline. Before the announcement, the probability that a retailer dispenses the correct amount of gasoline is about 50%. After the announcement, this probability increases up to 73%.

Table 2 shows that the mean shortage in the tests performed before the signature of the new contract is 2.5%, while the mean shortage afterwards is 1.3%. A test of means indicates that mean shortages are statistically different before and after the signature of the new contract. It follows that Mexican retail gasoline stations, on average, dispense a smaller shortage after the new contract allowed them to have a larger mark-up price.[11]

TABLE 2. Average shortage before and after the new contract

INSERT TABLE 2

b) The intensity of competition

Another result of the theoretical model says that the retailers' incentives to cheat are inversely related with the intensity of competition. In order to test this prediction, we construct a variable that measures the intensity of competition in different markets. Since there is no information about revenues of retailers at the firm level, the measure of competition in this paper is the number of firms in relation to the size of the market at the municipality.

The PCS database is combined with other sources of information like Quien es Quien en las Gasolineras (QQG) published by PROFECO and the Censos Económicos 2004 (CE) published by Instituto Nacional de Estadística y Geografía (INEGI). The CE database includes total revenues of retail gasoline and diesel services at the municipality level. This is the main reason to build a database where the unit of observation is the municipality. However, the cost of

[11] According to Levene's test, the variances of the two periods are different. Hence, the estimated statistic for the test of means is 4.19.

doing this is losing some observations when PCS and CE data are merged. In particular, the CE does not provide data on revenues of retail gasoline and diesel services for 10 municipalities in the PCS sample.[12] As mentioned before, the unit of observation in the new database is the municipality and the variables are defined in Table 3. The variable GS will be considered the measure of competition in this paper.

TABLE 3. Definition of variables

INSERT TABLE 3

Table 4 shows that on average the gasoline shortage is 1.68% while the median is 0.481%. In other words, the average liter in the municipalities is actually 983.2 milliliters while the median liter is 995.19 milliliters. Moreover, according to Norm 005, the average shortage is above the allowed tolerance. Similarly, on average there are 0.062 retailers per million of pesos sold in the municipality. That is, the average revenues of retailer gas stations are over 16 million pesos per year.

TABLE 4. Descriptive statistics

INSERT TABLE 4

A regression analysis is conducted to test whether more intense competition reduces the incentive that retail gasoline stations have to cheat. In particular, equation (10) is estimated to

[12] The municipalities are Tlalpujahua in Michoacan, Pedro Escobedo in Queretaro, Cuautlancingo and San Matías Tlalancaleca in Puebla and Chapantongo, San Agustín Tlaxiaca, Santiago Tulantepec, Tepetitlán, Tetepango and Zempoala in Hidalgo.

find out whether the intensity of competition explains the gasoline shortage in municipalities. According to the theoretical model, coefficient β_2 should be negative.

$$Shortage_i = \beta_0 + \beta_1 * Size_i + \beta_2 * GS_i + \beta_3 * South_i + \beta_4 * VMC_i + \varepsilon_i. \quad (10)$$

The variables related to geographic location are included to control for differences in moral or social costs that may exist in different regions of the country. Note that the role of the authority may vary between regions. That is, the probability of receiving a sanction does not have to be homogeneous across the country.

Since a high percentage (45.6%) of municipalities in the PCS sample dispense on average the amount of gasoline that consumers pay for, the dependent variable is considered as censored. Therefore, Table 5 shows the estimated parameters using the Tobit model. Additionally, this table presents Ordinary Least Squares (OLS) results for the non censored sample.

TABLE 5. Estimation results

INSERT TABLE 5

It is not difficult to note that the signs of the parameters are the same in the two estimated versions. In addition, all the parameters are significantly different from zero at least in one of the models. However, only coefficients for GS and South are statistically different from zero in both empirical models. In other words, these estimates are not affected by the method of estimation. The results indicate that more retailers per million of liters sold in a municipality reduce the average shortage. That is, as the theoretical model predicts, more competition reduces the incentives to cheat. Note also that retailers in the south region of Mexico dispense about 2 percentage points less gasoline per liter than retailers in the rest of the country.

VI. CONCLUSIONS

The highly regulated gasoline market in Mexico provides a unique setting to study the relation between fraud and competition. In this country, there is only one gasoline brand and no price competition. All retail stations must buy and sell gasoline distributed by PEMEX at fixed common prices. However, retailers located in different places may have incentives to set different prices depending on the characteristics of their local markets.

This paper studies the incentives that retail gas stations in Mexico have to cheat both theoretically and empirically. On the one hand, this work extends the model developed by Salop (1979) to study the incentives of retailers to dispense less gasoline than what consumers pay for, taking into account the characteristics of this market in Mexico. On the other hand, the predictions of the model are tested with public information from the PCS conducted by PROFECO.

Although all the retail gasoline stations charge official prices, dispensing incomplete liters is a mean by which retailers overprice. It is interesting to note that, in spite of other relevant incentives, this overprice responds to observable market conditions as the theory would predict. For instance, it would be expected to observe that retailers facing less intense competition set higher prices than those facing more intense competition. However, since firms are not able to modify prices according to market conditions, they are tempted to do it by dispensing incomplete liters. Similarly, an increment in the official mark-up price reduces retailers' incentive to overprice by dispensing incomplete liters.

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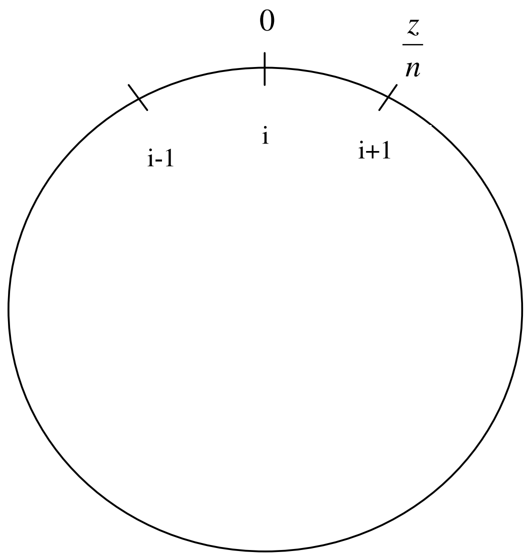

FIGURE 1

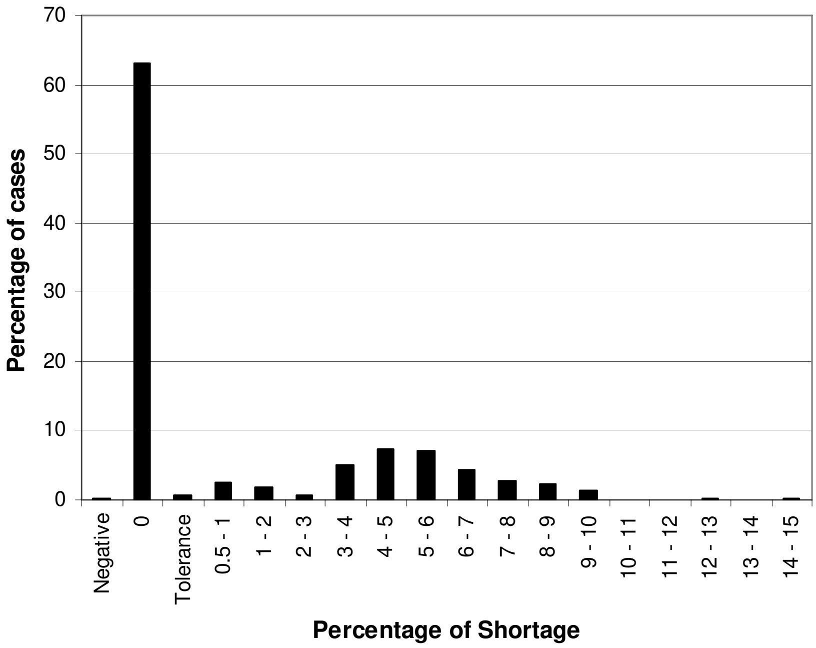

FIGURE 2.

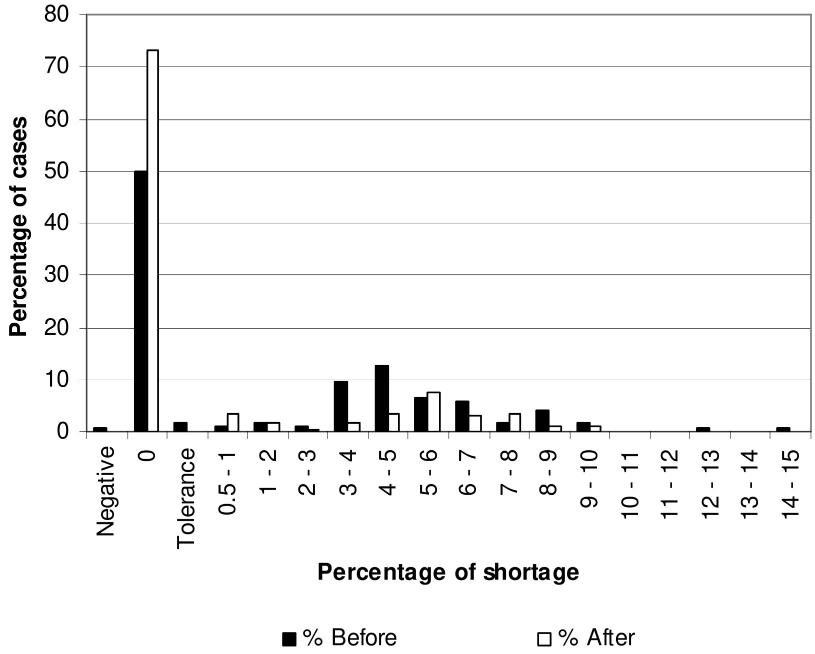
Percentage of cases
80
70
60
50
40
30
20
10
0
Negative
0
Tolerance
0.5 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 - 10
10 - 11
11 - 12
12 - 13
13 - 14
14 - 15
Percentage of shortage
% Before
% After

FIGURE 3.

TABLE 1.

Region	Tests	%	Municipalities	%
North	37	9.4	13	12.6
Central	181	45.9	29	28.2
South	88	22.3	40	38.8
VMC	88	22.3	21	20.4

Source: PCS (2007)

VMC is the Valley of Mexico City

TABLE 2.

	Tests	Average shortage	Standard deviation
Before	168	2.544	3.182
After	226	1.306	2.479

TABLE 3.

Variable	Definition	Source
$Shortage_i$	Mean percentage gasoline shortage according to the sample in municipality *i*.	PCS
$Size_i$	Mean number of gas pumps at gas stations included in the sample in municipality *i*.	PCS and QQG
GS_i	Retail gasoline stations per million of pesos of gasoline sold in municipality *i*.	QQG and CE
South	Dummy variable that indicates if the municipality is in the south region.	PCS and QQG
VMC	Dummy variable that indicates if the municipality is in the Valley of Mexico City.	PCS and QQG

TABLE 4.

Variable	Mean	Median	Standard deviation
Shortage	1.683	0.481	2.273
Size	22.278	20.000	9.819
GS	0.062	0.033	0.179
South	0.388	0.000	0.490
VMC	0.204	0.000	0.405

TABLE 5.

Variable	Tobit	OLS
Constant	1.548	3.183 **
	(1.290)	(1.109)
Size	– 0.080 *	– 0.029
	(0.044)	(0.039)
GS	– 18.198 **	– 18.896 **
	(8.599)	(7.124)
South	2.641 **	1.979 **
	(0.837)	(0.696)
VMC	2.875 **	1.102
	(0.893)	(0.710)
Number of observations	93	51
Adjusted R^2	0.207	0.222

* Significant at 10%

** Significant at 5 %