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"Testing for Imperfect Competition : the Argentine Gasoline Market."

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Testing for Imperfect Competition: the Argentine Gasoline Market*

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Abstract

After the deregulation of gasoline markets in Argentina in 1991, gasoline prices have not reacted to crude oil price changes as much as they have done in the United States. Not only have price responses been different, but also the level of prices in Argentina has remained higher than that in the US. In this paper, I study the extent to which a higher degree of market power in Argentina explains these differences in pricing behavior. To this end, I propose three approaches. First, I derive the long run response of gasoline prices to crude oil price changes and estimate the elasticity of gasoline price with respect to crude oil price for different market structures. The comparison of long run responses and elasticities rules out the price elasticity of demand as a candidate to explain differences between Argentina and the US. Second, I estimate an average industry conduct parameter. Using the American market as a benchmark, this model shows that oil firms in Argentina set prices as if the market were highly concentrated. The third approach, models demand and supply in a discrete choice

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framework treating gasoline as a differentiated product. Using firm-level data for five Argentine markets, I construct a likelihood ratio test to select among alternative supply relations. The supply relation obtained under Cournot competition provides the best fit to the data. Finally, the paper explores the role of the government as a "tacit regulator" and its impact on firms' pricing policies.

1 Introduction

After decades of imposing several types of regulations, the Argentine government deregulated the gasoline market in 1991. Once the restructuring and privatization of YPF (the largest firm in Argentina) was completed in 1993, the law established that the government should reduce its role exclusively to the enforcement of environmental laws that apply to this industry. Since 1997, following a sharp decline in crude oil prices, there have been complaints that gasoline prices in Argentina do not adjust to changes in crude oil prices as much as they do in the United States, and that the difference in the level of prices between these two countries increased significantly. From January 1997 until October 1998, the crude oil price fell 55.4 percent and the net price of premium gasoline fell 19.8 percent in the United States but only 7.4 percent in Argentina. Most of the arguments[1] used to explain the observed differences in levels and adjustment patterns of gasoline prices between these two countries assume that firms in Argentina are operating under an implicit agreement, but do not provide any conclusive evidence that supports that such an agreement exists.

In the first part of the paper I describe the evolution of the Argentine gasoline market and derive the long run response of gasoline prices to crude oil price changes in Argentina and the United States. To evaluate the hypothesis that the different responses of gasoline prices in these countries could be explained by demand elasticities or technology parameters I obtain

[1] Azpiazu (1995) is an example of these arguments.

elasticities of gasoline prices with respect to crude oil for alternative market structures and compare the actual difference in price responses with the differences that result from the estimation of elasticities of gasoline prices with respect to crude oil prices.

the role that the government played in this market before and after its deregulation. Even though the degree of government intervention in this market was significantly reduced, this section provides evidence that suggests that during the post-deregulation period, the presence of the government influenced firms' pricing decisions.

In the second part, I propose two models to study price competition in the Argentine gasoline market after its deregulation. The first model partly follows Porter's (1983) study of strategic interaction among nineteenth-century railroads. Under the assumption of a homogenous product market Porter estimates, using aggregate data, a parameter that measures the degree of competition. Porter and others (Rubinovitz (1993), Ellison (1994)) that estimate this parameter rely on structural changes within an industry that provide enough variation in observed conduct required for identification. The identification strategy that I use in this model is different than the one used in the papers previously mentioned. I do not rely on changes in regime between collusive and non-collusive phases in the Argentine gasoline market. Instead, the American gasoline market is used as a "benchmark". This comparison allows the identification of a *relative* average conduct parameter that measures the degree of competition. The term "relative" highlights the fact that the estimated conduct parameter for Argentina depends on the value the American conduct parameter takes. This parameter will be interpreted in terms of the Herfindahl index. The results of the estimation, conducted for the period January 1994-October 1998, show that the four largest firms in Argentina (that account for more than 90% of the gasoline sold) behave as if only two firms were competing Cournot. The estimated conduct parameter is 0.41[2] while the

[2]This value assumes the American conduct parameter is known to be zero.

average Herfindahl index during the same period was 0.28. Thus, this model suggests that the market acts as if it was far more concentrated than what the actual Herfindahl index shows.

A potential problem with the previous model lies in the assumption that gasoline is a homogenous product. As Bresnahan (1989) points out, assuming the product is homogenous rather than differentiated, could result in the attribution of market power to noncompetitive conduct when in fact the source of the market power is differentiated products. To fix ideas, imagine that consumers consider gasoline as a homogenous product and face a purchase decision between two gasoline stations of different brands located one next to the other[3]. It is clear that the one with the lower price will make all the sales. Provided it is common to observe clusters of gasoline stations of different brands closely located in cities and highways, a relevant empirical question is: are the prices of gasoline stations of different brands located one next to the other equal? A negative answer to this question suggests that this is a differentiated product market[4]. In order to assess wether this is the case, the methodology presented in Telser (1978) to study distribution of prices is applied to four markets in Argentina. The results show that there are persistent differences in prices among firms, implying that consumers do not consider gasoline from different brands as being perfect substitutes.

With this in mind, I propose an alternative model that uses a discrete choice framework[5] to study the degree of price competition in the Argentine gasoline market.. The demand is specified assuming that the brand summarizes all the relevant characteristics that differentiates gasoline. Three alternative forms of the supply relation (Bertrand, Cournot and

[3]This assumption about location eliminates the presence of search costs.

[4]In the introduction of the Product Differentiation Model I explain why gasoline could be considered a differentiated product in Argentina.

[5]For an explanation of the theory and estimation methods see Anderson (1992) and Berry (1994).

collusion) are derived. I then construct a test for model selection developed by Vuong (1989) and applied by Gasmi, Laffont and Vuong (1992), and find that Cournot is the behavioral model that provides the best fit to the data among the three forms of the supply relation.

Even though the Argentine government significantly reduced its intervention in the gasoline market during the post-deregulation period, its role is still important. The last section of the paper presents evidence that suggests that during the post-deregulation period the government behaved as a "tacit regulator" influencing firms' pricing decisions.

This paper is organized as follows. Section 2 presents a description of the Argentine gasoline market and the response of gasoline prices to crude oil price changes. Section 3 discusses the estimation of a relative average conduct parameter in Argentina under the assumption that gasoline is a homogenous product. Section 4 is divided in two subsections. The first studies the distribution of gasoline prices in four Argentine markets and the second models demand and alternative supply relations in a discrete choice framework. Section 5 describes the role the Argentine government has had in the gasoline market since its deregulation. Section 6 concludes.

2 The Argentine gasoline market

The evolution of the Argentine gasoline market was characterized by the belief that petroleum was a strategic resource. This belief justified a significant government intervention that was direct, through the control of the largest firm (YPF) in the Argentine gasoline market, and indirect via the regulatory framework. Before its privatization, YPF controlled 63 percent of the refining capacity, while Exxon and Shell, the other two large firms in the market, accounted for just 32 percent of the total refining capacity. The existence of excess capacity with respect to the disposable domestic oil led the government to set quotas to each refinery. Besides, the government determined domestic oil prices, wholesale and retail gasoline prices, retail margins and taxes.

The law guaranteed that regulated prices should cover production costs and give a reasonable return. But in reality, the government did not apply this law. Gasoline is an important determinant of the price index so whenever there was a new stabilization plan gasoline prices were used as an "anchor". The consequent reduction in margins forced refineries to be permanently involved in negotiations with the authorities. Figure 1 presents the evolution of regular gasoline and crude oil prices for the period 1984 - 1990. It can be seen that gasoline prices in Argentina did not follow changes in crude oil prices. Prices were modified when a new stabilization plan was implemented, following a reduction in real prices due to inflation. Figure 1 provides two examples of this price setting pattern. In 1985 and 1989 the real price of regular gasoline jumped more than 35 percent due to the implementation of a new economic plan while crude oil prices almost did not change or moved in the opposite direction. The huge swing in real prices during 1989 and 1990 is explained by a hyperinflation.

Not only the domestic commercialization was regulated. Imports of crude oil and gasoline were authorized only when there was a shortage in domestic production. There were almost no exports of crude oil or refined products during the period prior to deregulation due to inefficiencies in exploration, extraction and refining of crude oil.

The authorities decided where retail outlets should be located. A license was provided to the refinery and not to the owner of a retail outlet, implying that a retail outlet had to buy gasoline exclusively from the refinery that owned the license. To avoid hold up problems, discounts received by retailers were also regulated. The criterion by which new outlets were allowed to open was not clear but one of the rules closely followed was that outlets should not compete among them. The condition of local monopolies and regulated prices gave no incentives to provide adequate services to the consumer. Moreover, the inefficient government controls induced retail outlet operators to cheat by mixing regular and premium gasoline and selling it as premium gasoline. Before its privatization, YPF owned fifty five percent of all retail outlets, with a lower share in Buenos Aires, the most important market.

In January of 1991, the Argentine gasoline market was deregulated. Restrictions on prices, refining capacity, and location of retail outlets were eliminated. YPF, the largest firm in Argentina, was privatized in 1993, but a new management began a radical transformation process in 1991. Figure 2 gives a measure of the inefficiencies that YPF had when it was state-owned. Total personnel employed decreased from fifty two thousand in 1990 to six thousand in 1994. This reduction was matched by an increase in total sales from 3.5 to 4.4 billion dollars, which implies a very significant increase in labor productivity.

A study of the post-deregulation period has to rely on price and quantity data that starts in January of 1994 because between 1991 and 1993 the Argentine government did not conduct any comprehensive price survey of the gasoline market. Figure 3 presents premium gasoline prices net of taxes in Argentina and the United States and it also shows the crude oil price. It is clear from the graph that the level of prices in Argentina is higher than in the United States and that prices react less in Argentina to changes in crude oil prices. Although the reaction of regular and premium gasoline prices to changes in crude oil prices is very similar within a country, the difference in the level of regular gasoline prices between Argentina and the United States is smaller than the difference in premium prices. Figure 4 shows that during some months of 1995 and 1996 the level of regular gasoline prices was almost equal in both countries.

A simple way to compare the reaction of gasoline prices to changes in crude oil prices is by estimating an impulse response function that allow us to observe how much and how long it takes gasoline prices to adjust to a change in the crude oil price.

Impulse Response function

The adjustment of gasoline prices to changes in crude oil prices is not instantaneous. To capture the dynamic relation between these prices I regress gasoline prices on the current and lagged crude oil price and lagged gasoline prices,

$$\log Pg_t = \sum_{i=0}^{N} \alpha_i \log(wti_{t-i}) + \sum_{i=1}^{N} \beta_i \log(Pg_{t-i}) \tag{1}$$

where wti is the crude oil price and Pg is the price of gasoline. This reduced form equation allows us to measure the supply side shocks captured by the input prices. If the output price responds gradually to demand shocks as well as to cost shocks this would show up in an autorregresive process in the output price. We incorporate the autorregresive process in (1) including lagged gasoline prices. Borenstein, Cameron and Gilbert (1997) use a similar method to study the existence of an asymmetric response of gasoline prices to crude oil price changes in the American gasoline market.

In each regression I add lagged periods until the residuals are white noise (the null hypothesis of serial correlation and heteroskedasticity are rejected).

Figure 5 shows the cumulative response function of premium gasoline prices to crude oil price changes in Argentina and the United States. The total response, given in table V, is smaller in Argentina. After four months of a one percent increase in the crude oil price, premium gasoline price in the United States increases 42 percent while in Argentina it increases just 27 percent. Not only the total response is smaller in Argentina, the speed of adjustment is also much lower in this country. The difference in the speed of adjustment is given by the slopes of the cumulative adjustment function. Figure 5 shows that the most pronounced difference in the speed of adjustment between the American and Argentine premium gasoline markets occurs during the second month after the crude oil price change. There are almost no differences between premium and regular gasoline[6] cumulative adjustment to a crude oil price change.

[6]Regular gasoline cumulative adjustment is given in figure 6.

2.1 The response of gasoline prices and the elasticity of gasoline prices with respect to crude oil prices.

In the previous section we obtained the cumulative response of gasoline prices to crude oil price changes in Argentina and the United States. The observed difference in the long run response of prices between these two countries may be explained by differences in the price elasticity of demand. To evaluate this possibility, this section studies the response of gasoline prices to crude oil price changes by estimating an elasticity of gasoline price with respect to crude oil price changes. Since this elasticity depends not only on demand and supply factors (i.e. technology parameters) but also on the market structure, we derive it for Bertrand, Cournot and monopoly.

Demand

The total quantity demanded is assumed to be a quadratic function of price,

$$\log Q_t = \beta_0 + \beta_1 \log P_t + \beta_2 (\log P_t)^2 + \beta_3 \log G_t + u_{1t}$$

where G_t is income in period t. We chose this specification of the demand function over a loglinear specification because the former has a better fit to the data.

Supply

The cost of producing output q_{it} for firm i in period t is given by,

$$C_{it} = (wti_t^{\gamma} w_t^{\delta} r_t^{\lambda}) q_{it}^{\xi} \quad \text{for } i = 1, \ldots.., N$$

where wti is the price of crude oil, w gives a measure of labor costs, r is the cost of capital and q_{it} is the quantity produced by firm i in period t. The coefficient ξ represents the elasticity of variable costs with respect to output (returns to scale).

Given these functional forms for the demand and supply, we can derive the elasticity of gasoline price with respect to crude oil price[7]. This elasticity will vary according to the

[7]See the appendix for a detailed derivation of these elasticities.

market structure,

$$
\begin{aligned}
E^{comp} &= \frac{\gamma}{1-(\xi-1)\eta} \\
E^{cournot} &= \frac{\gamma}{1-\frac{2\beta_2}{(1+N\eta)\eta}-(\xi-1)\eta} \\
E^{monop} &= \frac{\gamma}{1-\frac{2\beta_2}{(1+\eta)\eta}-(\xi-1)\eta}
\end{aligned} \tag{2}
$$

where N is the number of firms in the market and η is the price elasticity of demand.

Using monthly observations for the period January 1994 - October 1998, we estimate the price elasticity of demand. Table VI presents the results. Because the demand function is quadratic in prices, the value of the price elasticity of demand depends on the level of prices. In table VI the price elasticity of demand is evaluated at the mean and one standard deviation of the price series. Demand of gasoline is more price elastic in Argentina and this result holds for premium and regular gasoline.

The estimated price elasticities of demand (η) are inserted in (2) to calculate the elasticities of gasoline prices with respect to crude oil. We need to parameterize the share of crude oil in gasoline production costs (γ) and the variable that measures returns to scale (ξ). The Energy Information Agency[8] provides a range of values for γ that is between 0.45 and 0.6. Tables VII and VIII show the estimated elasticities of gasoline price with respect to crude oil for different returns to scale[9] assuming that crude oil explains fifty percent of gasoline production costs. The fourth column of these tables presents the difference of long run responses and elasticities between the American and Argentine gasoline markets.

From the observation of tables VII and VIII, it is evident that the difference in long

[8] Petroleum Marketing Monthly, several issues.

[9] $\xi = 1$ constant returns to scale

$\xi > 1$ decreasing returns to scale

$\xi < 1$ increasing returns to scale

run responses of gasoline prices can not be explained by differences in price elasticities of demand. This result also holds when we compare the American and Argentine markets assuming alternative returns to scale and market structures.

3 Homogenous Product

In the previous section we concluded that differences in price elasticities of demand can not explain the different response of gasoline prices to crude oil price changes in Argentina and the United States. This conclusion lead us to study the existence of market power.

The objective of this section is to estimate an average conduct parameter that measures market power in the Argentine gasoline market. To identify this parameter we do not rely on response dynamics; instead we use differences in the level of prices.

3.1 Demand

Denote the market price in period t by p_t. The total quantity demanded is assumed to be a loglinear function of price[10],

$$\log Q_t = \alpha_0 + \alpha_1 \log P_t + \alpha_2 \log G_t + u_{1t} \tag{3}$$

where G_t is disposable income and $\{u_{1t} : t = 1, ..., T\}$ is a sequence of independently

[10] This specification of the demand for gasoline assumes there is only one type of gasoline. It could be argued that a consumer can choose between premium and regular gasoline and so both prices should be included in the demand. But this choice is not always possible. Some car manufacturers strongly recommend the use of a specific type of gasoline to avoid eventual engine damages. Besides, because regular and premium gasoline prices move together (for the period 1994-1998 the correlation was 0.984 in the United States and 0.993 in Argentina), including both prices would not give a precise estimate of the own price elasticity of demand.

distributed normal variables with zero mean and variance σ_1^2. Here α_1 is the price elasticity of demand, and presumably negative.

3.2 Supply relation

It is assumed that there are N active firms in the industry. The cost of producing output q_{it} for firm i in period t is given by

$$C_{it} = (wti_t^{\gamma} w_t^{\delta} r_t^{\lambda}) q_{it} \quad \text{for } i = 1, ..., N \tag{4}$$

where wti is the price of crude oil, w gives a measure of labor costs, r is the cost of capital and q_{it} is the quantity produced by firm i in period t.

By hypothesis all firms face the same wages, cost of capital and price of crude oil. The elasticity of variable costs with respect to output is set to be one (constant returns to scale). Wages and interest rates are included in the cost function to measure the impact of labor and capital on variable costs, while crude oil price (wti) is included because it is the most important input in the production of gasoline.

This cost function[11] is derived from a Cobb-Douglas production function. The coefficients on the input prices and quantity are related to the technological parameters for labor, capital and crude oil[12].

The actions firms take will depend on the behavioral assumption we make. Let us consider

[11] The cost function given by equation (4) assumes that firms produce one type of gasoline. This is an important simplification of the production process since many types of gasoline are produced simultaneously when crude oil is refined. Although firms can change the mix of output (to a certain degree) that can be extracted from refining crude oil, I will follow the literature that studies gasoline markets (Borenstein (1997), Energy Information Administration (1999)) and assume that firms produce only one type of gasoline.

[12] In this case, since we are assuming constant returns to scale, $A_L + A_K + A_O = 1$ where A_L, A_K, A_O are the parameters for labor, capital and crude oil in the production funtion $Y = L^{AL} K^{AK} O^{AO}$.

three alternatives: Monopoly, Cournot and Bertrand. The difference in behavior will be given by the type of marginal revenue "perceived" by the firms. Thus, the actions of firms under different behavioral assumptions can be summarized by

$$P_t[1 + \theta_{it}/\alpha_1] = MC_{it}(q_{it}) \quad \text{for } i = 1, ..., N \tag{5}$$

For estimation, I employ aggregate data. The individual supply equations given by (5) are weighted by market shares in time t, s_{it}, and added up:

$$\sum_{i=1}^{N} s_{it} P_t[1 + \theta_{it}/\alpha_1] = \sum_{i=1}^{N} s_{it} MC_{it}(q_{it})$$

$$P_t \underbrace{\sum_{i=1}^{N} s_{it}}_{=1} + P_t/\alpha_1 \underbrace{\sum_{i=1}^{N} s_{it}\theta_{it}}_{\equiv \theta_t} = \sum_{i=1}^{N} s_{it} MC_{it}(q_{it})$$

Market shares are equal across firms and constant over time ($s_{it} = 1/N \equiv s_i$) because we assumed that all firms face the same marginal costs.

Then, the supply relationship can be written as

$$P_t(1 + \theta_t/\alpha_1) = (wti_t^{\gamma} w_t^{\delta} r_t^{\lambda}) \tag{6}$$

where α_1 is the constant price elasticity of demand.

Here θ_t equals zero , H, or 1 for Bertrand, Cournot, or perfectly collusive firms, respectively. H is the Herfindahl index, $H = \sum_i s_i^2$ and is invariant across time as long as the number of firms remains unchanged. During the period that I analyze, there was no major entry or exit in the Argentine[13] and American gasoline markets.

[13] In 1995, EG3, which had a market share close to 10% during the period studied, was created as a merger of three small firms.

Equation (6) is estimated using aggregate industry data. When there is market power, different firms will almost certainly have different marginal costs in equilibrium, unless they have identical, constant marginal costs. There could be cases in which industry-wide marginal costs are equal to each firm's marginal cost; an example being a cartel that succeeds in rationalizing production. But in general, (6) will need to be interpreted as some sort of average. As explained in Bresnahan (1989), because there is nothing in the logic of oligopoly theory to force all firms to have the same conduct parameter, it is better to interpret θ_t as a measure of the *industry average conduct.*

Papers that study the existence of implicit coordination in prices (Bresnahan (1987), Slade (1992), Rubinovitz (1993)) and others that study how conduct changes in an industry characterized by an explicit cartel (Porter (1983), Ellison, (1994)), identify the conduct parameter (θ) using the variation between periods of successful cooperation and outright competition within a market. I use an alternative identification strategy. In common with the papers previously mentioned, I identify the conduct parameter using differences in price levels, but the source of variation in prices is obtained comparing two markets, the Argentine and American gasoline markets. This estimation procedure allows the identification of a *relative* conduct parameter between markets.

Most of the papers previously mentioned, assume reversion to Bertrand when there is no cooperation (θ takes a value of zero). I provide a range of values for the conduct parameter in Argentina assuming that the American conduct parameter takes a value in a small range close to zero. This assumption implies that the American gasoline market is competitive, a conclusion of recent studies of pricing behavior in this market (Borenstein, (1997), Shephard and Borenstein, (1996)). The lack of government regulations that influence firms' pricing decisions in the American market and the fact that it is competitive justifies its choice as a "benchmark" market. If the estimation, assuming that the value of θ for the American market is zero, gives a value of θ equal to one in Argentina, this would imply that firms operating in the Argentine gasoline market behave as if they were a monopoly[14]. On the other hand, if the estimated θ is zero, we can conclude that both markets are competitive[15].

Taking logs in equation (6), the supply relation of the industry is given by:

$$\log P_t = \mu + \gamma \log wti_t + \delta \log w_t + \lambda \log r_t + u_{2t} \qquad (7)$$

where $\mu = -\log[1 + \theta/\alpha_1]$

$\{u_{21}, ..., u_{2T}\}$ is assumed to be a sequence of independent normal variables, with mean zero, variance σ_2^2 and $COV(u_{1t}, u_{2t}) = \sigma_{12}$.

3.3 Empirical model

The analysis of Argentine gasoline prices does not provide any evidence of drastic changes in prices caused by factors other than changes in the crude oil price[16]. As an example, figure 9 plots net premium gasoline prices set by the four biggest firms in Cordoba[17]. Although there are some changes in relative prices, the pairwise correlation of prices in any market is not lower than 0.504. The fact that relative prices among firms are relatively stable and that

[14]The as-if interpretation of the conduct parameter is based on the observation that, for given demand and cost conditions, one can compute the conjecture that would yield the observed price-cost margins if firms were playing a conjectural variation equilibrium, even if observed behavior is in fact generated by some other oligopoly game. Bresnahan (1989) relates this argument with a variety of oligopoly theories.

[15]In a recent paper, Corts (1999) criticized the relevance of the inferences that are drawn using the methodology adopted here to estimate θ. In particular, he argues that the conduct parameter method is valid only if the true process underlying the observed equilibrium generates behavior that is identical on the margin, and not just on average, to a conjectural variations game.

[16]I consider the West Texas Intermediate price as the "world price" of crude oil.

[17]The pattern of prices is very similar in all States. This market was chosen as an example. It does not have any particular feature that distinguishes it from all the other markets in Argentina.

there are no significant changes in prices within and across markets, suggests that, during the sample period 1994-1998, firms' pricing behavior did not change (regular gasoline has a very similar pricing behavior). In the estimation the American gasoline market is used as a "benchmark" market, allowing the identification of a relative average conduct parameter from changes in the difference of price levels.

The empirical model to be estimated is derived from the demand (3) and supply (7) equations, where the superscripts denote United States (U) and Argentina (A).

$$\log Q_t^A = \alpha_0^A + \alpha_1^A \log p_t^A + \alpha_2^A \log G_t^A + u_{1t}^A$$

$$\log Q_t^U = \alpha_0^U + \alpha_1^U \log p_t^U + \alpha_2^U \log G_t^U + u_{1t}^U$$

$$\log P_t^A = \mu + \gamma^A \log wti_t + \delta^A \log w_t^A + \lambda^A \log r_t^A + \beta I + u_{2t}^A$$

$$\log P_t^U = \mu + \gamma^U \log wti_t + \delta^U \log w_t^U + \lambda^U \log r_t^U + u_{2t}^U$$

The specification of the supply relation that corresponds to Argentina includes an indicator variable (I). We can write the expression for the coefficient on the indicator variable (β) as:

$$\beta = -\log[1 + \frac{\theta_A}{\alpha_A}] - \left(-\log[1 + \frac{\theta_U}{\alpha_U}]\right) \tag{8}$$

The constant in both supply relations are constrained to be equal so the joint estimation of these equations allows us to interpret β as the difference in prices between the two markets not explained by differences in marginal cost.

Equation (8) should be simplified to obtain an expression that relates the conduct parameters in Argentina and United States. Unfortunately, it is not possible to relate θ_A and

θ_U in a direct way (i.e. a ratio or difference of these variables can not be obtained as a function of the other variables included in equation (8)). In order to reduce this problem, θ_A is solved as a function of θ_U.

$$\theta_A = \frac{\alpha_U + \theta_U}{\exp(\beta)\frac{\alpha_U}{\alpha_A}} - \alpha_A \tag{9}$$

To assess the significance of the conduct parameter, the delta method[18] is used. Assuming that firms in the American gasoline market behave as the Bertrand model predicts ($\theta_U = 0$), the average conduct parameter in Argentina depends on the value that α_A and β take.

The implicit assumption behind the expression for β is that the omitted variables in the marginal cost specification have the same effect on prices in each country. These variables, that in general are the non tradable component of gasoline production costs, could be the marginal cost of storage, transportation costs or any other variable cost associated with production (for example additives). It is expected that, if there are differences in marginal costs not captured in the estimation, these differences are small enough not to significantly bias the results.

3.4 Data

The Argentine gasoline market was deregulated in 1991. Before 1991, the government set the prices of all the products transacted in this market. During the period 1991-1994 there was no official survey of prices and quantities. In January 1994, the Department of Energy began to collect monthly data of prices and quantities by state. This survey includes the prices set and the quantity sold by firm that operates in each state. The available data covers the period January 1994-October 1998, a total of 58 observations.

Data for two types of gasoline is used: premium and regular. The most important

[18] In the Appendix, the application of the delta method to this set up is shown.

difference between premium and regular gasoline is the octane rating. In both countries, regular gasoline's octane rating varies between 85 and 88 while premium gasoline's rating varies between 92 and 95.

Gasoline prices in Argentina are heavily taxed and the tax rate is not neutral between regular and premium gasoline; taxes on premium gasoline are higher. During the period under analysis, there were two tax changes: in April 1995, the value added tax increased from 18% to 21% and in October of 1996, the constant tax per unit increased from 38.75 to 48.75 cents per liter for premium gasoline and from 28.78 to 38.78 cents per liter for regular gasoline. Taxes explain, in the case of premium gasoline, almost 60% of the total price.

The American price and quantity data were provided by the Energy Information Administration. Even though monthly data are available since 1984, I only use data that cover the same period for which the Argentine data are available. Prices and quantities are measured in cents per gallon and gallons respectively. In order to use the same units for both data sets all units were converted to liters[19].

The crude oil price used in the estimation is the West Texas Intermediate. Although there is not a unique "world" price of crude oil, due to differences in quality, the WTI price is used in the literature that studies oil prices (Adelman (1993)).

Demand equations and supply relations in Argentina and the United States are simultaneously estimated using full information maximum likelihood. Using the same specification, two sets of regressions are estimated, one for regular and the other for premium gasoline. The price included in the demand in each country is gross of taxes while the one included in the supply relationship is net of taxes. In the demand equations, monthly dummies are included to capture seasonality effects.

Although the rate of inflation was low in both countries during the period 1994-1998,

[19] 1 gallon = 3.785 liters

all variables that were in nominal terms were deflated and converted to constant dollars of October 1998. The possible distortions that changes in exchange rates may cause are not present since Argentina has pegged its exchange rate with the US dollar[20]. As I explain in the previous subsection, a potential problem that may arise when using price data from two different economies is the impact that changes in non-tradable input prices may have on the final price. These changes, that influence the difference in price levels can not be separately identified in this specification.

3.5 Results

From the joint estimation of demand and supply relations in each country the value of the relative average conduct parameter can be recovered. Using premium and regular gasoline data sets, two different conduct parameters can be obtained, allowing a study of the behavior in each market.

3.5.1 Premium Gasoline

Table IX presents the results for premium gasoline. The estimates of price elasticities of demand are very similar in both countries, close to -1. Income elasticities are both positive, an expected result since premium gasoline is a higher-quality product compared to regular gasoline.

Most of the monthly dummies in the demand equation are significant at the 5% level[21], a result that was expected due to the seasonality in gasoline consumption (in Argentina it is higher during the summer, especially in December and January, while in the United States it is also higher during the summer but, due to opposite seasons, in July and August).

[20]The Convertibility Law, established in 1991 set the exchange rate: 1 Argentinian Peso = 1 US dollar.

[21]The estimated values for these variables are not included in table IX.

An often cited criticism to Porter's study is that the price elasticity of demand could be significantly biased due to the lack of good instruments. This is not the case in this paper because the available instruments -price of crude oil and monthly dummies- were highly correlated with the price of gasoline in Argentina and the United States.

Wages and interest rates do not seem to have significant explanatory power in any of the two countries. A possible explanation for the lack of explanatory power of wages could be found in the relatively low participation of labor costs on total variable costs. The interpretation of the insignificance of the interest rate is more puzzling. One reason could be that I am not measuring the relevant opportunity cost of capital. Different interest rates were included in the regressions but in all cases the estimated coefficients were not significant.

Taking into account differences in marginal costs, net prices in Argentina are higher than in the United States. This difference is captured in the coefficient of the dummy variable included in the Argentine supply relation. With this information, the relative average conduct parameter can be obtained, using the formula given by equation (9). Replacing the estimated values for $\beta, \alpha_A, \alpha_U$ in (9) and assuming the American conduct parameter is known to be zero θ_A takes a value of 0.419. Applying the delta method, the standard error of the estimated conduct parameter equals 0.152 so we can reject the null hypothesis that $\theta_A = 0$[22]. It was shown in the empirical model section that θ can be interpreted as if firms were playing Cournot. Moreover, the value of θ is directly related to the Herfindahl index, so the conduct parameter, that in this case has a value of 0.419, can be interpreted as if firms in Argentina were playing Cournot with either two or three firms in the market. The Herfindahl index with two firms in the market having a market share of 50 percent each, equals 0.50 while if three firms are in the market, this index equals 0.33.

The average of the *actual* Herfindahl index in Argentina for the period 1994-1998 was

[22]The explanation of how the standard error is computed can be found in the Appendix.

0.28. For the same period, the *actual* Herfindahl index in the United States was 0.063. If we assume that θ_U equals 0.063, the estimated value for θ_A would be 0.456.

The estimated values for θ_A suggest that the market acts as if it is much more concentrated than what the actual Herfindahl index shows. Moreover, assuming θ_U is between 0.05 and 0.1, firms in Argentina behave as if there were only two firms in the market.

Although this result does not lend support to the hypothesis that firms in Argentina operate under an implicit agreement (a cartel), price competition is significantly less intense than in the United States.

3.5.2 Regular gasoline

The estimated coefficients obtained using regular gasoline data are shown in the second column of Table X. The estimates of the price elasticity of demand are smaller (in absolute value) than those obtained for premium gasoline. A surprising result is the negative income elasticity of demand for this type of gasoline in Argentina. Coloma (1998), with a similar demand specification, also obtained a negative estimate of the income elasticity. A possible explanation could be that consumers perceive an important difference in quality between regular and premium gasoline so they switch to the higher quality product as income increases.

The impact on net prices that the WTI has is very similar across gasoline types in each country. The coefficient on the dummy variable is not significantly different than zero. This result does not allow a precise estimation of the relative conduct parameter but it suggests that the difference between average conduct parameters in Argentina and the United States is much smaller for regular gasoline than for premium gasoline.

A note on seasonality, margins and elasticities

An issue that I do not consider in the econometric specification of this section is the possible effect of seasonal prices on the results. Table XVII presents margins (price of gasoline - crude oil price) of premium and regular gasoline during winter and summer. In the United States, gasoline margins are much higher in summer (during the five year period 1994-1998, premium gasoline prices were 8% higher and regular gasoline prices were 13% higher in summer than in winter) while in Argentina margins remain almost constant through the different seasons. It may be the case that marginal costs increase during the summer but it could also be possible that consumers are less price sensitive during the summer. A lower price elasticity of demand would allow firms to modify their conduct (Borenstein and Shepard (1994) explain this possibility). An extension to the model of this section should consider seasonal variations in demand elasticities as they can impact the estimated industry average conduct parameter

4 Product differentiation

4.1 Gasoline as a branded product

The decision to buy a car is based on price and a set of physical attributes. Information about these attributes is easily obtained. But when it comes to buying gasoline it is not clear that the consumer knows the attributes of the product besides the type of gasoline she needs to buy (regular, premium). Then, a relevant question would be: is a consumer indifferent between two gasoline stations of different brands located one next to the other that charge the same price? To answer this question, following the methodology used by Telser (1978), I study the distribution of prices in four Argentine markets. The purpose of this analysis is to separate the observed dispersion of prices into that component due to persistent differences among brands and that part due to temporary differences[23].

A standard proposition of neoclassical economic theory asserts that in a competitive market only one price can prevail for a homogenous good. In reality, we often observe many different prices for what seems to be the same good. A price distribution can persist because traders are ignorant of prices and it is costly to reduce ignorance, or a price distribution can persist because the goods differ.

If sellers offer the same product and buyers' search is rational, there can be no persistent price differences among the sellers. Let p_{it} denote the price at firm i at time t. The following equation

$$p_{it} - \bar{p}_{.t} = \bar{p}_{i.} - \bar{p}_{..} + u_{it}$$

decomposes the price difference between seller i at time t and the average price of all the sellers at time t into a permanent difference, $\bar{p}_{i.} - \bar{p}_{..}$, and a temporary residual, u_{it}. (The notation $\bar{x}_{.t}$ denotes the average across the dotted subscript. Note that $\bar{p}_{i.} - \bar{p}_{..}$ is constant over time).

For a homogenous product sold by competing firms in the same market, the permanent differences ($\bar{p}_{i.} - \bar{p}_{..}$) would be zero. All of the price dispersion would result from the transient factors represented by u_{it}. Therefore, using firm-level data over time for a sample of closely spaced firms enables the measurement of the parameters of this model of prices. Although state-level price data is used in this study, we can still assume that the condition of closely spaced firms implied by the question we want to answer is not violated since there is almost no variability in prices among dealers of the same brand and in all these markets there are several areas with gasoline stations of the four main brands closely located.

Tables XI and XII give estimates for ($\bar{p}_{i.} - \bar{p}_{..}$) and the standard deviation of u_{it}. These

[23] As Telser argues, the temporary differences can be explained by the optimal lack of perfect information that accompanies a positive marginal cost of search.

estimates were obtained using monthly prices during the period January 1994-October 1998 for four markets: Buenos Aires, Capital City, Cordoba and Santa Fe[24]. The statistic H^2 is a simple measure of the relative importance of heterogeneity as an explanation of price differentials among the brands. The definition of H^2 is as follows:

$$H_i^2 = \frac{\left(\bar{p}_{i.} - \bar{p}_{..}\right)^2}{E\left(p_{it} - \bar{p}_{.t}\right)^2}$$

where $E\left(p_{it} - \bar{p}_{.t}\right)^2 = \left(\bar{p}_{i.} - \bar{p}_{..}\right)^2 + Eu_{it}^2$.

H^2 is analogous to the coefficient of determination in a regression equation. It measures the proportion of the variance of the price differential that we can attribute to the persistent difference between the given brand's price and the average price of all brands.

Table XI shows large differences among the H^2, which range from nearly zero to a maximum of 91 percent. It is worth noting that for both, premium and regular gasoline, Shell and YPF have a much higher H^2 than the other two firms[25]. Although the persistent price differentials among brands in this sample are small -an average of 2.5% and 1.6% of the premium and regular gasoline prices respectively-, it suggests that brands are valued differently by consumers. Perhaps, the permanent difference in prices is due to the nature of services a customer can obtain from the brands. A brand can provide special services for its customers: flat tire repairs, free car wash and so on. But this does not seem to explain what differentiates brands in Argentina. The common belief is that the main difference among brands is the monitoring capacity each of them is capable of exerting on dealers. The monitoring activities reduce the likelihood that a dealer "cheats" by mixing gasoline or adding water. Thus, a customer is willing to pay more to reduce the probability of buying low quality gasoline and damage her car's engine. Independently of the precise group of reasons, the price study

[24]These four markets account for more than 65% of total gasoline consumption in Argentina.

[25]Buenos Aires is the only market (regular gasoline) where this pattern is not observed.

shows that consumers in Argentina consider gasoline as a differentiated product. The next section models demand and supply in a framework that assumes products are differentiated by brands.

4.2 The discrete choice model.

4.2.1 The demand side

The demand side of the market is modelled in a discrete choice framework. The utility of consumer i for product j depends on the characteristics of the product and the consumer: $U(x_j, p_j, \varepsilon_i, \theta_d)$, where x_j, p_j and θ_d are product characteristics, price and demand parameters respectively. The term ε_i captures consumer specific terms that are not observed in the data. Recent papers that model the demand function (Nevo (1997), and Berry, Levinsohn and Pakes (1995)) assume a random coefficient specification for utility. Due to lack of detailed data on gasoline stations and brand attributes, I will assume that a set of brand dummies summarizes consumers taste for product characteristics.

In this specification, the indirect utility[26] of consumer i for product j is given by:

$$u_{ij} = D_j\beta - \alpha p_j + \varepsilon_{ij} \tag{10}$$

where D_j is the product j brand dummy and the parameter α, that represents the marginal disutility of price increase, is invariant across consumers.

As explained in Berry (1994), each consumer purchases the good that gives the highest utility. That is, conditional on the characteristics (brand dummies) and prices p consumer i will purchase good j if and only if for all $k \geq 0$ and $k \neq j$ $U(D_j, p_j, \varepsilon_i, \theta_d) > U(D_k, p_k, \varepsilon_i, \theta_d)$. This implicitly defines the set of unobservable taste parameters, ε_{ij} that result in the purchase of good j and so, assuming a specific distribution for ε, the market share of the j^{th} firm can

[26] Anderson (1992) presents a detailed derivation of the indirect utility function.

be obtained. It is necessary to calculate the market share because the decisions of individual consumers are not observed. The estimation has to rely on the market outcomes of price and quantity sold by each firm.

The shape of the demand function depends crucially on the distribution of the random shocks ε. I assume a logit model framework: ε_{ij} is identically and independently distributed across products and consumers with the "extreme value" distribution function $\exp(-\exp(-\varepsilon))$.

Market size and the outside good:

The measure of consumers in a market is denoted M. The observed output quantity of firm j is

$$q_j = M s_j(\mathrm{D}, \mathrm{p}, \theta_d)$$

In addition to the competing products $j = 1, ..., N$ it is also assumed the existence of an outside good, $j = 0$. Consumers may choose to purchase the outside good instead of one of the N "inside" products. The distinction is that the price of the outside good is not set in response to the prices of the inside goods. In the absence of an outside good, consumers are forced to choose from the inside good and demand depends only on differences in prices. Therefore, a general increase in prices will not decrease aggregate output. The presence of the outside good with market share s_0 means that observations on the output quantities of the N firms $(q_1, ..., q_N)$ are not sufficient to calculate the market shares of the $N+1$ total alternatives. If the total market size M is directly observed, then s_j can be calculated as $s_j = q_j/M$. Nevo (1997) considers M to be the total population while BLP (1995) assumes that the size of the market is given by the quantity of households. Following these papers, I assume that each person buys one liter of gasoline per day. I also estimated the model setting the value of the outside good equal to 0,75 and 1,25 liters and the results were very similar (not given in Tables XIII and XV).

Let's denote the mean utility level of product j as

$$\delta_j \equiv D_j\beta - \alpha p_j$$

The market share of product j is then given by

$$S_j(\delta) = e^{\delta_j}/(\sum_{k=0}^{N} e^{\delta_k})$$

With the mean utility of the outside good normalized to zero,

$$\ln(s_j) - \ln(s_0) = \delta_j \equiv D_j\beta - \alpha p_j$$

So δ_j is uniquely identified directly from the observed market shares.

Independence-of-irrelevant-alternatives problem

The independence-of-irrelevant-alternatives problem arises from the fact that in the multinomial logit model the relative probability of choosing two existing alternatives is unaffected by the presence of additional alternatives. As an example, suppose a commuter is twice as likely to commute by subway as by bus and three times as likely to commute by private car as by bus, so that the probabilities of commuting by bus, subway and private car are 1/6, 2/6 and 3/6, respectively. Now suppose an extra bus service is added, differing form the existing bus service only in the color of the buses. One would expect the probabilities of commuting by new bus, old bus, subway and private car to be 1/12, 1/12, 2/6 and 3/6, respectively. Instead, the logit model produces probabilities 1/7, 1/7, 2/7 and 3/7, to preserve the relative probabilities.

Another problem with the logit model is that the assumption made about the additive error term places very strong restrictions on the pattern of cross-price elasticities from the estimated model. As Nevo (1997) explains, this problem is more relevant when the industry is characterized by multiproduct (brand) firms, there are many close substitutes and new products are introduced.

During the period under study, there was not any introduction of a new product in the Argentine gasoline market so the assumption made about the structure of the error term is not inappropriate to model supply and demand and choose the type of behavior (Collusion, Cournot, Bertrand) that has the best fit to the data.

4.2.2 The supply side

Total costs for firm j are given by the function $C_j(q_j, w_j, \gamma)$, and marginal costs are $c_j(q_j, w_j, \gamma)$ where γ is a vector of unknown parameters and w_j is the price of crude oil.

Three models of firm behavior are considered: Bertrand, Cournot and Collusion.

Profits for firm j are given by:

$$\pi_j(\mathrm{p}, w_j, \theta) = p_j M S_j(\mathrm{D}, \mathrm{p}, \theta_d) - C_j(q_j, w_j, \gamma)$$

where $\theta = (\theta_d, \gamma)$.

If firms are price setters and assuming the existence of a pure-strategy interior equilibrium, the price vector satisfies the first order conditions

$$[p_j - c_j(q_j, w_j, \gamma)]\,[\partial S_j(\mathrm{D}, \mathrm{p}, \theta_d)/\partial p_j] + S_j(\mathrm{D}, \mathrm{p}, \theta_d) = 0$$

or

$$p_j = c_j + S_j / \mid \partial S_j / \partial p_j \mid$$

Under the assumption of a logit model, the first order condition is

$$p_j = c_j + \frac{1}{\alpha}\left(\frac{1}{(1 - s_j)}\right)$$

for $j = 1, ..., N$.

When there is an implicit agreement in the market (collusion), the profit maximization problem is solved for one firm that takes into account how changing the price of firm i affects the shares of all other firms in the agreement. The supply relation is given by

$$p_j = c_j + \frac{1}{\alpha}\left(\frac{1}{s_0}\right)$$

for $j = 1, ..., N$.

If the behavioral assumption is Cournot, firms choose quantities (shares) and take as given the shares of the other firms in the market. This implies a supply relation of the form[27]

$$p_j = c_j + \frac{1}{\alpha}\left(\frac{s_j + s_0}{s_0}\right)$$

for $j = 1, ..., N$.

Note that $p_{j,bertrand} < p_{j,cournot} < p_{j,collusion}$.

4.2.3 Data and Estimation

In order to determine which type of behavior explains the observed prices and quantities in the Argentine gasoline market, following Gasmi (1991) and Gasmi, Laffont and Vuong (1992), demand and supply are jointly estimated using full information maximum likelihood. To select among the competing models, which are non-nested, pairwise tests for nonnested hypothesis proposed by Voung (1989) are applied. These tests are based on the likelihood ratio (LR) principle, and are designed to test the null hypothesis that two competing models adjust equally well to the data versus the alternative hypothesis that one model fits better. Some properties of these tests are that they are symmetric and directional, and that neither model needs to be correctly specified. Hence, these tests are especially appropriate in this case because our competing models might be at best approximations to what really happened.

[27]In the Appendix, a detailed derivation of the supply relation under Cournot and Collusion is provided.

For each pair of models (M_f, M_g), we calculate the likelihood ratio statistic normalized by

$$n^{1/2}w_n = \frac{1}{2}\left[\sum_{t=1}^{n}\left(\hat{u}_{ft}'\hat{\Sigma}_f^{-1}\hat{u}_{ft} - \hat{u}_{gt}'\hat{\Sigma}_g^{-1}\hat{u}_{gt}\right)^2\right]^{1/2}$$

where $\hat{\Sigma}_s \hat{u}_s$ are the estimated covariance matrix and residuals for model $M_s, s = f, g$. The resulting normalized statistic is asymptotically normally distributed under the null hypothesis of equal fit. Thus, given a critical value c from the standard normal distribution at some significance level, we cannot reject the null hypothesis, and we conclude that the data do not enable us to discriminate between the two models if the normalized LR statistic is smaller than c in absolute value. On the other hand, if the normalized LR statistic is smaller than $-c$ we conclude that M_g is significantly better, while if it is greater than $+c$, we conclude that M_f is significantly better.

The data set used in the estimation consists of monthly prices and quantity of premium and regular gasoline sold by firm in five markets during the period January 1994-October 1998[28].

To estimate market shares, I rely on the assumption that the outside good is given by each person in the population consuming one litre of gasoline (premium or regular according to the model to be estimated) per day. Quantity sold per firm is divided by the total size of the outside good and the share of the outside good is obtained by subtracting the sum of all firms' shares in each market. By using this procedure a problem may arise in the estimation because one of the questions we want to answer -if a consumer is indifferent between two gasoline stations of different brands located one next to the other that charge the same price- would have the wrong answer. The source of this problem is that if aggregate quantity is not adjusted by the number of gasoline stations, the brand dummies would mainly pick the

[28]The firms are EG3, Esso, Shell and YPF. The five markets (Buenos Aires, Cordoba, Santa Fe, Mendoza and Tucuman), account for 60% of total gasoline consumed in Argentina.

effect of location[29]. To eliminate the effect of location the quantity sold by firm in each state has to be divided by the quantity of gasoline stations each firm has. Thus, controlling for price, a positive brand dummy suggests that consumers value more this brand compared to the one left out of the regression.

The price of crude oil is the WTI, -same price for all firms-. To account for unobserved differences in costs, brand dummies are included in the supply relation.

Due to seasonality, monthly dummies are included in the demand. Regional dummies (one for each state) do not significantly change the results.

Table XIII shows the results for premium gasoline. This table presents the estimated values for price, brand dummies, crude oil and the value of the log likelihood using different behavioral assumptions. According to the demand dummies, Shell has the highest valuation followed by Esso, YPF and EG3. This ranking of valuation agrees with the ranking of prices observed in the market except for EG3 whose price is higher than the price charged by YPF.

The values obtained for the LR statistic are given in table XIV. A value that is higher than the critical value chosen from the normal distribution, allow us to discriminate between two models. Collusion seems to be the worst model when trying to explain firms' behavior in the Argentine premium gasoline market. When comparing Cournot and Bertrand, the former behavioral model seems to fit the data better.

Table XV summarizes the results of the model using regular gasoline data. The brand dummies indicate that the ranking of quality is different than the one obtained for premium gasoline. The relative position of YPF improves and even though Shell maintains its position as the top quality brand, the difference between this brand and YPF is much smaller.

A problem that characterized the Argentine premium gasoline market before its deregu-

[29]If firm A has ten times more gasoline stations than B, firm A's brand dummy would be positive even though consumers consider B to be a higher quality brand than A. In this case, the dummy variable would be capturing the fact that A sells more than B because has many more locations.

lation was the high probability of buying adulterated gasoline (gasoline stations would mix regular and premium gasoline and sell it as premium gasoline). This problem was more pronounced in YPF that still was state-owned. During that time, consumers trusted more those gasoline stations that were privately owned (Esso and Shell). After deregulation, despite Shell's and Esso's higher prices, market shares have not changed significantly. This suggests that consumers still perceive that these two firms provide a better service (better monitoring of cheating). As previously mentioned, the ranking of quality for regular gasoline is different than the one for premium gasoline (Esso and YPF change places). Esso has not invested as much as YPF to provide additional services in gasoline stations (drug store, coffee shop, car wash). This difference in services may explain the difference in the ranking of quality between regular and premium gasoline. Services are more heavily weighted by regular gasoline consumers because they do not have to worry about the probability of buying adulterated gasoline.

Using the calculation of the likelihood ratio statistic for regular gasoline (Table XVI) Bertrand and monopoly are rejected in favor of Cournot. An important difference between regular and premium gasoline is that using regular gasoline data, it is more difficult to distinguish between Bertrand and Cournot and determine which model best describes price competition.

These results suggests that, even though the Argentine gasoline market is deregulated, price competition is not as intense as Bertrand would predict in a differentiated product market. This model rejects the extreme types of behavior (firms acting independently and monopoly) but does not allow us to identify the precise form of interaction that exists in this market.

5 The role of the Argentine government.

From the study of elasticities of gasoline prices with respect to crude oil prices and long run responses of gasoline prices to crude oil prices, we can infer that gasoline prices in Argentina are much more rigid than in the United States. Gasoline prices in the former country usually ignore price movements of crude oil that is the most important input in the production of gasoline. Figure 8 shows regular gasoline margins[30] in the Argentine and American markets for the period January 1994-October 1998. It also shows the behavior of the West Texas Intermediate price of crude oil. Margins in the American and Argentine regular gasoline market have a very different behavior. In the United States, it is not possible to distinguish a trend in the margin. It fluctuates much more than the Argentine margin in a period-by-period basis but it remains close to a value of 9 cents independent of the crude oil price level. In contrast, price margins in Argentine tends to move in an opposite direction[31] to the crude oil price. Between January 1994 and March 1996 crude oil prices increased 40% and regular gasoline margins in Argentina decreased 35%. The opposite effect occurs for the period April 1996 - October 1998 when crude oil prices fell 43% and margins increased 36%. The different behavior in margins implies that for a given change in crude oil prices, retail prices change less in Argentina. Argentine firms internalize the fluctuations of crude oil prices.

One interpretation of figure 8 and the results obtained in the homogenous and differentiated product models is that oil firms in Argentina are engaged in a price agreement and the stability of prices is a component of the strategy to maintain this agreement . However, this interpretation ignores the role that the government retains in this market. Government intervention in this market was very important from the beginning in the 1920s until its

[30] Gasoline price net of taxes - crude oil price.

[31] The correlation between these two series is -0.64.

deregulation in 1991. Although since 1993, when the privatization of YPF was completed, the government gave up direct intervention in the market, its presence remains important and may have greatly influenced firms' decisions, specially those taken by YPF's management. The privatization of YPF was different from most of the others done by the Argentine government because management control was not transferred to a single foreign firm. The initial capital distribution of the privatization plan is shown in figure 7. Even though the state and provinces had the right to appoint a minority of the board, giving the private investors the effective control of the company, the Argentine government kept a "golden share" that allowed it to veto an eventual take-over and other important decisions. This clause reduces the power of the market to control management performance. Besides, it implicitly creates a particular relation between private management and the members of the board appointed by the government. Management decisions have to meet possible objections raised by government's directors. Thus, YPF's pricing decisions and consequently the other firms' prices (since all participants in the market agree that YPF has been the price leader since 1991) may be influenced by the implicit presence of the government on its board of directors.

Newspapers have provided evidence of the interference of the Argentine government in oil firms' pricing decisions. As an example, a report published in June of 1998[32], describes how the government, using the threat of a new legal framework for the oil market, demanded a decrease in gasoline prices. Moreover, this report highlights that it was not the first time the government influenced prices. Before the general elections of October 1997, YPF and the other firms in the market announced a price increase but they could not implement it due to government's pressure.

[32] El Cronista Comercial, June 3rd, 1998: "El Gobierno insiste en que YPF empuje el precio de la nafta hacia abajo". See also El Cronista Comercial, December 3rd, 1998 and La Nacion, February 27th 1998.

The evidence presented here suggests that the influence the government retains over the Argentine gasoline market must not be ignored. Prices seem be set in an environment of "tacit regulation" even though the law says that the market is deregulated and so the government's role should be reduced exclusively to the enforcement of safety and environmental laws that apply to the market.

Firms in the gasoline market not only compete on price. The quality of the service provided in a retail outlet influences the purchasing decision, especially in this market where it is very difficult for the consumer to assess the quality of gasoline. If firms perceive constraints to compete on prices, they tend to compete on quality. In Argentina, firms have invested to improve the quality of services changing the appearance of the gasoline stations and providing additional services like small shops and car wash. Although quality competition may be a tool to soften price competition and facilitate the implementation of a price agreement, it seems that in Argentina this is not the case.

Summarizing, the role of the government as an implicit regulator may be a plausible explanation of the price rigidity in the Argentine gasoline market.

6 Conclusion

This paper presents different models to study price competition in the post-deregulation Argentine gasoline market. A comparison of the cumulative response of gasoline prices to crude oil price changes and the elasticity of gasoline prices with respect to crude oil prices shows that gasoline prices in Argentina react significantly less than in the United States to changes in crude oil prices.

Assuming that gasoline is a homogenous product, using price and quantity data from the Argentine and American gasoline markets we identified a relative industry-average conduct parameter. Although differences in marginal costs between these two countries may bias the estimated conduct parameter, the results suggest that price competition is less intense in the Argentine gasoline market.

The third model addresses the same question but assumes that consumers do not consider gasoline from different brands as being perfect substitutes. Three alternative forms for the supply relation -Cournot, Bertrand and Collusion- were derived and estimated in a discrete choice framework. I use a likelihood ratio test to select among these three alternatives. Cournot behavior best explains how firms competed during the period January 1994 - October 1998 for both regular and premium gasoline. We have to be cautious with this result. The model allow us to reject the presence of the extreme forms of behavior in the market (Bertrand and monopoly) but we can not identify firms' pricing behavior from a variety of possible strategies that lie between Bertrand and Cournot.

The influence that the Argentine government has had in the gasoline market during the post-deregulation period is important. Through its holding of a golden share in YPF and using political pressure, the government affected firms' pricing policies and other dimensions of competition. In a study conducted in 1998,.The Argentine Antitrust Commission argues that price competition in the gasoline market is not significant and that firms compete through advertising and investments to improve the services provided in gasoline stations. Although that study does not explicitly mention the government as an agent that influences prices in the gasoline market, it argues that the lack of price competition could be explained by logistic and legal barriers that hinder the importing of gasoline and make entry very difficult. The reasons provided by the Antitrust Commission complements the explanation I provide in this paper.

The results from the models presented in this paper seem to agree with the Commission's conclusions. After eight years of deregulation, price competition is less intense than it was expected to be.

7 Appendix

7.1 Elasticity of gasoline price with respect to crude oil price

7.1.1 Competitive market

In equilibrium, price equals marginal cost,

$$P_t = \xi(wti_t^{\gamma} w_t^{\delta} r_t^{\lambda}) q_{it}^{(\xi-1)}$$

Note that $q_{it} = \frac{Q_t}{N}$ and taking logs (ignoring for simplicity labor and capital costs)

$$\log P_t = \log(\xi) + \gamma \log(wti_t) - (\xi - 1)\log(N) + (\xi - 1)\log(Q_t)$$

$$\begin{aligned} \frac{\partial \log P_t}{\partial \log wti_t} &= \gamma + (\xi - 1)\frac{\partial \log Q_t}{\partial \log P_t}\frac{\partial \log P_t}{\partial \log wti_t} \\ &= \gamma + (\xi - 1)(\beta_1 + 2\beta_2 \log(P_t))\frac{\partial \log P_t}{\partial \log wti_t} \end{aligned}$$

$$\frac{\partial \log P_t}{\partial \log wti_t} = \frac{\gamma}{1 - (\xi - 1)(\beta_1 + 2\beta_2 \log(P_t))}$$

Note that I am assuming that changes in the quantity demanded do not affect the input price. This is an appropriate assumption for the Argentine market but not for the American gasoline market. In the long run, demand changes in the American market will affect crude oil prices. Borenstein (1997) uses instruments -sweet oil futures in the United Kingdom- but explains that the results are almost identical if crude oil prices are used. I follow his results and use the West Texas Intermediate price in the estimation.

7.1.2 Cournot (assuming symmetry and N firms in the market)

Marginal revenue is given by

$$P_t + q_{it}(\frac{\partial F_t}{\partial Q_t}\frac{\partial Q_t}{\partial q_{it}})$$

or

$$P_t\left[1+\frac{1}{N\eta}\right]$$

where η is the price elasticity of demand

Setting marginal revenue equal to marginal cost,

$$P_t\left[1+\frac{1}{N\eta}\right] = \xi(wti_t^{\gamma}w_t^{\delta}r_t^{\lambda})q_{it}^{(\xi-1)}$$

Taking logs and simplifying,

$$\frac{\partial \log P_t}{\partial \log wti_t} = \frac{\gamma}{\left[1-\frac{2\beta_2}{(1+N(\beta_1+2\beta_2\log(P_t))(\beta_1+2\beta_2\log(P_t))}(\xi-1)(\beta_1+2\beta_2\log(P_t))\right]}$$

7.1.3 Monopoly

Given the Lerner index

$$\frac{P_t - MC_t}{P_t} = \frac{1}{(\beta_1+2\beta_2\log(P_t))}$$

we can obtain

$$\frac{\partial \log P_t}{\partial \log wti_t} = \frac{\gamma}{\left[1-\frac{2\beta_2}{(1+(\beta_1+2\beta_2\log(P_t))(\beta_1+2\beta_2\log(P_t))}(\xi-1)(\beta_1+2\beta_2\log(P_t))\right]}$$

Summarizing, the elasticities of gasoline prices with respect to crude oil price are

$$\begin{aligned} E^{comp} &= \frac{\gamma}{1-(\xi-1)\eta} \\ E^{cournot} &= \frac{\gamma}{1-\frac{2\beta_2}{(1+N\eta)\eta}-(\xi-1)\eta} \\ E^{monop} &= \frac{\gamma}{1-\frac{2\beta_2}{(1+\eta)\eta}-(\xi-1)\eta} \end{aligned} \quad (11)$$

The greater the share of crude oil (γ) in gasoline production costs, the greater the elasticity of gasoline prices with respect to crude oil. Independently of the market structure, the price of gasoline reacts more to changes in crude oil prices when there are increasing returns to scale ($\xi < 1$) than when there are constant or decreasing returns to scale. The effect that the price elasticity of demand has on the elasticity of gasoline prices with respect to crude oil depends on the value of the parameter measuring returns to scale. Given our estimates, the more elastic the price elasticity of demand, the smaller the price elasticity of gasoline prices with respect to crude oil.

7.2 Homogenous Product

7.2.1 Possible source of bias

Suppose that an extra term in the supply relation (7) was omitted and denote this term Z_A and Z_U for Argentina and the United States respectively. Then, β can be written as

$$\beta = -\log[1 + \frac{\theta_A}{\alpha_A}] + \log(Z_A) - \left(-\log[1 + \frac{\theta_U}{\alpha_U}] + \log(Z_U)\right)$$

Simplifying we get

$$\underbrace{e^{\beta}\,\frac{\alpha_U}{\alpha_A}\frac{Z_U}{Z_A}}_{M^*} = \frac{\alpha_U + \theta_U}{\alpha_A + \theta_A}$$

If $Z_A > Z_U$, the Argentine firms are relatively less efficient and so $M^* < M$ (which does not include the Z terms). Because

$$\theta_A = \frac{\alpha_U + \theta_U}{M} - \alpha_A$$

is used in the paper, if the correct specification is given by M^* the estimated value for θ_A could be upward biased.

7.2.2 Delta Method

Let's suppose that the parameter θ is a function of the vector γ ($\theta = h(\gamma)$).

Then the variance of θ is given by the following formula (for the derivation see Greene (1993)):

$$Var(\theta) = \frac{\partial h(\gamma)}{\partial \gamma'} Var(\gamma) \frac{\partial h(\gamma)'}{\partial \gamma'}$$

Using equation (9) $\partial h(\gamma)/\partial \gamma$ is given by:

$$\begin{aligned} \frac{\partial h(\gamma)}{\partial \alpha_A} &= (\exp(-\beta) - 1) \\ \frac{\partial h(\gamma)}{\partial \beta} &= -(\exp(-\beta)\alpha_A) \end{aligned}$$

The standard deviation of the conduct parameter obtained using premium gasoline data is given by

$$\partial h(\gamma)/\partial \gamma = \left[\frac{\partial h(\gamma)}{\partial \alpha_A} \frac{\partial h(\gamma)}{\partial \beta} \right] = \left[-0.4378 \quad 0.1985 \right]$$

$$\begin{aligned} Var(\gamma) &= \begin{bmatrix} 0.0223 & -0.0084 \\ -0.0084 & 0.0518 \end{bmatrix} \\ Var(\theta_A) &= 0.0233 \end{aligned}$$

So the standard deviation is 0.152. This calculation assumes θ_U is known to be zero.

7.2.3 Identification of θ

The parameter θ can be identified under the specification assumed in this paper. But under a different specification of the supply relation, identification may not be possible. Suppose for example that the cost function of firm i is:

$$C_{it} = k_i q_{it}^{\eta} \quad \text{for } i = 1, \ldots\ldots, N$$

where k_i is a firm specific cost shifter. The supply relation would be:

$$\log P_t = \mu + \phi \log Q_t + U_t$$

where, $\mu = -\log[1 + \theta/\alpha_1] + \log(\eta(\sum_i k_i^{1/1-\eta})^{1-\eta})$. It is not possible to identify θ from the estimation of μ because $\sum_i k_i$ is unknown. This example shows that the identification of θ relies on the particular specification of the cost function. It could also depend on the specification of the demand function. If a linear demand and a quadratic cost function are specified, an approach like the one presented here can not be used to distinguish between a monopoly and a competitive industry. When we estimate the supply equation, we cannot ascertain whether the coefficients on quantity represents conduct, or whether it represents the change in marginal cost when the quantity changes.

7.2.4 Data Description

- Prices and quantities.

Argentina: Survey conducted by the Department of Energy (Secretaría de Energía, Subsecretaría de Combustibles)

United States: Energy Information Administration.

- Wages

Argentina: Wages of the Petroleum Sector (FIEL) and Downstream Wages (Evolución de Gestión, years 1994-1998).

United States: Sic 517 (Petroleum Products and Commercialization): Average hourly wages, US Department of Labor, Bureau of Labor Statistics.

- Income

Argentina: International Monetary Fund, Statistical Yearbook, 1994-1998

United States: Real Disposable Income Survey of Current Business. Table 4: National Income and Disposition of Personal Income. Bureau of Economic Analysis.

- Interest Rate

  Argentina: Loan interest rate to largest firms (25%), Central Bank of Argentina

  United States: 3-Month Treasury Bill Rate, Auction Average, Average of Business Days, Federal Reserve Board of Governors.

- Crude Oil Price: West Texas Intermediate (WTI), Energy Information Administration, Department of Energy, United States.

7.3 Differentiated Product

7.3.1 Collusion:

If we consider the profit maximization problem under collusion:

$$Max_{\{p_i\}_{i=1}^{N}} \pi_i = \sum_{i=1}^{N} (p_i - c_i) M s_i$$

The first-order conditions are given by $(i = 1, ...N)$

$$(p_i - c_i)(\partial s_i / \partial p_i) + s_i + \sum_{j \neq i} (p_j - c_j) \partial s_j / \partial p_i = 0$$

$$p_i = c_i - \frac{s_i}{(\partial s_i / \partial p_i)} - \sum_{j \neq i} (p_j - c_j) \frac{\partial s_j / \partial p_i}{\partial s_i / \partial p_i}$$

$$p_i = c_i + \frac{1}{\alpha} \frac{s_i}{(\partial s_i / \partial \delta_i)} - \sum_{j \neq i} (p_j - c_j) \frac{1}{(-\alpha)} \frac{\partial s_j / \partial \delta_i \partial \delta_i / \partial p_i}{\partial s_i / \partial \delta_i}$$

$$p_i = c_i + \frac{1}{\alpha}\frac{1}{1-s_i} - \sum_{j\neq i}(p_j - c_j)\frac{1}{(-\alpha)}\frac{(-s_j s_i)(-\alpha)}{s_i(1-s_i)}$$

simplifying

$$p_i = c_i + \frac{1}{\alpha}\frac{1}{1-s_i} + \sum_{j\neq i}(p_j - c_j)\frac{s_j}{(1-s_i)}$$

We can write the F.O.C. for collusion when there are four firms in matrix form as

$$\underbrace{\begin{bmatrix} 1 & \frac{-s_2}{1-s_1} & \frac{-s_3}{1-s_1} & \frac{-s_4}{1-s_1} \\ \frac{-s_1}{1-s_2} & 1 & \frac{-s_3}{1-s_2} & \frac{-s_4}{1-s_2} \\ \frac{-s1}{1-s_3} & \frac{-s_2}{1-s_3} & 1 & \frac{-s_4}{1-s_3} \\ \frac{-s_1}{1-s_4} & \frac{-s_2}{1-s_4} & \frac{-s_3}{1-s_4} & 1 \end{bmatrix}}_{A}\underbrace{\begin{bmatrix} p_1 \\ p_2 \\ p_3 \\ p_4 \end{bmatrix}}_{P} = \frac{1}{\alpha}\underbrace{\begin{bmatrix} \frac{1}{1-s_1} \\ \frac{1}{1-s_2} \\ \frac{1}{1-s_3} \\ \frac{1}{1-s_4} \end{bmatrix}}_{K} + \underbrace{\begin{bmatrix} 1 & \frac{-s_2}{1-s_1} & \frac{-s_3}{1-s_1} & \frac{-s_4}{1-s_1} \\ \frac{-s_1}{1-s_2} & 1 & \frac{-s_3}{1-s_2} & \frac{-s_4}{1-s_2} \\ \frac{-s1}{1-s_3} & \frac{-s_2}{1-s_3} & 1 & \frac{-s_4}{1-s_3} \\ \frac{-s_1}{1-s_4} & \frac{-s_2}{1-s_4} & \frac{-s_3}{1-s_4} & 1 \end{bmatrix}}_{A}\underbrace{\begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix}}_{C}$$

Using matrix notation

$$P = \frac{1}{\alpha}A^{-1}K + C$$

The supply relation, after multiplying is given by

$$p_i = c_i + \frac{1}{\alpha}\frac{1}{s_0}$$

for $i = 1, ..., N$

7.3.2 Cournot:

Firm's maximization problem is

$$Max_{\{p_i\}}\pi_i = (p_i(\text{s}) - c_i)Ms_i$$

where s is the vector of market shares. The first order conditions are

$$(p_i - c_i) + s_i \partial p_i / \partial s_i = 0$$

Under Cournot, firms choose quantities (shares) and take as given the shares of the other firms. Firms do not consider the effect that changing their shares have on the other firms' prices: the F.O.C does not include the term $\sum_{j \neq i} s_j \partial p_j / \partial s_i$.

Let $s_k = f_k(p_1, .., p_j)$. If we totally differentiate the demand system with respect to s_1(assuming there are only 4 firms):

$$\begin{aligned}
1 &= \frac{\partial f_1}{\partial p_1}\frac{\partial p_1}{\partial s_1} + \frac{\partial f_1}{\partial p_2}\frac{\partial p_2}{\partial s_1} + \frac{\partial f_1}{\partial p_3}\frac{\partial p_3}{\partial s_1} + \frac{\partial f_1}{\partial p_4}\frac{\partial p_4}{\partial s_1} \\
0 &= \frac{\partial f_2}{\partial p_1}\frac{\partial p_1}{\partial s_1} + \frac{\partial f_2}{\partial p_2}\frac{\partial p_2}{\partial s_1} + \frac{\partial f_2}{\partial p_3}\frac{\partial p_3}{\partial s_1} + \frac{\partial f_2}{\partial p_4}\frac{\partial p_4}{\partial s_1} \\
0 &= \frac{\partial f_3}{\partial p_1}\frac{\partial p_1}{\partial s_1} + \frac{\partial f_3}{\partial p_2}\frac{\partial p_2}{\partial s_1} + \frac{\partial f_3}{\partial p_3}\frac{\partial p_3}{\partial s_1} + \frac{\partial f_3}{\partial p_4}\frac{\partial p_4}{\partial s_1} \\
0 &= \frac{\partial f_4}{\partial p_1}\frac{\partial p_1}{\partial s_1} + \frac{\partial f_4}{\partial p_2}\frac{\partial p_2}{\partial s_1} + \frac{\partial f_4}{\partial p_3}\frac{\partial p_3}{\partial s_1} + \frac{\partial f_4}{\partial p_4}\frac{\partial p_4}{\partial s_1}
\end{aligned}$$

Given that in the logit model $\frac{\partial f_l}{\partial p_m} = \alpha s_l s_m$, this system of equations can be written in matrix form

$$\underbrace{\begin{bmatrix} 1/\alpha \\ 0 \\ 0 \\ 0 \end{bmatrix}}_{C} = \underbrace{\begin{bmatrix} -s_1(s_1-1) & s_1 s_2 & s_1 s_3 & s_1 s_4 \\ s_2 s_1 & -s_2(s_2-1) & s_2 s_3 & s_2 s_4 \\ s_3 s_1 & s_3 s_2 & -s_3(s_3-1) & s_3 s_4 \\ s_4 s_1 & s_4 s_2 & s_4 s_3 & -s_4(s_4-1) \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} \frac{\partial p_1}{\partial s_1} \\ \frac{\partial p_2}{\partial s_1} \\ \frac{\partial p_3}{\partial s_1} \\ \frac{\partial p_4}{\partial s_1} \end{bmatrix}}_{\Delta P}$$

Note that $\Delta P = A^{-1}C$. Replacing the value of $\frac{\partial p_i}{\partial s_i}$ in the first order condition, the following expression for the supply relation is obtained

$$p_i = c_i + \frac{1}{\alpha}\left(\frac{s_0 + s_i}{s_0}\right)$$

for $i = 1, ..., N$.

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Table I: Autorregresive distributed lag relation

Premium gasoline. Argentina

	coefficient	std. error
log(WTI)	0.0707	0.021
log(WTI(-1))	0.0259	0.011
log(WTI(-2))	0.0275	0.041
log(WTI(-3))	-0.068	0.031
log(premium(-1))	0.9329	0.103
log(premium(-2))	-0.189	0.135
log(premium(-3))	0.041	0.033
constant	0.0808	0.040

Table II: Autorregresive distributed lag relation

Premium gasoline. United States

	coefficient	std. error
log(WTI)	0.0954	0.017
log(WTI(-1))	0.0797	0.029
log(WTI(-2))	-0.1673	0.031
log(WTI(-3))	0.0703	0.023
log(premium(-1))	1.4013	0.074
log(premium(-2))	-0.6941	0.109
log(premium(-3))	0.1445	0.055
constant	0.0088	0.008

Table III: Autorregresive distributed lag relation

Regular gasoline. Argentina

	coefficient	std. error
log(WTI)	0.0613	0.027
log(WTI(-1))	0.0166	0.041
log(WTI(-2))	-0.0366	0.044
log(WTI(-3))	0.0190	0.031
log(regular(-1))	0.8044	0.084
log(regular(-2))	-0.1590	0.012
log(regular(-3))	0.0561	0.083
constant	0.0284	0.036

Table IV: Autorregresive distributed lag relation

Regular gasoline. United States

	coefficient	std. error
log(WTI)	0.116	0.019
log(WTI(-1))	0.0814	0.034
log(WTI(-2))	-0.1897	0.035
log(WTI(-3))	0.0865	0.026
log(regular(-1))	1.2651	0.074
log(regular(-2))	-0.5213	0.106
log(regular(-3))	0.0693	0.056
constant	-0.0165	0.011

Table V: Long run response of gasoline prices

	Argentina	United States
Premium gasoline	26.1%	52.6%
Regular gasoline	19.9%	50.5%

Table VI: Price elasticity of demand

		Argentina	United States
Premium gasoline			
	mean price	-2.86	-1.42
	(+) one std. dev.	-2.92	-1.45
	(-) one std. dev.	-2.80	-1.38
Regular gasoline			
	mean price	-2.06	-1.23
	(+) one std. dev.	-2.16	-1.25
	(-) one std. dev.	-1.95	-1.21

Table VII: Elasticities of gasoline prices with respect to crude oil. Premium gasoline

	United States	Argentina	Difference
Long Run response	0.526	0.261	0.265
$\gamma = 0.5$ $\xi = 1$			
$E^{comp.}$	0.5	0.5	0
$E^{cournot}$	0.477	0.471	0.006
$E^{monop.}$	0.152	0.371	-0.219
$\gamma = 0.5$ $\xi = 0.95$			
$E^{comp.}$	0.538	0.583	-0.045
$E^{cournot}$	0.512	0.544	-0.032
$E^{monop.}$	0.155	0.414	-0.259
$\gamma = 0.5$ $\xi = 1.05$			
$E^{comp.}$	0.467	0.437	0.03
$E^{cournot}$	0.447	0.415	0.032
$E^{monop.}$	0.148	0.335	-0.187

Number of firms: United States: 15, Argentina: 4

Price elasticity of demand:

United States: -1.42. Argentina: -2.86

Table VIII: Elasticities of gasoline prices with respect to crude oil. Regular gasoline

	United States	Argentina	Difference
Long Run response	0.505	0.199	0.306
$\gamma = 0.5$ $\xi = 1$			
$E^{comp.}$	0.5	0.5	0
$E^{cournot}$	0.484	0.435	0.049
$E^{monop.}$	0.143	0.248	-0.105
$\gamma = 0.5$ $\xi = 0.95$			
$E^{comp.}$	0.533	0.557	-0.024
$E^{cournot}$	0.514	0.478	0.036
$E^{monop.}$	0.145	0.262	-0.117
$\gamma = 0.5$ $\xi = 1.05$			
$E^{comp.}$	0.471	0.453	0.018
$E^{cournot}$	0.457	0.399	0.058
$E^{monop.}$	0.140	0.236	-0.096

Number of firms: United States: 15, Argentina: 4

Price elasticity of demand:

United States: -1.23. Argentina: -2.06

Table IX: Homogenous Product. Premium Gasoline

		United States	Argentina
Demand			
	Price	-0.93	-0.959
		(0.02)	(0.16)
	Income	1.09	0.803
		(0.03)	(0.02)
	R^2	0.873	0.832
Supply			
	Constant	-6.53	
		(0.03)	
	WTI	0.413	0.177
		(0.09)	(0.04)
	Dummy Argentina		0.576
			(0.227)
	R^2	0.683	0.505

Standard errors in parenthesis.

Demand: monthly dummies are not included

Supply: wages and interest rate are not included because the estimated coefficients are not significantly different than zero.

Table X: Homogenous Product. Regular Gasoline

		United States	Argentina
Demand			
	Price	-0.258	-0.523
		(0.03)	(0.17)
	Income	1.226	-1.01
		(0.04)	(0.01)
	R^2	0.892	0.737
Supply			
	Constant	-2.774	
		(0.25)	
	WTI	0.409	0.156
		(0.07)	(0.068)
	Dummy Argentina		0.301
			(0.21)
	R^2	0.631	0.392

Standard errors in parenthesis.

Demand: monthly dummies are not included

Supply: wages and interest rate are not included because the estimated coefficients are not significantly different than zero.

Table XI : Price Differences: Permanent and Transitory. Premium Gasoline

Market	Firm	Permanent Price Difference	Std. Deviation U_{it}	H_i^2
Buenos Aires	EG3	0.2	0.6	0.095
	ESSO	-0.4	0.9	0.179
	SHELL	2.2	1.2	0.779
	YPF	-1.9	0.8	0.835
Capital City	EG3	0.6	0.9	0.335
	ESSO	-0.9	1.2	0.356
	SHELL	2.8	1.4	0.808
	YPF	-2.6	1.1	0.859
Cordoba	EG3	0.4	0.9	0.159
	ESSO	-0.3	0.7	0.181
	SHELL	2.6	0.9	0.903
	YPF	-2.7	1.1	0.852
Santa Fe	EG3	-0.1	0.8	0.033
	ESSO	0.6	1.7	0.117
	SHELL	3.1	1.4	0.827
	YPF	-3.6	1.1	0.915

$$H_i^2 = \frac{\left(\bar{p}_{i.} - \bar{p}_{..}\right)^2}{\left[\left(\bar{p}_{i.} - \bar{p}_{..}\right)^2 + S.D^2(U_{it})\right]}$$

Table XII : Price Differences: Permanent and Transitory. Regular Gasoline

Market	Firm	Permanent Price Difference	Std. Deviation U_{it}	H_i^2
Buenos Aires	EG3	0.3	0.8	0.134
	ESSO	0.3	0.5	0.202
	SHELL	-0.1	0.9	0.008
	YPF	-0.5	0.9	0.247
Capital City	EG3	0.1	0.4	0.072
	ESSO	-0.2	0.6	0.16
	SHELL	0.8	0.6	0.654
	YPF	-0.7	0.5	0.637
Cordoba	EG3	0.2	0.7	0.093
	ESSO	-4.0	0.9	0.179
	SHELL	1.2	0.6	0.807
	YPF	-1.0	0.8	0.618
Santa Fe	EG3	-0.1	0.7	0.042
	ESSO	0.6	0.9	0.344
	SHELL	1.4	0.5	0.896
	YPF	-1.9	1.0	0.779

$$H_i^2 = \frac{\left(\bar{p}_{i.} - \bar{p}_{..}\right)^2}{\left[\left(\bar{p}_{i.} - \bar{p}_{..}\right)^2 + S.D^2(U_{it})\right]}$$

Table XIII: Product differentiation. Premium gasoline

		Bertrand	Cournot	Collusion
Demand				
	Price	-4.523	-5.808	-8.56
		(0.169)	(0.129)	(0.444)
	Deg3	-0.131	-0.078	-0.01
		(0.033)	(0.034)	(0.042)
	Desso	0.062	0.1536	0.184
		(0.029)	(0.03)	(0.041)
	Dshell	0.621	0.739	0.836
		(0.032)	(0.036)	(0.046)
Supply				
	WTI	0.481	0.363	0.112
		(0.031)	(0.024)	(0.098)
	Deg3	0.009	0.018	0.055
		(0.002)	(0.028)	(0.04)
	Desso	0.02	0.028	0.04
		(0.001)	(0.002)	(0.004)
	Dshell	0.051	0.058	0.054
		(0.002)	(0.002)	(0.004)
log likelihood		2399.43	2547.75	1161.23

Table XIV: Likelihood Ratio statistic for model selection

Premium gasoline

	LR statistic
Cournot - Bertrand	4.12
Bertrand - Collusion	26.85
Cournot - Collusion	43.91

Table XV: Product differentiation. Regular gasoline

		Bertrand	Cournot	Collusion
Demand				
	Price	-4.71	-5.01	-8.40
		(0.113)	(0.085)	(0.57)
	Deg3	-0.2315	-0.252	-0.259
		(0.03)	(0.042)	(0.086)
	Desso	-0.258	-0.236	-0.203
		(0.031)	(0.034)	(0.052)
	Dshell	0.181	0.207	0.255
		(0.029)	(0.032)	(0.052)
Supply				
	WTI	0.22	0.189	0.246
		(0.03)	(0.023)	(0.048)
	Deg3	0.0004	-0.0006	-0.0014
		(0.002)	(0.002)	(0.007)
	Desso	0.006	0.006	0.01
		(0.001)	(0.002)	(0.003)
	Dshell	0.02	0.021	0.018
		(0.001)	(0.001)	(0.0025)
log likelihood		2582.03	2611.75	1621.13

Table XVI: Likelihood Ratio statistic for model selection

Regular gasoline

	LR statistic
Cournot - Bertrand	2.03
Bertrand - Collusion	11.36
Cournot - Collusion	12.70

Table XVII: Gasoline Margins (price of gasoline - crude oil price). Summer and winter

		US prem.	US reg.	ARG. prem.	ARG reg.
1994	summer	0.133	0.083	0.252	0.163
	winter	0.134	0.082	0.242	0.150
1995	summer	0.146	0.096	0.234	0.134
	winter	0.128	0.078	0.231	0.128
1996	summer	0.140	0.092	0.223	0.127
	winter	0.126	0.078	0.231	0.142
1997	summer	0.149	0.101	0.244	0.158
	winter	0.137	0.089	0.254	0.171
1998	summer	0.140	0.089	0.264	0.179
	winter	0.133	0.083	0.260	0.183
% change (avg.)	summer/winter	7.78	12.98	0.13	-1.39

Figure 1
Prices: Regular Gasoline and Crude Oil (Pesos of April 1994)

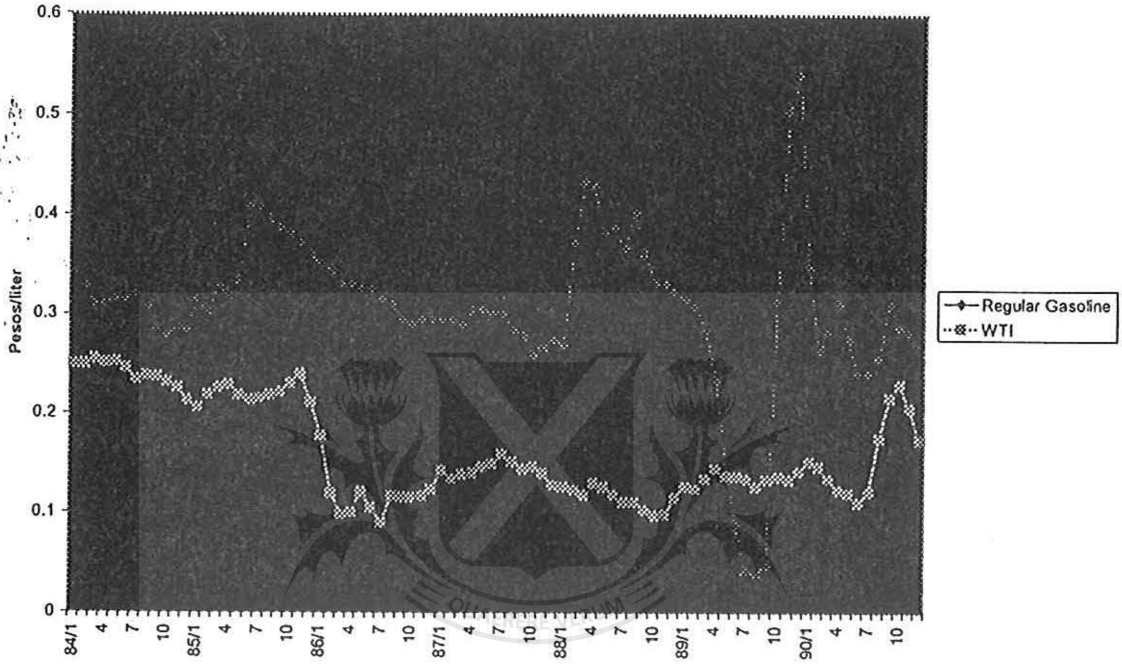

Figure 2
Total Personnel in YPF, 1983-1995

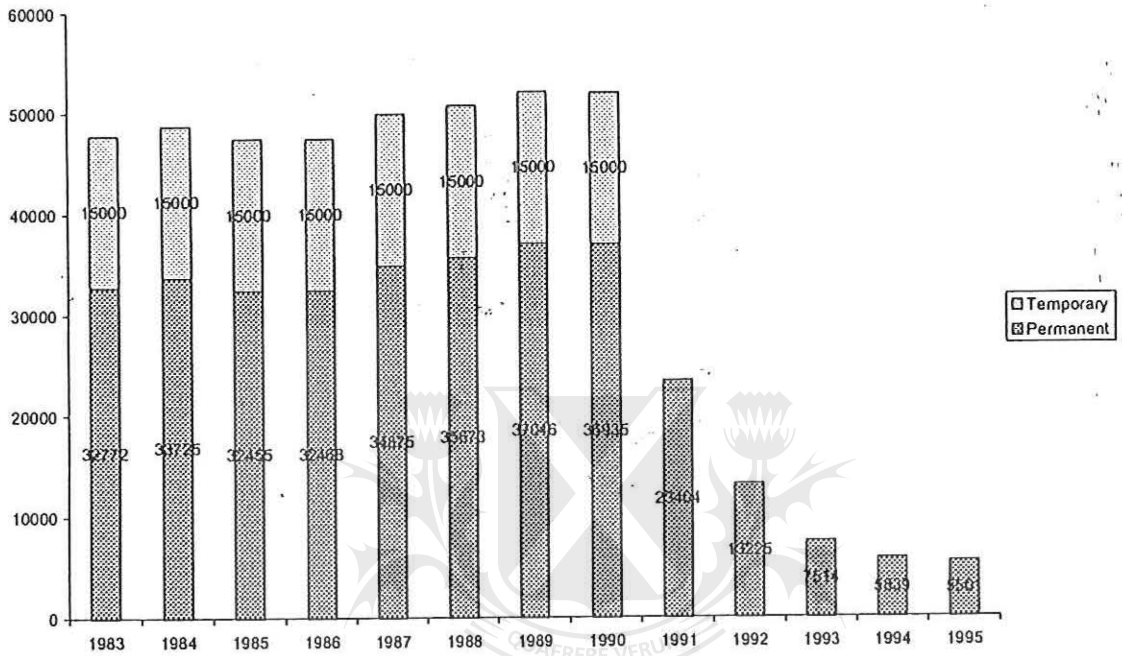

Figure 3
Premium Gasoline Prices

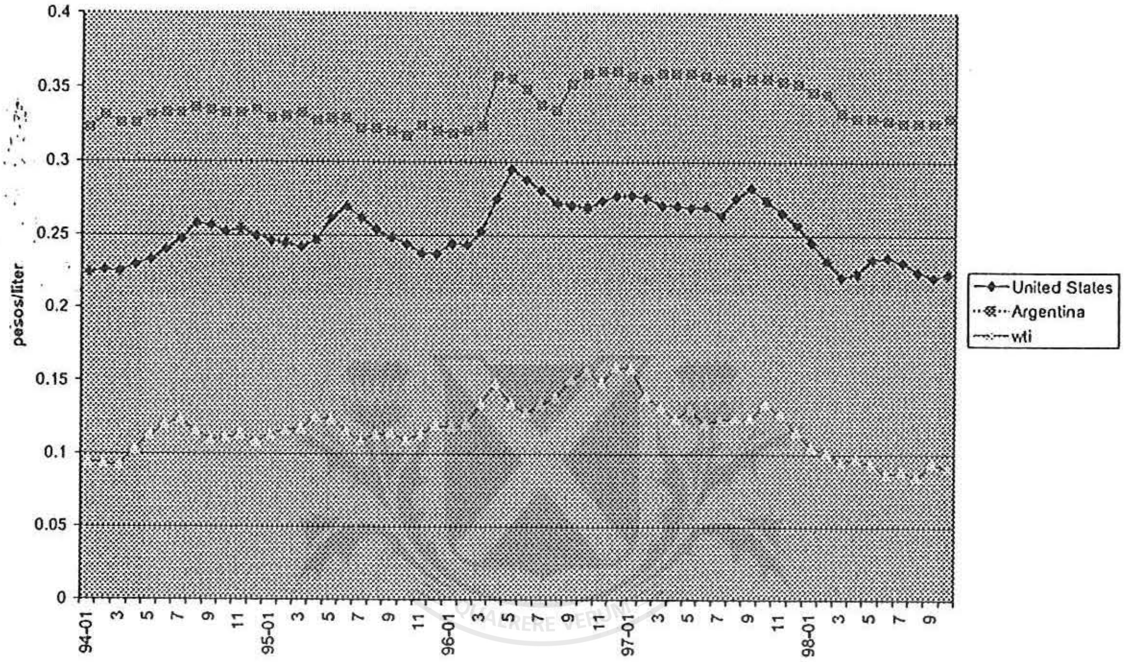

Figure 4
Regular Gasoline Prices

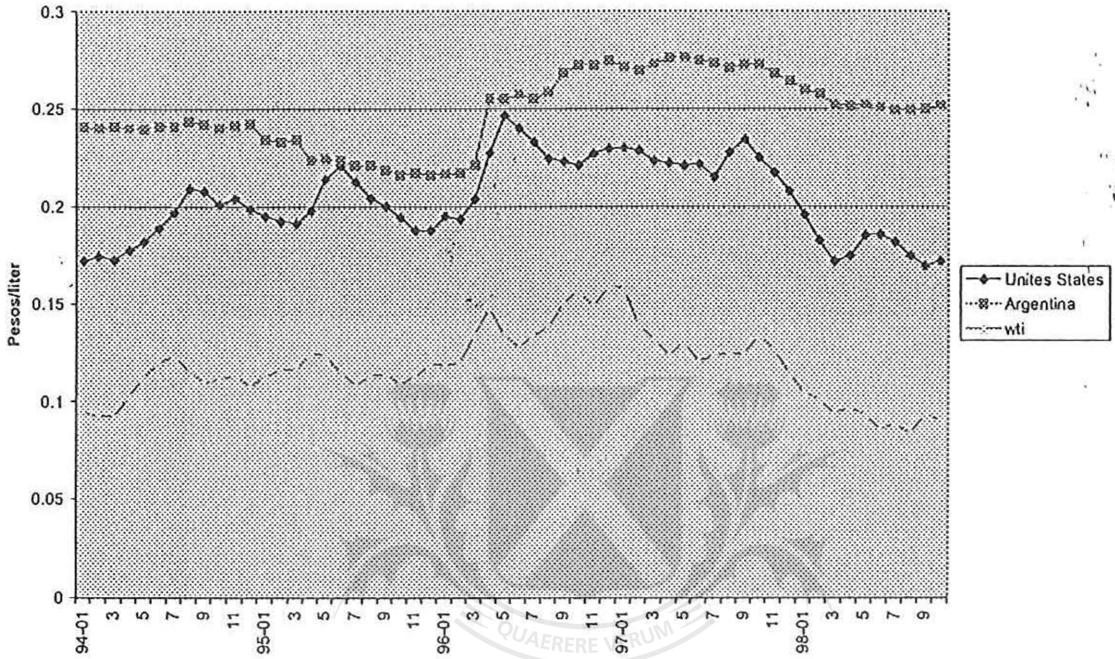

Figure 5
Crude-to-Retail Cumulative Adjustment: Premium Gasoline

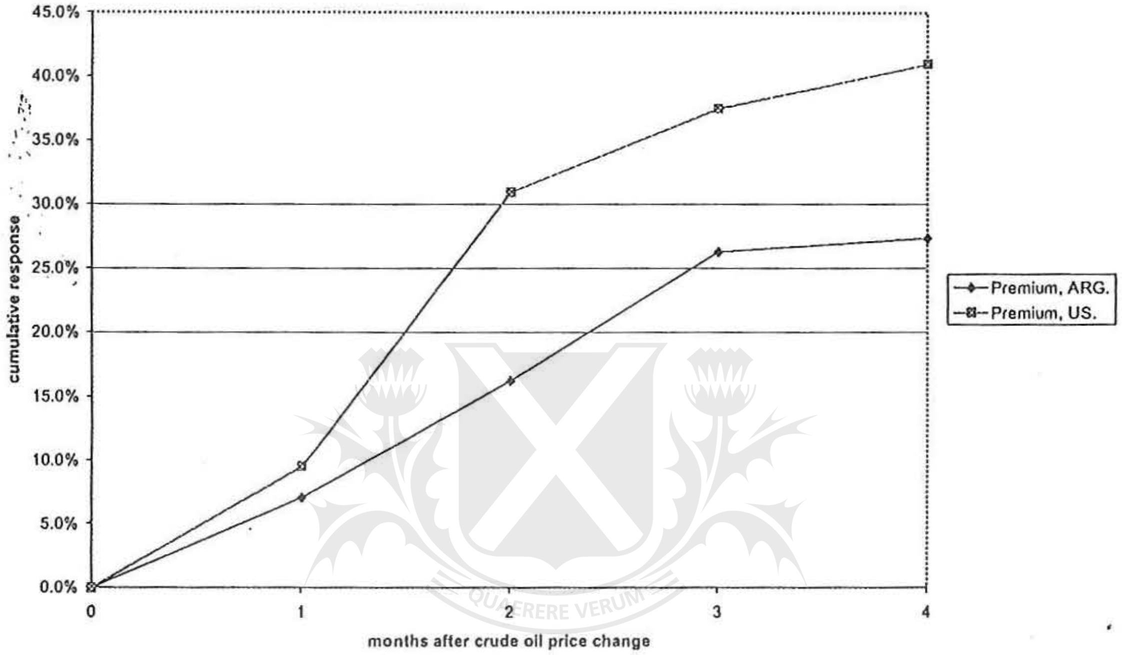

Figure 6
Crude-to-Retail Cumulative Adjustment: Regular Gasoline

Figure 7
Initial Capital Distribution

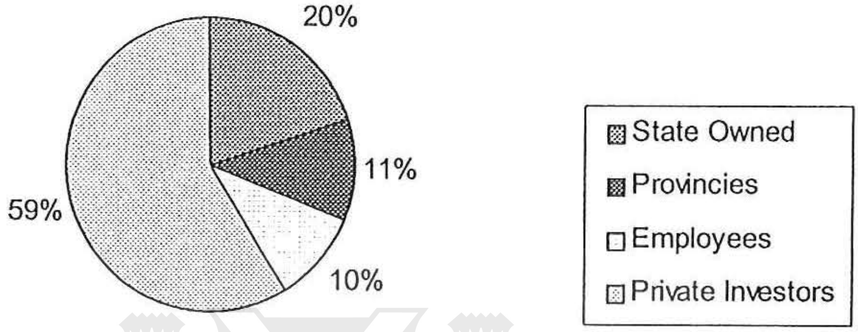

Figure 8
Margins: Regular Gasoline Price - Crude Oil Price

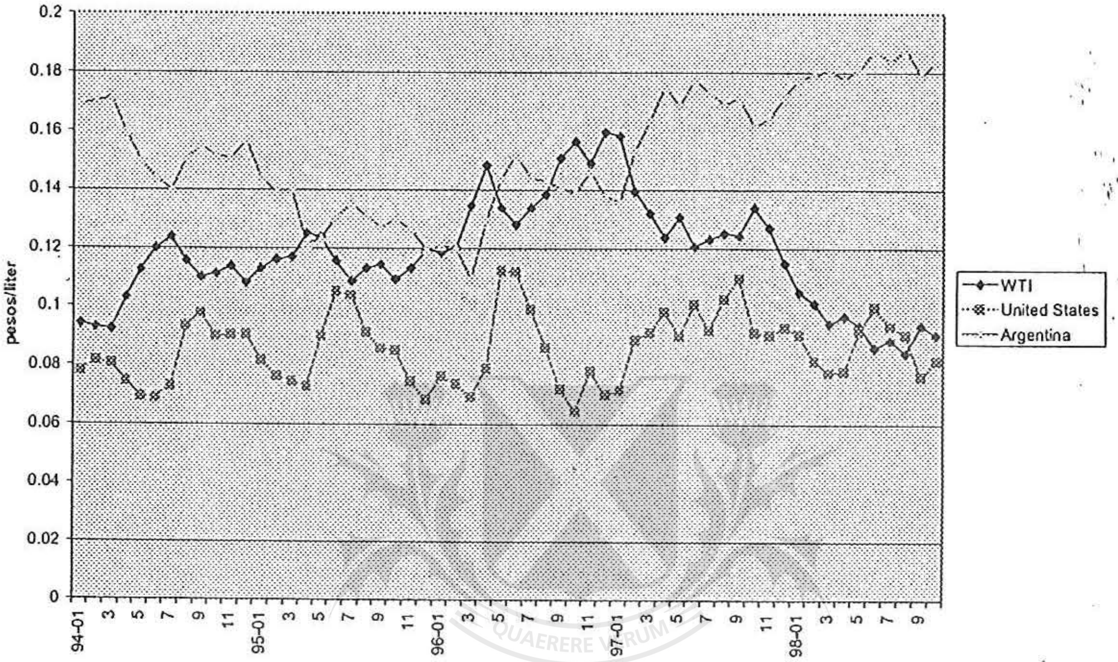

Figure 9
Cordoba: Premium Gasoline Prices