Market power in the liquid fuels wholesale chain in Argentina: an empirical analysis

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Abstract

This paper studies the demand for liquid fuels at the wholesale level, using the discrete choice approach. Demand is conditioned by the presence of wholesale competitors, the existence of a reward card, and the percentage of flagged outlets kept by each firm. Using a novel dataset from Argentina, we provide new empirical evidence that quantifies market power across firms and regions.

We find differences among markups estimated at regional levels, based both on different presence of the firms within each region and on price elasticity of demand of each region itself. Even though leading firms tend to have higher markups on the whole, there are specific niche markets where small firms reach higher markups than those they could have obtained in more crowded markets, exceeding markups obtained by larger competitors.

Price elasticity of demand is different among regions, partly because it reflects the variability that coexists in the productive structure of each economy and because of different income levels and consumption patterns in these geographic areas.

Keywords: Liquid Fuels; Market Power; Product Differentiation; Discrete Choice; Demand Estimation.

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1 Introduction

The liquid fuels market is important for a variety of reasons. Its performance affects other markets and may condition a country's macroeconomic development. In a few countries, also, the sector has been heavily regulated for purposes such as inflation control and-or as a social policy. This has been the case, for example, in Argentina in the last couple decades, except for short periods of time during the 2015-2019 period.[1]

Despite its significance, there is scarce empirical economic examination of Argentina's liquid fuels segment. This paper seeks to address this gap by studying the 2016-2019 period, where the sector was liberalized and imports and exports were allowed. More specifically, we address the issue of how firms set differentiated wholesale prices for gasoline and diesel based on regional demand and supply characteristics, and what is the market power different firms hold at different regions of the country.

Understanding the determinants of fuel demand and pricing strategies is crucial for policy-making and economic planning. Fuel prices impact various sectors and have broader economic implications. The existing literature has extensively analyzed fuel markets, focusing on the relationship between crude oil prices and gasoline (e.g., Godby, Lintner, Stengos, and Wandschneider (2000), Bachmeier and Griffin (2003), Atil, Lahiani, and Nguyen (2014)) and the key predictors of demand and market organization (e.g., Lewis (2012), Andreoli-Versbach and Franck (2015), Lee (2009), Byrne and de Roos (2019), Hastings (2009)).

There is no empirical literature studying Argentina's liquid fuels segment during this particular period, and previous literature is scarce. Coloma (2002), using a traditional supply and demand approach, studies the impact the merger of YPF and Repsol had on the market, concluding it had a negative impact associated to the increased market power of the merged firm. Mercuri (2001), on the other hand, analyzes the asymmetries in the price response of different types of fuel to fluctuations in the international price of a barrel of oil, using time series models. The author corroborates the widespread belief that the reaction in fuel prices is in magnitude and speed higher in the case of barrel price increases. Similarly, Porto and Pizzi (2018) analyze the pass-through of international prices to domestic fuel prices, using multivariate dynamic models and using lagged crude oil prices as an explanatory variable, as well as the lagged product price variable (gasoline and diesel), in the period 2005-2017. The authors confirm Mercuri (2001)'s findings,

[1] Price controls have been implemented through different mechanisms throughout the production and commercialization chain and involve measures such as the establishment of progressive tariffs on exports of crude oil and its by-products, the establishment of minimum values for cutting by-products with biofuels, among others.

and point out that between 2005-2016 there was a decoupling of domestic and external prices, which is mainly explained by the introduction of specific export taxes.

Studying the case of Argentina in the 2016-2019 period is particularly interesting, as it is a short period of time where the market was suddenly deregulated despite its large concentration indexes and the important regional differences in concentration. In this period we also observed the bankrupt of one of the medium-size suppliers (Oil Combustibles) and the merger of two relatively small firms (SCP and DAPSA). Our paper is the first that helps explain regional price and markup differences among different firms and products in this turbulent context. A deep analysis of the pricing policies of the different firms during this period seems relevant for the design of future policies.

We apply the well-known discrete choice approach, which models the aggregate demand for products as the probability of choosing a brand over all others if the characteristics associated with the product provide greater utility to the "consumer". It might be argued that the relevant part of the chain to asses is retail. However, differences in wholesale prices are relevant as they explain nearly all observable differences in retail prices, as retailers generally follow a constant-mark-up policy rather than marking-up prices in proportion to the inverse demand elasticity (Hastings (2009)).

We estimate the wholesale demand for fuels considering them as differentiated products, where firms consider customer characteristics to determine their market offerings. This analysis uses data from Argentina for the period 2016-2019, during which price liberalization and free import policies were in place. We follow Berry (1994) and Berry, Levinsohn, and Pakes (1995)'s discrete choice models with random coefficients.

As a methodological contribution, we propose a definition of the outside option as the difference between potential sales and effective sales made by firms. Potential sales are conceived as those that firms can effectively provide in each particular market, and were estimated as the maximum volume of sales made in the market in the period between the year immediately before and after the month/year under analysis. This definition of external good is particularly useful in cases in which some firms merged, since the potential sales of the merger year are compared against the year immediately after, in which the company is already operating as merged, in order not to underestimate the potential sales. This is of particular interest because over the past ten years, Argentina's downstream market has operated under many contractual reorganizations. The strategy allows us not only to estimate the model even though we do not count on a stable firm panel data over the period of analysis, but also to obtained markups estimations of firms that are new in terms of brand, but have acquired other companies facilities, such as Gulf.

Our findings indicate that firms set different wholesale prices and margins based on regional demand and supply characteristics. Firms seek to differentiate their products with alternative strategies, such as reward cards, concentration of flagged outlets within specific geographic areas, and various specific promotions and benefits.

We observe important dispersion of markups for different firms in the same region and for the same firm in different regions. Moreover, even though leading firms tend to have higher markups, there are niche markets where small firms reach higher markups than those they could have obtained in more crowded markets, exceeding markups obtained by larger competitors.

This paper contributes to understanding how regional demand characteristics influence wholesale fuel pricing in Argentina. It fills a gap in the literature by providing insights into the price differentiation strategies of firms and their implications for market power at regional level. It also contributes to the broader understanding of the economic mechanisms guiding the decisions of market participants, enriching the discussion on energy policy in the fuel sector.

The findings are relevant for policymakers aiming to regulate or deregulate the fuel market effectively. It is a highly concentrated market with relevant regional disparities and, as mentioned before, an important effect in the economy as a whole.

The rest of the paper is organized as follows. Section 2 sets out the theoretical framework, including identification and estimation strategies. Section 3 details the application of the model to the Argentine fuel market and presents the estimation results. Section 4 evaluates the market power predicted by our empirical model. Section 5 presents the conclusions and suggests future research directions. The Appendix includes additional results regarding the random coefficients specification.

2 The Model

2.1 Setup

The theoretical base model used in this research is derived from the model proposed by Berry (1994) and Berry, Levinsohn, and Pakes (1995). The model presented by Berry (1994) is extended by assuming that individuals differ at the regional level. A model of random coefficients by region is then estimated, adjusted by the use of an instrument for product prices following the model of Swamy (1970). The instruments used in this paper consist of a function of competitors' prices, following Nevo (2001)'s approach. Further details about their construction can be found in Section 3.1.

In particular, following Berry, Levinsohn, and Pakes (1995) we use a model of random coefficients per individual. This approach generates more reasonable substitution patterns. The utility function takes the form:

$$u_{ij} = x_j \beta_i - \alpha_i p_j + \xi_j + \epsilon_{ij}, \tag{1}$$

where β_i and α_i are random variables linked to consumer preferences. The variable p_j is the price for brand j and the variables in x_j are observable characteristics that affect demand. The term ξ_j can be thought of as consumers' mean valuation of unobserved product characteristics, such as unobserved quality. The "error term" ϵ_{ij} captures random variation in tastes

We refer to this model as the random coefficients model by region. This specification is estimated at the region level as an attempt to characterize wholesale demand through specific geographic factors.

Berry (1994) suggests a version of the model where heterogeneity among individuals is captured only through a mean zero heteroskedastic error which reports the effects of random taste parameters. Under this specific assumption the utility function would take the form:

$$u_{ij} = x_j \beta + \xi_j - \alpha p_j + \nu_{ij}, \tag{2}$$

where $\nu_{ij} = [\sum_k x_{jk} \sigma_k \zeta_{ik}]$ and the term $\sigma_k \zeta_{ik}$ comes from the assumption that taste parameter β can be decompose into $\beta_{ik} = \beta_k + \sigma_k \zeta_{ik}$.

Market size and external good. The measure of the total market size is denoted by M. This value can be observed or estimated. In the case of fuels, it is defined by the total volume traded in each market by product. The observed quantity of the firm's output is:

$$q_j = \mathbf{M} \times s_j(\mathbf{x}, \xi, \mathbf{p}, \theta_d), \tag{3}$$

where s_j is firm j market share.

Together with the list of products competing in the market (products with horizontal differentiation, which in this case are each represented by a different flag or firm), $j = 1, ..., N$, the existence of an external good $j = 0$ is assumed. This specification enables dealing with the fact that consumers may decide not to buy any of the N offered goods. In the context of the fuel market, the existence of the external good makes sense if one considers that the demand of gas station owners is a derived demand, which ultimately depends on the demand of final consumers. Then, the final consumer can choose not to consume any of the available options, and this translates into not buying in the wholesale market.

The existence of an external good with observed market share s_0, while timely, implies that the mere observation of the quantities produced by the N firms $(q_1, ..., q_N)$ are not sufficient to calculate the market shares of $(N + 1)$ alternatives. If the total market size M is directly observable, s_j can be calculated directly as $s_j = q_j/M$.

The definition of external good is closely related to the problem under analysis and implies assigning a market share to the no-purchase alternative. In this market, the external good is defined as the potential sales not purchased in the period by the different companies in the wholesale segment. To estimate the magnitude of potential sales, the maximum sales volume for each of the flags in each period (month/year) is calculated as the maximum sales volume of the years immediately preceding and following the period under analysis. The magnitude of the external good is then defined as the difference between potential sales in a given market and actual sales for the period in question. Under this approach, potential sales of companies that were under the process of a merger under the period (and concentrate supply contracts with several more gas stations) are not underestimated.

Supply. It is assumed that N firms in the market have pricing power. The total costs of firm j are given by the cost function $C_j(q_j, w_j, \omega_j, \gamma)$ and marginal costs are $c_j(q_j, w_j, \omega_j, \gamma)$, where γ is a vector of unknown parameters, ω_j are unobserved characteristics related to marginal costs and w_j are observed characteristics related to costs . The net profit for firm j in each market is

$$\pi_j(\mathbf{p}, \mathbf{z}, \xi, \omega_j, \theta) = p_j \mathbf{M} \mathcal{s}_j(\mathbf{x}, \xi, \mathbf{p}, \theta_d) - C_j(\mathbf{q_j}, \mathbf{w_j}, \omega_\mathbf{j}, \gamma), \tag{4}$$

where $\theta = (\theta_d, \gamma)$. Assuming the existence of an inner equilibrium in pure strategies (Berry, 1994), the price vector satisfies the first order condition:

$$[p_j - c_j(q_j, w_j; \omega_j, \gamma)][\partial \mathcal{s}_j(\mathbf{x}, \xi, \mathbf{p}, \theta_\mathbf{d})/\partial p_j] + \mathcal{s}_j(\mathbf{x}, \xi, \mathbf{p}, \theta_\mathbf{d}) = 0,$$

or, equivalent:

$$p_j = c_j + \mathcal{s}_j / |\partial \mathcal{s}_j / \partial p_j|. \tag{5}$$

If there are N equations, they define a unique equilibrium for values of c_j. Thus, the first-order conditions implicitly define a reduced form function for the price, $p_j(\mathbf{z}, \xi, \omega, \theta)$, as a function of exogenous variables and parameters. The equilibrium price, in conjunction with the demand function thus defines a reduced form expression for the equilibrium quantities, given by $q_j(\mathbf{z}, \xi, \omega, \theta) = \mathbf{M}\mathcal{s}_j(\mathbf{x}, \xi, p(\mathbf{z}, \xi, \omega, \theta), \theta_{\mathbf{d}})$.

2.2 Identification and Estimation

The presence of the term ξ_j corresponding to the unobserved characteristics brings econometric difficulties in estimating the demand for good j. In equilibrium, the observed market shares s_j should be equal to those predicted by a model $\mathcal{s}_j$:

$$s_j = \mathcal{s}_j(\mathbf{x}, \mathbf{p}, \xi, \theta).$$

Berry (1994) suggests exploiting the fact that $s = \mathcal{s}(\delta)$ holds with equality, to rescue the value of $\delta = (\mathcal{s})^{-1}(\mathbf{s})$, provided that the function $\mathcal{s}$ admits inverse.

Thus, the observed market shares, in conjunction with the distributional assumptions about ν, uniquely determine the average utility of consumers for each good.

This vector of mean utilities that depends on the observed market shares $\delta(\mathbf{s})$ can be used in a simple estimation strategy. The calculated average utility levels can be treated as a known nonlinear transformation of the market shares. Following equation (2) proposed by Berry (1994), for true values of (α, β) it holds:

$$\delta_j(\mathbf{s}) = x_j\beta - \alpha p_j + \xi_j. \tag{6}$$

This equation can be estimated using standard instrumental variables techniques to learn the unknown parameters. In particular, valid instrument Z should satisfy

$$\frac{1}{J}\sum_{j=1}^{J}((\delta_j(\mathbf{s}) - x_j\beta + \alpha p_j)Z) \to 0. \tag{7}$$

Logit and Random Coefficients Models

For the logit model, it is assumed that heterogeneity among individuals enters the model only through the random, additive, separable error ϵ_{ij} which is independent and identically distributed across consumers and across markets. Under an extreme type I distribution, the market shares function has an analytical form given by

$$s_j(\delta) = \frac{e^{\delta_j}}{\sum_{k=0}^{N} e^{\delta_j}}. \tag{8}$$

Normalizing the average utility of the external good $\delta_0 = 0$ and taking logs to linearize, gives the expression for the average utility of product j

$$ln(s_j) - ln(s_0) \equiv \delta_j = x_j\beta - \alpha p_j + \xi_j. \tag{9}$$

In this way δ_j is unambiguously identified directly by a simple algebraic calculation.

Next, the logit model is implemented using an IV regression of the difference between the logarithms of the market share in (x_j, p_j). Again, despite the simplicity of its implementation, it produces undesirable substitution patterns, which limits the conclusions that can be derived from it.

On the other hand, the random coefficients model in equation (1), is estimated by applying the logit model to each of the products analyzed, by geographic region: Cuyo, Patagonia, Northwest, Northeast, and Pampeana. This implies assuming that the individuals who make up each of the regions are relatively homogeneous among themselves within the regions, but differ among regions. The strategy of estimating the model at the regional level seeks to enrich the analysis by incorporating heterogeneity factors based on regional geographic diversity. The choice of geographic openness responds to the need for the most relevant variables in the analysis to be identified (the latter conditioned the decision to select regions over provinces). For estimation, we used the procedure indicated by Swamy (1970) but considering the use of instruments for the price variable, so that specific coefficients were obtained for each product and for each panel, defined by the sales (prices and quantities) by region, period, and commercialization channel. Specifically, to obtain the coefficients associated with the variables of interest, the coefficients were estimated for each panel β_i:

$$\beta_i = (Z^T X)^{-1} Z^T Y, \tag{10}$$

where Z is the instrument matrix, the instrument of the non-price variables being the variables themselves. The general coefficients associated to the estimation by instrumental variables, given by the vector $\hat{\beta}$, are the result of the following expression:

$$\hat{\beta} = \sum_i W_i \beta_i,$$

where W_i acts as a weight that penalizes the regional estimates with a greater magnitude of variability in relation to the variability of the coefficients of the other regions. The variance-covariance matrix was adjusted by the degrees of freedom resulting from the instrumentation performed.

3 Application: Fuel Market in Argentina

Fuel prices are a sensitive variable in a country whose north-south extension is approximately 3,779 kilometers, with an uneven distribution of road infrastructure centered in the Autonomous City of Buenos Aires (CABA) and Greater Buenos Aires area. This affects logistics costs and establishes different cost structures depending on the geographical location of those involved.

The fuel value chain ranges from mineral extraction to refining, distribution, wholesale, and retail. The actors involved may participate in some link of the chain, or be fully integrated, as is the case of YPF S.A., a company whose activity includes all the stages mentioned above.

From the point of view of the wholesale market, the sale of liquid fuels can be conceived as an oligopolistic market of differentiated products. The horizontal differentiation is related to the differences final consumers perceive from the different retailers (e.g., loyalty programs, specific discounts with certain banks, etc.). There is also vertical differentiation, related to the different fuel qualities. Moreover, the wholesale market is characterized by important entry costs due to several factors, among which are the high logistics costs related to the handling of the product, the investments required to carry out the activity, and the marketing expenses, related to positioning a brand.

The differentiation strategies among brands are diverse, and may include the degree of purity of the final product within the standard purity margins defined by the regulatory agency for each category, additional services targeted to specific customers, score cards, discounts through partnerships with various banks, reward cards, and geographic location, among others.

The presence or not of the companies in each market, as well as the number of gas stations associated with each company, are part of the observed characteristics of the products. The benefits associated with each flag (such as points cards redeemable for products or discounts) are more attractive to final consumers, and they represent an advantage for gas station owners. Likewise, the presence of the brand (quantity and extension) in the different markets permits the final consumer to take advantage of the benefits associated with the flags that have customer loyalty instruments. Thus, it is observed that the companies with the greatest presence in the country are those with web applications, cards, and/or specific discounts to build customer loyalty.

Without discriminating by region or by year, total sales in Argentina in the 2016-2019 period show a high degree of concentration for both gasoline and diesel, in both regular and premium versions. To illustrate this fact, the value of the Herfindahl-Hirschman Index (HHI) for the four products is shown.

Table 1: Herfindahl-Hirschman Index at the aggregate level (Argentina, mean value by region), by product, for the period 2016-2019.

Product	**Diesel**	**Premium Diesel**	**Regular Gasoline**	**Premium Gasoline**
HH Index	7203.83	6839.65	4790.50	5818.80

Source: Own elaboration based on database.

A value above 2,500 is already considered indicative of high levels of concentration, and in the case of Argentina, for sales carried out in the marketing channels and period under study, the index greatly exceeds this threshold. This value increases significantly in geographic regions where the number of competitors decreases, and total sales are concentrated in a few companies.

3.1 Estimates for Gasoline and Diesel Demand

The results obtained from the estimations carried out for diesel and gasoline are presented below. Further details on the database treatment can be found in subsection A of the Appendix. The results of the estimations made by applying the Ordinary Least Squares (OLS) method, Instrumental Variables (IV) method to estimate the logit model proposed by Berry (1994), and the logit model with random coefficients by region are shown. The comparison of the model estimated by OLS with the others allows visualizing the importance of instrumenting the price, which is assumed to be correlated with the measurement error, in the presence of unobserved variables in the analysis (correlated with the price).

Instruments used. A set of instruments associated with the characteristics of the database was constructed, some of which are suggested by Nevo (2000). Given the market definition, the instrument was established considering the type of product, province, month, year, and marketing channel.

After carefully analyzing the different instrument alternatives available, the instruments that exhibited favorable results in the endogeneity and relative relevance F-tests of the instruments were selected. This led to instrumenting the price of diesel fuels with the maximum price of the competition in the marketing channel, within the region, and the price of gasoline with the average price of the flag in other marketing channels in the province, and an indicator variable of the existence or not of a refinery in the province. Instruments showed good results, both at the aggregate level and at the panel level (for each region): in each case, the instrument was checked to ensure that it complied with the desired conditions at the aggregate level and at the regional level. The case of gasoline, for which two instruments were used, also verified that the over-identification test was met.

Definition of external good. The definition of external good corresponds to the potential sales not made by the banners in each market. For this purpose, the maximum volume of sales made in the market in the period between the year immediately before and after the month/year under analysis was taken as a reference. The difference between potential and actual sales thus represents the external good. This definition of external good is particularly useful for cases in which some firms merged, since the potential sales of the merger year, which in the period under study occurs before 2019, are compared against the year immediately after, in which the company is already operating as merged, in order not to underestimate the potential sales.

Fuel demand estimation. The results obtained from estimating the demands for diesel and gasoline, controlling for quality (using the "premium" variable) in each case, are presented in Table 2. The logit model is estimated using three different methods: OLS without instrumenting for price, instrumental variables method (using an instrument for price, appropriate for each product), and, finally, a random coefficients model instrumented by region (Cuyo, Patagonia, Northeast, Northwest, and Pampeana regions). Panels by region were used primarily because the number of observations at the provincial level, for the period under study, did not allow the identification of all the coefficients by province. Sales were grouped by marketing channel into retail sales to gas stations (including sales through different contractual modalities as consignment sales and purchase and sale contracts), sales to the agricultural sector, wholesale sales (storage and distribution), freight transport, public passenger transport, other types of transport, bunker, and other marketing channels.

The following variables were included in the estimates: price (average without taxes in constant currency, weighted by sales volume), premium (quality indicator), reward card (indicating the existence of a customer loyalty card associated with benefits for purchases), number of wholesale competitors (number of wholesale companies that sell in the province), flagged outlets (percentage of flagged outlets by province and company), urbanization (percentage relationship between the urban population living in cities and the total population for each province), and logarithm of the number of vehicle registrations (with variability by province and year). Control variables by region are also included in the general estimation by OLS and in the IV regression.

Diesel, Table 2. The use of a price instrument increases the absolute value of the coefficient, in this case by three times. The value of the coefficient controlling for product quality also increases substantially. The existence of a loyalty points card is significant for the instrumental variables model with a fixed effect by region but is not statistically significant for the random coefficients model. The number of competitors in the wholesale segment has the expected sign and is significant, reflecting that the greater the number of competitors, the lower the probability of purchasing from a particular flag. The number of flagged gas stations in the retail segment is a relevant variable and increases the probability of purchase in the wholesale segment. This variable, a priori, is a good indicator of the geographic coverage of a flag, since a company that has flagged many stations has an extended network in its territory, while a lower number of flagged stations would indicate the opposite. The urbanization rate is not a significant variable. The change in the vehicle fleet for the time period considered has a null effect on the demand for diesel fuels. The random coefficients model at the general level presents similar results to the fixed effects model (which is the instrumental variables model with control by region). The Hausman test enabled selecting the random effects model over the fixed effects model.

The Appendix shows the estimates for each of the regions derived from using the random effects model, and the variability in the value of the regressors at the regional level can be analyzed. Of particular interest is the value of the price coefficient, which in the case of diesel fuels has a higher absolute value in the

Pampeana region, i.e., a higher price elasticity of demand. The existence of a customer loyalty card increases the probability of sale only in Pampeana region. The increase in the number of wholesale competitors has a more attenuated effect in the Pampeana region compared to the rest of the country. The number of flagged outlets is a relevant variable in the analysis, especially in Northwest and Northeast regions.

Table 2: Results for diesel products

Alternative Models	(1) OLS	(2) IV	(3) RC
Price	−0.03***	−0.12***	−0.11***
Premium	0.30***	0.84***	0.87***
Reward card	0.14***	0.16***	−0.27
Wholesale competitors	−0.35***	−0.40***	−0.53***
Flagged outlets	1.89***	1.85***	2.31***
Urbanization	−0.58*	−1.08***	−1.91
Vehicle fleet (log)	0.05***	0.02	−0.11
Constant	4.11***	8.22***	10.93***
Observations	16218	16218	16218

Notes: Estimates corresponding to equation (12) using different methods of estimation, for the period January 2016 - July 2019, for diesel products. Region controls: Cuyo, Pampeana, Patagonia, NOA and NEA in (1) and (2). * $p < 0.05$, ** $p < 0.01$ and *** $p < 0.001$.

Gasoline, Table 3. As in the case of diesel fuels, the use of an instrument for gasoline prices is highly relevant: the coefficient goes from being null and non-significant to significant and negative, both for the instrumental variables model with fixed effects by region and for the random coefficients model. The value of the coefficient controlling for quality also increases substantially. The existence of a loyalty points card for gasoline, unlike for diesel products, substantially increases the likelihood of purchase for the flags. The number of competitors in the wholesale segment has the expected sign: the greater the number of competitors, the lower the probability of purchasing from a particular flag as with diesel fuels, although in the case of gasoline this phenomenon is of greater magnitude. The number of flagged gas stations in the retail segment is a relevant variable and increases the probability of purchase in the wholesale segment. The level of urbanization would decrease the probability of purchase, by decreasing the relative distances of automobile travel.

As with diesel fuels, the variability in the vehicle fleet in the period is not relevant for the analysis, possibly because the time period is not long enough to show structural changes in the number of vehicles per province. The random coefficients model presents similar results to the instrumental variables model with fixed effects by region. The Hausman test enables us to select the random effects model over the fixed effects model for gasoline.

The Appendix shows the estimates for each of the regions derived from using the random effects model for gasoline. The price coefficient is of particular interest in this analysis, which in the case of gasoline has a higher absolute value in the Cuyo and Northwest regions in relation to the other regions, that is, a higher price elasticity of demand. The existence of a loyalty card with benefits for customers does not seem to have any effect in the Patagonia region, being statistically insignificant in that region. In the case of gasoline fuels, the number of wholesale competitors decreases the probability of purchasing a particular flag and is a significant variable for determining the probability of sale. This effect is lower in absolute value in the Pampeana region. In almost every region of the country, with the exception of Patagonia region, unlike for diesel products, the existence of a loyalty card does have a positive effect on the probability of sale. The number of flagged outlets is not a significant variable for determining the probability of sales for the Cuyo region, but it is relevant for every other region in the country. The urbanization rate is an important variable, with a significant coefficient for the Cuyo, Patagonia, Northwest, and Pampeana regions.

Table 3: Results for gasoline products.

Alternative Models	(1) OLS	(2) IV	(3) RC
Price	-0.00	-0.18^{***}	-0.19^{***}
Premium	-0.15^{***}	0.71^{***}	0.83^{***}
Reward card	0.31^{***}	0.60^{***}	0.91^{**}
Wholesale competitors	-0.39^{***}	-0.64^{***}	-0.90^{***}
Flagged outlets	1.80^{***}	1.46^{***}	1.34^{**}
Urbanization	-1.75^{***}	-3.29^{***}	-5.96^{*}
Vehicle fleet (log)	0.14^{***}	0.09^{***}	-0.04
Constant	2.89^{***}	11.64^{***}	16.71^{**}
Observations	10333	10333	10333

Notes: Estimates corresponding to equation (12) using different methods of estimation, for the period January 2016 - July 2019, for gasoline products. Region controls: Cuyo, Pampeana, Patagonia,NOA and NEA in (1) and (2). * $p < 0.05$, ** $p < 0.01$ and *** $p < 0.001$.

4 Evaluation of Predicted Markups

Using the estimates given by the random coefficients model and the specification given by equation (5), we can recover the markup measure or Lerner index, given by:

$$\frac{p_j - c_j}{p_j} = \frac{s_j/p_j}{|\partial s_j/\partial p_j|}.$$

The results obtained should be considered within the limitations imposed by the models used. In general terms, when analyzing the results for the entire country, under the random coefficients model, a greater market power can be seen in the regular varieties on average in relation to the premium varieties for diesel, which is intuitive, considering that the premium varieties have an immediate, usable substitute of inferior quality and lower cost. When inspecting the magnitude for the three top firms in terms of commercialized volume for diesel (YPF, Shell and Axion), markups are higher for premium varieties in Axion and Shell, while YPF markups are higher for the regular variety. In the case of gasoline, the three top firms in terms of volume commercialized in the period under consideration are the same as for diesel companies, but markups do not differ considerably between regular and premium varieties for each firm.

The YPF flag presents higher markups in relation to the rest of the flags for all the products analyzed, and it is the flag with the highest average market share in the country as a whole. However, among the companies with the highest Lerner Index for common diesel are Oil Combustibles, Axion, and Sociedad Comercial del Plata (SCP); for premium diesel, Axion, Shell, Oil Combustibles; for gasoline, Refinor, SCP, and Axion; and for premium gasoline, SCP, Axion, and Dapsa. It is important to clarify that the values are averages for the period January 2016 - July 2019, which explains why the aforementioned companies may have obtained a higher markup in a time interval within the period analyzed, and a lower markup in another interval of the period. The companies with the lowest markup according to the information analyzed are PDV Sur, Puma, Petrobras, and Pampa Energia.[2] The fact that YPF exhibits higher markups than many of its competitors is possibly related to the fact that this company depends mainly on the crude oil it extracts itself. Axion and Shell by instance, imported on average 6% of the total products processed in their refineries in the period, which increases their cost of production.

When analyzing average profit margins by region, there were substantial differences with respect to

[2] Within the companies included here, which leaves aside those companies whose size of operations is marginal on an individual basis.

Table 4: Average markups by company and product, total country, period January 2016-July 2019.

Product	**Diesel**	**Premium Diesel**	**Regular Gasoline**	**Premium Gasoline**
Axion	5.25	7.05	5.33	5.00
Dapsa	3.61	.	4.08	4.40
Gulf	4.21	4.19	1.99	2.42
Oil Comb.	8.56	5.07	3.77	1.88
Pampa Energia	2.84	2.73	1.67	0.94
PDV Sur	0.10	0.03	0.08	0.02
Petrobras	3.00	1.71	1.75	1.00
Puma	2.82	2.40	1.74	0.78
Refinor	4.03	3.34	8.23	3.68
Shell	3.46	5.64	3.08	3.11
SCP	5.96	5.00	5.92	5.31
YPF	16.18	13.90	8.97	9.07

Notes: Results from the estimations of the RC model. Average prices are taken for the whole country, periods and marketing channels, weighted by sales volume per company. Empty cells indicate that there is not enough data for the estimation.

the strategies used by the companies, both geographically and by product. In general terms, in the case of diesel fuels, lower markups were observed for almost every company and product in the Pampeana region, which has the highest level of competition in the wholesale market, although they are not necessarily the lowest markups for every firm. In the case of gasoline, Northwest and Cuyo regions had lower margins on average than the other regions.

YPF and Oil Combustibles estimated markups were higher than the general average in every region of the country for regular diesel, while Axion had estimated markups that were lower than this average for almost every region with the exception of the Pampeana region. Puma (which is the commercial name of Trafigura S.A.), obtained estimated markups below the general average for every region, while Shell only had estimated markups above average in the Pampeana region.

Oil Combustibles went bankrupt in May 2018. Part of its assets were sold to Gulf, which obtained estimated markups above average in the Pampeana region both for regular and premium diesel.[3] Gulf markups were lower than those of its predecessor, partly because Gulf acquired only part of Oil Combustibles, and because as a new brand it takes time to build loyalty. DAPSA, which acquired the remainder of the assets of Oil Combustibles, obtained above average markups in the Cuyo and Northeast regions for regular diesel. SCP, which acquired DAPSA in December of 2018, obtained above

[3] YPF bought the assets of Oil Combustibles in October of 2018, that consisted on 135 flagged outlets, agrogas stations and a refinery, in partnership with DAPSA. The former then sold its part to Gulf in December of 2018.

average markups in the Cuyo, Northeast, and Pampeana regions, both for regular and premium diesel.[4] SCP markups were higher than markups obtained by DAPSA, as one should expect, because the company increased its overall market share.

Regarding premium diesel, YPF and Axion had markups above general average for every region, while Shell only showed markups above average for the Pampeana region. Oil Combustibles showed markups above average for the Northwest region only. DAPSA did not have significant sales of premium diesel during the period, while SCP obtained markups above average for the Cuyo, Northeast, and Pampeana regions (in the case of SCP, this is a consequence of having previous assets in the oil market apart from those obtained when DAPSA was bought, especially those belonging to Compañia General de Combustibles S.A). Once again, Shell showed markups above average solely for the Pampeana region.

To asses the heterogeneity among markups of different regions we analyze the ratio of highest to lowest markup among regions for the main companies and different products. YPF exhibits a ratio of 2.8 and 3.4 for regular and premium diesel, respectively. For Axion these ratios amount to 1.6 and 2.7, while for Shell, the ratios were 5.4 and 4.0. SCP showed a ratio of 3.8 in the case of regular diesel and 2.9 in the case of premium diesel.

This ratio is relevant because it helps to strengthen the hypothesis that companies take into account geographical characteristics, among others, when determining prices in the market. It is also important to understand that firms not only achieve different profits in each region for each product, but they are also exposed to distinct variability in their income. This variability depends on the product and the strategy followed in a particular market, which will be conditioned by demand.

The gasoline market showed some differences in terms of the major participants' identities and magnitudes of markups by product, as compared to diesel varieties. YPF, Shell, and Axion are still the top three firms in the market in terms of commercialized volume, but in the gasoline market, Refinor appears as an important actor, followed by SCP.

Refinor's estimated markups for regular gasoline were the highest for almost every region of the country with the exception of Cuyo. YPF followed Refinor in terms of markup magnitude. This situation is possibly related to the fact that YPF owns 50% of Refinor, and it can influence price decisions. Both Shell and Axion, the second and third companies in importance in terms of volume, showed markups above

[4] As mentioned before, the database was updated to take these changes into account, especially those regarding market shares and flagged outlets. DAPSA disappears from database when it was sold to SCP to avoid duplicates with the rest of the companies that were acquired by some other company in the period under analysis.

Table 5: Markups by company and region, for common diesel, period January 2016-July 2019.

Region	**Cuyo**	**Patagonia**	**Northeast**	**Northwest**	**Pampeana**
Axion	6.62	5.90	6.81	4.31	4.40
Dapsa	12.79	.	11.72	.	1.90
Gulf	1.37	.	1.43	.	3.94
Oil Comb.	12.86	9.72	14.18	11.48	5.47
Pampa Energia	5.06	8.47	12.16	.	1.53
PDV Sur	.	.	.	.	0.11
Petrobras	3.29	8.49	17.21	.	1.32
Puma	2.11	3.59	0.94	1.45	1.81
Refinor	.	0.62	0.45	4.08	0.82
Shell	1.70	0.89	4.79	3.02	4.32
SCP	13.35	.	14.67	.	3.85
YPF	24.03	19.25	18.84	16.30	8.64
Average	8.32	7.12	9.38	6.77	3.18

Notes: Results from the estimations of the RC model. Average prices are taken for the region, for the period under analysis, weighted by sales volume per company. Empty cells indicate that there is not enough data for the estimation.

average in the Pampeana region (and only Axion in Cuyo). SCP showed higher markups than DAPSA, which is of particular interest, because as mentioned earlier, SCP bought DAPSA in 2018, increasing its market share and its markups. Other companies' markups tend to reflect the existence of market niches, which are understood as strategic positions of firms on specific commercialization channels and provinces.

For premium gasoline, YPF showed the highest markups for every region, with the exception of the Patagonia region. Refinor followed YPF in terms of markups magnitude. Axion and Shell, two companies with a relevant commercialized volume in the market, showed significant differences on markups in relation to YPF; in Cuyo, the Axion markup was less than half the YPF markup, while in Patagonia, the Axion markup was about a third of the YPF markup. Shell presents markups below average for every region but the Pampeana region, where it concentrates its major sales. Once again, the rest of the companies in the market exhibit various estimated markups, depending on the region.

YPF exhibits a difference of 6.3 and 5.5 between the markup obtained in the region with the highest markup, and the region with the lowest markup, for regular and premium gasoline, respectively. Refinor showed ratios of 6.3 for regular gasoline and 12.9 for premium gasoline. Shell obtained a difference between the highest and lowest estimated markups of 12.9 and 9.4 for regular and premium gasoline, respectively. Axion's ratios were 5.2 and 3.8. Once again, these results are important because they show the different outcomes of decisions based on unequal starting points regarding infrastructure and localization strategies, among others.

Table 6: Markups by company and region, for premium diesel, period January 2016-July 2019.

Region	**Cuyo**	**Patagonia**	**Northeast**	**Northwest**	**Pampeana**
Axion	12.15	6.53	9.38	7.89	4.48
Dapsa	.	.	.	.	.
Gulf	3.22	.	5.80	.	3.00
Oil Comb.	4.86	.	6.45	12.31	2.55
Pampa Energia	.	5.75	.	.	0.74
PDV Sur	.	.	0.34	.	0.03
Petrobras	.	3.59	.	.	0.74
Puma	3.66	2.08	0.33	0.61	1.19
Refinor	.	.	.	2.79	.
Shell	8.36	2.09	6.57	3.19	5.68
SCP	10.50	.	9.50	.	3.63
YPF	24.00	18.10	14.68	15.16	7.07
Average	9.54	6.36	6.63	6.99	2.91

Notes: Results from the estimations of the RC model. Average prices are taken for the region, for the period under analysis, weighted by sales volume per company and product. Empty cells indicate that there is not enough data for the estimation.

Estimated markups differ among regions for a specific company, and among companies in the same region. These differences are related not only to the existence of competition but also to the ability of firms to scatter themselves geographically in order to gain higher market shares and set higher prices, when demand conditions allow it. Higher concentration levels could lead to higher markups, as is suggested in the cases of SCP and DAPSA, which have higher markups in more concentrated regions as Cuyo and Northeast.[5]

It is important to highlight the important differences in markups when we compare the different regions and the country as a whole (Tables 5 to 7 vs. Table 4). For example, YPF -the largest firm- has markups ranging from 8.6% to 24% for regular diesel and from 4.4% to 27.4% for regular gasoline for different regions.

Also, firms market power differs by product. For example, in the case of regular gasoline, Refinor shows margins similar to YPF and even higher in four of the five regions, while in the case of premium gasoline, the situation is reversed and YPF shows higher profit margins than the other companies, with the exception of the Patagonia region.

If we look at the average markup values by region and product, it is clear that in the Cuyo, Northeast, and Northwest regions the markups of diesel fuels are higher than the markups of gasoline, while in the

[5]DAPSA was fully acquired by SCP in 2018, as mentioned earlier.

Table 7: Markups by company and region, for gasoline, period January 2016-July 2019.

Region	**Cuyo**	**Patagonia**	**Northeast**	**Northwest**	**Pampeana**
Axion	3.25	11.12	7.53	2.12	9.94
Dapsa	3.58	.	9.88	.	6.06
Gulf	0.39	.	0.28	.	4.92
Oil Comb.	2.67	.	9.28	2.81	4.40
Pampa Energia	.	11.46	.	.	1.88
PDV Sur	.	.	.	.	0.15
Petrobras	.	11.70	.	.	2.05
Puma	0.38	6.02	0.95	0.72	2.37
Refinor	.	29.21	16.15	4.66	19.88
Shell	1.34	0.63	5.14	0.69	8.11
SCP	4.00	.	10.21	.	10.20
YPF	6.46	27.37	10.80	4.35	12.39
Average	2.76	13.93	7.80	2.56	6.86

Notes: Results from the estimations of the RC model. Average prices are taken for the region, for the period under analysis, weighted by sales volume per company. Empty cells indicate that there is not enough data for the estimation.

Patagonia and Pampeana regions, the average markups of gasoline are higher than the average markups of diesel fuels.

5 Conclusions

The demand for the major products traded in the liquid fuels market in Argentina is clearly concentrated, and this concentration increases when local markets are considered. The number of firms operating at regional level is significantly smaller than at national level. This phenomenon is clearly observed as one moves away from the country's capital city.

The demand faced by the wholesale fuel market is conditioned by different factors, among which are unobserved characteristics of the product (such as the contractual form assumed by the operators or owners of gas stations with the brand, the requirements to be able to operate under a certain flag, average duration of the contracts, and specific promotions by segment, among others) and observed characteristics (such as the benefits associated with each brand: loyalty cards, discounts for bank promotions for end consumers, number of flagged gas stations, and geographic location of the points of sale, among others).

The companies take these factors into account when determining the prices of their products and apply specific profit margins by product and region. The exercise of market power, measured by the Lerner

Table 8: Markups by company and region, for premium gasoline, period January 2016-July 2019.

Region	**Cuyo**	**Patagonia**	**Northeast**	**Northwest**	**Pampeana**
Axion	2.57	8.97	6.15	2.38	8.98
Dapsa	3.61	.	7.39	.	7.35
Gulf	0.65	.	.	.	5.07
Oil Comb.	0.90	.	3.65	2.21	1.78
Pampa Energia	.	5.96	.	.	1.05
PDV Sur	.	.	.	.	0.04
Petrobras	.	6.49	.	.	1.19
Puma	0.06	2.59	0.14	0.20	1.07
Refinor	.	29.67	8.44	2.30	10.94
Shell	1.52	1.43	4.81	0.90	8.44
SCP	3.54	.	9.69	.	10.25
YPF	6.46	27.01	10.97	4.95	12.68
Average	2.41	11.73	6.41	2.16	5.74

Notes: Results from the estimations of the RC model. Average prices are taken for the region, for the period under analysis, weighted by sales volume per company and product. Empty cells indicate that there is not enough data for the estimation.

index, by region and flag, is naturally linked to the companies' market share -which exhibits important regional differences- and their demand elasticity. This implies that gas station owners will pay greater prices based on their location, not necessarily because a company must deal with higher cost of provision, but, for example, because they deal with relatively low competition levels.

A byproduct of our empirical analysis is how to measure the outside option for this market. We use a novel way of determining the outside option magnitude based on the difference between potential sales for the market as a whole and actual sales.

Hopefully, this paper will enrich discussions about how prices are determined in the wholesale chain, and how that determination affects both the retail segment and the consumers. The analysis relies on obtaining consistent estimates of demand parameters and correctly specifying cost structures. Further studies should take into account different cost structures among companies, as well as various utility (or profit) functions to characterize gas station demands.

Statements and Declarations

The authors did not receive support from any organization for the submitted work. The authors have no competing interests to declare that are relevant to the content of this article. Data availability (datasets and codes) are available upon request under the form of supplementary material.

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Appendix

A. Database Considerations

The main source of information enabling this study is the wholesale sales database published by the National Energy Secretariat. The database contains information about volume and price for every product, firm, and sale points by month and year. We combine these data with information regarding retail sales. Specifically, the number of outlets per company and period in the country as a whole and at the provincial level were calculated to obtain a measure of geographical presence for each firm. The gas stations of the retail base were grouped in such a way that they properly reflect the change in the companies in charge of supplying fuel, regardless of delays in times of registration. This mainly attends to the acquisition of the assets of the Petrobras banner by Pampa Energia S.A. in July 2016, and its subsequent sale to the company Trafigura S.A. (which currently owns the Puma banner) in December 2017. Likewise, the gas stations of the former Oil Combustibles S.A. were distributed according to the distribution request made by the awarded companies (Destileria Argentina de Petroleo S.A. and YPF S.A., who assigned 124 points of sale of the former Oil to Delta Patagonia S.A.), as determined by the relevant court resolution. Additionally, census information provided by the National Institute of Statistics and Censuses was used to account for differences in levels of urbanization, and vehicle fleet (including cars, buses, and other vehicles) data by province were published by the Association of Vehicle Concessionaires of Argentina (in Spanish, ACARA - Asociación de Concesionarios de autos de la República Argentina).

Specific price indexes were used in order to homogenize values with respect to a common reference period (December 2020), using the Internal Wholesale Price Index published by the National Institute of Statistics and Censuses. In order to carry out this work, the price net (of taxes) is used as the reference price. This means that the price is free of fossil fuel tax, carbon dioxide tax and VAT. Whenever prices after taxes were smaller than prices net of taxes, they were edited using the Manual provided by the National Energy Secretariat to recalculate net price.

Given the reclassification made, the market share of each company in the wholesale chain was estimated. Market share is defined as the portion of a company's total sales volume in a given geographical area, time period, and marketing channel. In this study, the market is defined as the combination "province/month/marketing channel," which implies that the market share of each company will be determined by the number of cubic meters meters of fuel sold per province, month, and marketing channel, for every product. The marketing channel was grouped as follows: Agro, Bunker, gas station retail, gas station wholesale, freight transport, public passenger transport, transport others and other channels. Sales to own gas stations are kept out of gas station retail, since they are not included in the analysis because we understand there is no strategic interaction between different actors in that case, but direct sales from wholesalers to final consumers.

The analysis was carried out for four by-products: common and premium diesel, and common and premium gasoline. The marketing channels were reclassified to group the sales made by each flag. Since the wholesale marketing of liquid fuels is being modeled, sales of liquid fuels by wholesale companies to their own outlets have been excluded from the analysis. This exclusion was done because it is understood that in such cases, there is no negotiation between the parties, it is in fact a direct sale in the retail chain, and there are no competitors.

Data was selected including the period January 2016 –July 2019 as a period of free price setting, considering that on August of 2019 the government issued a decree to freeze fossil fuels prices for ninety days (Decree 566/2019).

B. Results of demand estimates at regional level

The results of the demand estimates for each product and region resulting from applying the random coefficients model specified by Swamy (1970), instrumented using the tools specified in Section 2.2, can be viewed below.

B1. Results of the random coefficients model by region: Diesel.

	Price	Premium	Reward Card	Wholesalen competitors	Flagged outlets	Urbanization	Log vehicle fleet.	Cons.
Cuyo	-0.08***	0.77***	-0.50***	-0.58***	1.88***	-6.62***	-0.31***	16.31***
Patagonia	-0.10***	0.64***	-0.66***	-0.60***	1.46***	-4.95***	0.08	11.53***
Northeast	-0.10***	1.00***	-0.03	-0.59***	2.78***	2.78***	0.01	4.94***
Northwest	-0.12***	0.87***	-0.66***	-0.55***	3.02***	-3.79***	-0.17***	13.37***
Pampeana	-0.16***	1.09***	0.51***	-0.30***	2.42***	2.64***	-0.20***	9.14***

B2. Results of the random coefficients model by region: Gasoline.

	Price	Premium	Reward Card	Wholesalen competitors	Flagged outlets	Urbanization	Log vehicle fleet.	Cons.
Cuyo	-0.31***	1.32***	1.32***	-0.93***	-0.27	-18.31***	-0.67***	39.00***
Patagonia	-0.07***	0.49***	-0.11	-0.75***	1.51***	-5.69***	0.22***	9.08***
Northeast	-0.14***	0.62***	0.62***	-0.78***	1.29***	0.88	0.24***	5.50*
Northwest	-0.36***	1.52***	2.06***	-1.69***	3.01***	-6.26***	-0.13	24.97***
Pampeana	-0.10***	0.28***	0.71***	-0.41***	1.19***	-2.41***	0.09***	8.20***