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MARKET DEFINITION THROUGH DEMAND-AND-SUPPLY ESTIMATIONS, WITH AN APPLICATION TO THE ARGENTINE DISHWASHING DETERGENT INDUSTRY

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Market definition through demand-and-supply estimations, with an application to the Argentine dishwashing detergent industry

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Abstract: This paper develops a method for market definition using demand-and-supply estimations. That method is then applied to the Argentine dishwashing detergent industry, using data from the years 2022-2024. The results are compared to the ones obtained using only demand estimations, and the conclusion is that the use of supply price equations generates a considerable improvement in those results. Through our empirical estimations, we also find that the dishwashing detergent industry in Argentina seems to be divided in two relevant markets: one that includes the two main detergent brands, and another one that encompasses the remaining brands.

Keywords: supply-and-demand estimation, market definition, Argentina, detergent.

JEL classification: C3, L4, L6.

Market definition implies using procedures aimed at inferring if two or more products, that belong to the same industry, are also part of the same market. Those procedures can be of different nature, but in all cases they imply the use of tests about the degree of substitutability of the products under analysis. One of the main avenues to implement market definition is through demand estimation, and that is a procedure that we have used in previous work with different variations (e.g., Coloma, 2011, 2023; Benítez & Coloma, 2022).

In this literature, the word "market" is used in a relatively strict fashion, since the very logic of its procedures is aimed at determining whether products are sufficiently similar and substitutable. If they are, it is assumed that all of them are in the same market and, if they are not, it can be considered that there are different markets. This can be a significant feature in the evaluation of mergers and acquisitions by competition authorities, since in those cases it is generally important to know if a certain merger is "horizontal" (i.e., between firms that compete in the same market) or "conglomerate" (i.e., between firms that operate in separate markets).

There are situations, however, in which demand estimation becomes inadequate to apply the standard market definition methodology. In those cases, it could be useful to supplement demand estimations with supply estimations. Demand-and-supply estimation is a procedure that has a long tradition in the empirical industrial organization literature,[1] in which it is mainly used

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[1] See, for example, Perloff, Karp & Golan (2007), chapter 3.

to test different alternative market behavior (e.g., competition, leadership, collusion). Its use in market definition, conversely, is relatively infrequent, since normally for that type of problems it is enough to estimate demand elasticities (without using supply estimations).

However, when we find cases in which the elasticities obtained through demand estimations are inadequate for one of the steps needed in the market definition procedure, a way to solve the problem can be to supplement those estimations with supply price estimations. That is what we will present in this paper, in which we propose a method that combines demand estimations with supply price estimations, under the assumption that suppliers behave as Bertrand oligopolists (i.e., that there is price competition) in a context of differentiated products.

The proposed methodology will be applied to the case of the dishwashing detergent industry in Argentina, using data from the period 2022-2024. This is an industry in which differentiation is mainly vertical (through some brands that are associated to a higher price and quality, and other brands that are cheaper and are supposed to possess a lower quality). At the beginning of 2024, there was a relatively important merger in that market, and we will also make use of that fact in our estimations.

The structure of this paper is the following. In section 1 we will explain the theory behind market definition and demand-and-supply estimation. Then, in section 2, we will apply that methodology to the figures of the Argentine dishwashing detergent industry, and we will try to define which are the relevant markets in that industry. In section 3 we will compare the results obtained with the ones gotten using demand estimation only. Finally, in section 4, we will present some concluding remarks.

1. Market definition and demand-and-supply estimation

The main link between the methodologies of market definition and demand estimation has to do with the concept of critical elasticity. The idea behind this concept is that, for a set of products to form a single market (instead of being part of larger market), it is necessary that its demand has a relatively low own-price elasticity (i.e., lower than a certain value called "critical elasticity").

Under that view, a set of products whose demand has a relatively high own-price elasticity is interpreted as a case in which that set of products is not a market in itself, since that high elasticity is presumed to exist due to the fact that the buyers of those products have the alternative of buying other goods which are close substitutes to them. It is therefore necessary to include those goods in the definition of the market under analysis, and to recalculate the corresponding price elasticity of demand, in order to check that the own-price elasticity of the new set of products (which includes more goods that the original set) is low enough, so that we can consider that we have a "relevant market". If this does not occur, we have to add new additional products to the definition of the market, and repeat the procedure.

To define which is the value of the critical elasticity, against which we will compare the actual demand elasticity of the different sets of products, there are several alternatives. The most widespread is the one that relies on the so-called "hypothetical monopolist test", under which the critical elasticity is the higher value that a market's own-price demand elasticity should have so that a hypothetical profit-maximizing monopolist, that supplies all the products in that market, finds profitable to undertake a "small but significant and non-transitory increase in prices", assuming that the sale conditions for all the other products remain constant.[2]

One possible formula for critical elasticity (*Ec*) is the following:

$$Ec = -\frac{1+r}{m+r} \quad (1) \ ;$$

where *r* is the small but significant and non-transitory increase in prices (which is typically assumed to be equal to 10%), and *m* is a profit margin, suitable for the industry under analysis.[3]

As we can see, the key parameter to define the value of critical elasticity is the profit margin, and that margin can be calculated in different ways. One possibility is to use accounting information from the firms that operate in the corresponding industry. This implies to take the value of the sales revenue for those firms and to subtract the cost of the products sold, in order to obtain a figure for gross profit. That figure can be divided by the sales revenue in order to obtain an accounting ratio, which can be used as an approximation for the value of *m* in equation 1.

That method, however, has a number of shortcomings. On one hand, it is possible that the firms, which operate in the industry whose markets are being evaluated, are also active in other industries and markets, and this makes accounting information about revenues and costs a pool of figures from multiple industries besides the one that we are analyzing. On the other hand, the logic behind the critical elasticity formula is that the value of *m* must be an approximation of the so-

[2] This idea was originally introduced by the US merger guidelines, and it was later collected by other countries' legislations and by a large part of the literature about this topic. In the present version of those guidelines (DOJ & FTC, 2023), it appears in section 4.3.A.

[3] For an explanation of the logic behind this formula, see Church & Ware (2000), chapter 19.

called "Lerner index" of the industry under analysis, which is no other thing than the margin between price and marginal cost. Notwithstanding, when we use accounting information, there is no easy way to allocate costs in order to approximate the marginal cost of the products of interest, and it is therefore possible that the calculated margin be larger or smaller than the "true" profit margin that we are trying to estimate.

Due to all that, a more adequate alternative to calculate the margin for the critical elasticity formula can be to use estimations for the demand elasticities of the firms that operate in the industry under analysis. This is a criterion that, besides, is consistent with the figures against which we are going to compare that critical elasticity, which are the actual own-price elasticities of the products of that industry. If, for example, we have data to estimate demand functions for a group of products defined according to their characteristics, and also according to the firms that supply them, then the elasticities of those products can be used both for calculating the markets' demand elasticities and the firms' demand elasticities. Using the estimated values for those elasticities, it is possible to obtain the margins at which firms should be operating (e.g., by calculating the inverse of the absolute values for those elasticities), and those margins can be used to compute the value of *m* in the critical elasticity formula (e.g., by defining *m* as the "average industry margin").[4]

The critical elasticity value can be compared with the actual demand elasticities of different sets of products. In order to do that, a relatively practical way is to estimate logarithmic demand functions of the following form:

$$ln(Q_i) = \alpha_i + \beta_{ii} \cdot ln(P_i) + \sum_{j \neq i} \beta_{ij} \cdot ln(P_j) + \beta_{iY} \cdot ln(Y) + \rho \cdot ln(Q_{i(t-1)}) \qquad (2) \;;$$

where Q_i is the quantity of the product whose demand is being estimated, P_i is the price of that product, P_j is the price of another product (e.g., a substitute of product i), Y is the buyers' income, and $Q_{i(t-1)}$ is the quantity of product i bought in the previous period of time. In this context, coefficients β_{ii}, β_{ij}, β_{iY}, and ρ are parameters to be estimated, and can be interpreted as approximations to different elements that have to do with the concept of demand elasticity. Indeed, β_{ii} will be a measure of short-run own-price demand elasticity, while β_{ij} will be a short-run cross elasticity, and β_{iY} will be the corresponding short-run income elasticity. Coefficient ρ, finally, will be a measure of the autocorrelation that may exist between quantities demanded in two consecutive

[4] This implies to assume that firms compete in prices (Bertrand oligopoly). Elasticities can also be used to calculate margins under other assumptions (e.g., Cournot oligopoly, collusion). For an illustration of this, see Coloma (2024).

periods of time.

The inclusion of a lagged quantity (and the corresponding estimation of ρ) has to do with the approximation of long-run elasticities in a context of a short-run estimation. For example, if we divide the values of coefficients β_{ii}, β_{ij} and β_{iY} by "$1-\rho$", it is possible to obtain estimators for long-run demand elasticities. This implies defining those long-run elasticities as the ones that hold in the system's "steady state", which will occur when "$Q_i = Q_{i(t-1)}$".[5]

The described demand functions can also include restrictions that come from the theory of consumer behavior which is behind those functions. One of them is the so-called "zero-degree homogeneity of demand", which prescribes that the sum of all price and income elasticities of a demand function must add up to zero. In our case, this implies that:

$$ln(Q_i) = \alpha_i + \beta_{ii} \cdot ln(P_i/Y) + \sum_{j \neq i} \beta_{ij} \cdot ln(P_j/Y) + \rho \cdot ln(Q_{i(t-1)}) \qquad (3) ;$$

which in turn means that the value of β_{iY} can be defined as equal to "$-\beta_{ii} - \Sigma\beta_{ij}$".[6]

Another set of restrictions that can be incorporated in demand estimation is the one known as "(Slutsky matrix) symmetry restrictions". In order to do that, it is necessary to estimate several demand functions simultaneously, and to include those restrictions in the definitions of the cross elasticities between the products whose demands are estimated. One way to do that is through the concept of elasticity of substitution (σ_{ij}), which can be introduced in demand equations instead of the cross elasticity parameters.[7] This implies writing equations like these:

$$ln(Q_i) = \alpha_i + \beta_{ii} \cdot ln(P_i/Y) + \sigma_{ij} \cdot s_j \cdot ln(P_j/Y) + \sum_{k \neq i \neq j} \sigma_{ik} \cdot s_k \cdot ln(P_k/Y) + \rho \cdot ln(Q_{i(t-1)}) \quad (4) ;$$

$$ln(Q_j) = \alpha_j + \beta_{jj} \cdot ln(P_j/Y) + \sigma_{ij} \cdot s_i \cdot ln(P_i/Y) + \sum_{k \neq i \neq j} \sigma_{jk} \cdot s_k \cdot ln(P_k/Y) + \rho \cdot ln(Q_{j(t-1)}) \quad (5) ;$$

where s_i, s_j and s_k are the revenue shares of products i, j and k. Note that σ_{ij} is a parameter that appears in the two equations (corresponding to the demands of products i and j), and its relationship with the corresponding cross elasticities is the following:

$$\beta_{ij} = \sigma_{ij} \cdot s_j \quad ; \qquad \beta_{ji} = \sigma_{ij} \cdot s_i \qquad (6) .$$

[5] For an explanation of the logic behind this procedure, see Cuddington & Dagher (2015).
[6] For a more detailed explanation of this relationship, see Alston, Chalfant & Piggott (2002).
[7] The inclusion of symmetry restrictions can also be performed differently. For other alternatives applicable to logarithmic demand models, see Yang & Preckel (2024).

The symmetry of the elasticity of substitution has to do with the idea that it depends on the utility that consumers derive from the alternative consumption of two goods. In fact, this concept is related to the ratio between the marginal utilities of those goods, which does not depend on the order in which the utility function is derived with respect to the goods' quantities. The relationship between elasticities of substitution and cross elasticities, in turn, comes from the interaction between the utility function and the consumers' budget constraints, and this implies that each cross elasticity depends on the elasticity of substitution and on the revenue share (or the consumers' expenditure share) of each of the analyzed goods.[8]

The model described for the estimation of demand functions can also be useful to calculate the elasticity of a demand function that comes from aggregating other functions. Let us assume that we want to aggregate the demands of products *i* and *j* into a single demand for product "*i* + *j*". If we know the values of the coefficients estimated under equations 4 and 5, then the short-run own-price elasticity of the demand for "*i* + *j*" (equal to "$\beta_{(i+j)(i+j)}$") will be:

$$\beta_{(i+j)(i+j)} = \left(\beta_{ii} + \sigma_{ij} \cdot s_j\right) \cdot \frac{s_i}{s_i+s_j} + \left(\beta_{jj} + \sigma_{ij} \cdot s_i\right) \cdot \frac{s_j}{s_i+s_j} = \frac{\beta_{ii} \cdot s_i + \beta_{jj} \cdot s_j + 2 \cdot \sigma_{ij} \cdot s_i \cdot s_j}{s_i+s_j} \qquad (7) \;;$$

and it can be calculated using the estimated values for β_{ii}, β_{jj} and σ_{ij}. Of course, this elasticity can also be transformed into a long-run figure (equal to "$\eta_{(i+j)(i+j)}$"), by dividing its value by "*1-ρ*". Then it will hold that:

$$\eta_{(i+j)(i+j)} = \frac{\beta_{(i+j)(i+j)}}{1-\rho} = \frac{\beta_{ii} \cdot s_i + \beta_{jj} \cdot s_j + 2 \cdot \sigma_{ij} \cdot s_i \cdot s_j}{(s_i+s_j) \cdot (1-\rho)} \qquad (8) \;.$$

What we have described can be enough for market definition in many situations. If, for example, we estimate several demand functions at a level of different product brands, and each of those brands belongs to a specific segment of the market (e.g., high, medium, low) and also to a specific firm that supplies the market, then we can calculate elasticities at the level of a segment and at the level of a firm. This also allows us to estimate profit margins for firms, and we can then use those margins to calculate an average industry margin (which can in turn be used to calculate a critical elasticity). That critical elasticity can be compared with the own-price elasticities estimated by segment, and that comparison will tell us if those segments are relevant markets in

[8] For more details about the differences between price elasticities and elasticities of substitution, see Greer (2012), chapter 9.

themselves. If they are not, we can repeat the aggregation procedure for larger product categories (for example, for a category that combines two previously analyzed segments) and see if those categories are relevant markets.

Through the way in which this procedure works, and assuming that the estimated elasticity values have the expected signs (i.e., that β_{ii} y β_{ij} are negative, and σ_{ij} is positive), the more the aggregated products, the smaller the absolute values of the own-price elasticities (i.e., the demands will be progressively more inelastic, until obtaining a number suitable to consider that a certain category of products is a relevant market). Of course, this might occur when all the products in the industry are aggregated. In that case, the relevant market would be only one, and we should not divide it into several separate markets.

The procedure described in the previous paragraphs, however, only works correctly if the estimated long-run elasticities at the level of the firms are relatively high (i.e., if they are larger than one in absolute value). This is an important requirement, because those elasticities must be used to estimate profit margins, and those margins are coherent with the logic of the model if their values are between 0 and 100% (which requires that the own-price firm elasticities are larger than one). If this does not occur, then the calculation procedure of the critical elasticity fails.

A correction of the procedure that can help to solve this problem is to include a series of supply price functions in the system of equations. Those supply price functions can have a form like the following:

$$P_i = \gamma_i + \sum_n \gamma_{ni} \cdot X_n + m_i \cdot \widehat{P_i} \quad (9) \;;$$

where P_i is the price of product i, X_n is a vector of exogenous variables that have influence on the marginal cost of that product, m_i is a margin or Lerner index to be estimated, and γ_i and γ_{ni} are parameters. The symbol "^", in turn, shows that the variable P_i that appears as independent is in fact an "instrumental variable", which comes from having performed a previous regression of P_i against a series of exogenous variables from the demand side of the market.[9]

To estimate the value of m_i, in turn, it is possible to use the values of the demand parameters that are being estimated simultaneously. For example, if product *i* is the only good supplied by a

[9] This way to write supply price functions is compatible with logarithmic demand functions. If, instead, demand functions were linear, the last term of the supply price function would depend on the quantity of product i (Q_i), and this variable would not be multiplied by a proportional margin but by the absolute value of the inverse of the corresponding demand function. For a more complete explanation of this, see Coloma (2024).

certain firm in this industry, then m_i will be the absolute value of the inverse of the long-run own-price elasticity of the corresponding demand function, and can be introduced into equation 9 in the following way:

$$P_i = \gamma_i + \sum_n \gamma_{ni} \cdot X_n - \frac{1-\rho}{\beta_{ii}} \cdot \widehat{P_i} \quad (10) \ .$$

If, conversely, the firm that supplies product i also supplies product j, and both products have demands that are being estimated in the system under analysis, then the value of m_i will come from a more complex formula, which will also include the elasticity of substitution between i and j (σ_{ij}). In that case, equation 10 should be written like this:

$$P_i = \gamma_i + \sum_n \gamma_{ni} \cdot X_n - \frac{1-\rho}{\beta_{ii}+\sigma_{ij} \cdot s_j} \cdot \widehat{P_i} \quad (11) \ .$$

Equations 10 and 11 can also be combined if there is a merger in the industry under analysis. Let us suppose, for example, that, at a certain point in time, product i is acquired by the firm that supplies product j. In that case, the supply price equation for product i would become something like this:

$$P_i = \gamma_i + \sum_n \gamma_{ni} \cdot X_n - \frac{1-\rho}{\beta_{ii}} \cdot \widehat{P_i} \cdot (1-M) - \frac{1-\rho}{\beta_{ii}+\sigma_{ij} \cdot s_j} \cdot \widehat{P_i} \cdot M \quad (12) \ ;$$

where *M* is a dummy variable that takes a value equal to one for the periods of time after the merger between i and j, and a value equal to zero for the periods of time before that merger.

2. An application to the Argentine dishwashing detergent industry

2.1. Description of the data

Dishwashing detergents are cleaning products that are used to wash dishes, glasses, cooking pots, cutlery, and other components of kitchenware. A very important division in this category occurs between products that are used in dishwashing machines (typically powder detergents), and products that are used for hand washing (typically liquid detergents). This last group of goods is the one that will be analyzed in this application of our method of demand-and-supply estimation. The database for the estimation is formed by monthly series about quantities and revenues for the different brands of dishwashing detergent sold in Argentina during the period that goes from January 2022 to December 2024.[10] Dividing the revenue values by their corresponding quantity values, it is possible to obtain average price series, which will also have a monthly frequency.

Table 1. Dishwashing detergents, Argentina (2022-2024)

Concept	2022	2023	2024	Total
Quantities (liters)				
Magistral (Procter/Dreamco)	17,797,173	13,466,804	9,550,183	40,814,159
Cif (Unilever)	12,391,601	15,602,403	17,556,719	45,550,722
Zorro (Dreamco)	2,016,777	2,680,296	1,447,681	6,144,754
Ala (Unilever)	15,410,451	13,528,170	9,835,581	38,774,203
Other brands	12,030,168	13,482,092	13,031,963	38,544,222
Total	59,646,170	58,759,764	51,422,126	169,828,060
Prices (Arg$/liter)				
Magistral (Procter/Dreamco)	609.92	1435.26	4824.24	2289.81
Cif (Unilever)	487.60	1095.39	3637.94	1740.31
Zorro (Dreamco)	318.00	688.78	2747.29	1251.36
Ala (Unilever)	239.02	623.22	2533.19	1131.81
Other brands	182.33	388.93	1672.09	747.79
Total	392.57	883.94	3123.67	1466.73
Revenue shares (%)				
Magistral (Procter/Dreamco)	46.36%	37.21%	28.68%	37.72%
Cif (Unilever)	25.80%	32.90%	39.76%	32.58%
Zorro (Dreamco)	2.74%	3.55%	2.48%	2.96%
Ala (Unilever)	15.73%	16.23%	15.51%	15.79%
Other brands	9.37%	10.10%	13.57%	10.95%

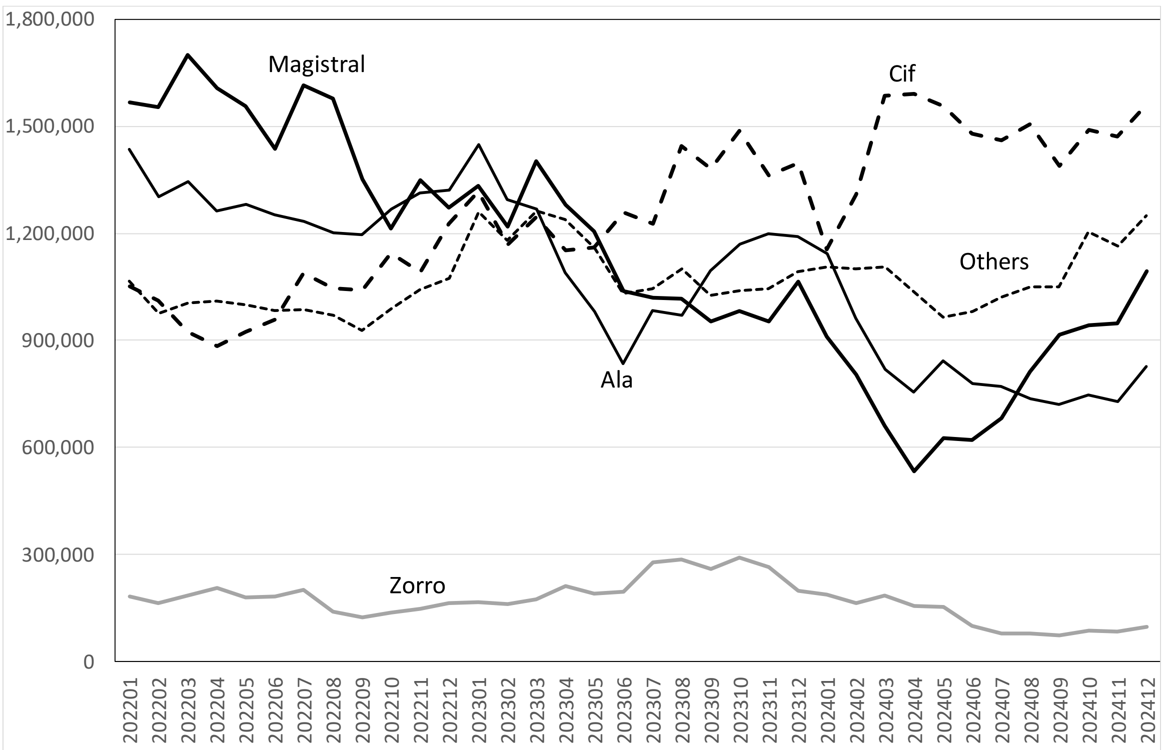
Source: Own calculation, based on data from A. C. Nielsen.

On table 1 we can see the main figures, related to quantities, average prices and revenue market shares. The information is summarized using annual data by brands, separating the four main ones (Magistral, Cif, Zorro and Ala) from a residual group that aggregates all the other detergents. Note that two of the most important brands (Cif and Ala) are supplied by a single firm (Unilever), while the brand Zorro is provided by the firm Dreamco. The brand Magistral, in turn, was supplied by a third company (Procter & Gamble) until the end of 2023, but in 2024 it was acquired by Dreamco. Finally, the remaining brands are supplied by several firms (Bora, Guma, Glow, Domitec, Queruclor, etc.) whose individual revenue shares are all below 2%. Some of those brands belong to retail distributors and supermarket chains.

[10] All the information about this industry comes from data gathered by the consulting firm A. C. Nielsen. Revenue figures correspond to sales to final consumers.

From the quantity figures reported on table 1, we can see that the general trend has been declining, since the total quantity sold in 2024 was 13.8% smaller than the one from 2022. The composition of that quantity, moreover, also changed across time, since, for example, the brand Cif increased its quantity sales by 41.7% (if we compare 2024 with 2022), while the brand Magistral had a decrease of 46.3%. Since May 2024 until the end of the period under analysis, however, the sales of Magistral began to recover steadily, as can be seen in figure 1.

Figure 1. Quantities sold by brand (in liters per month)



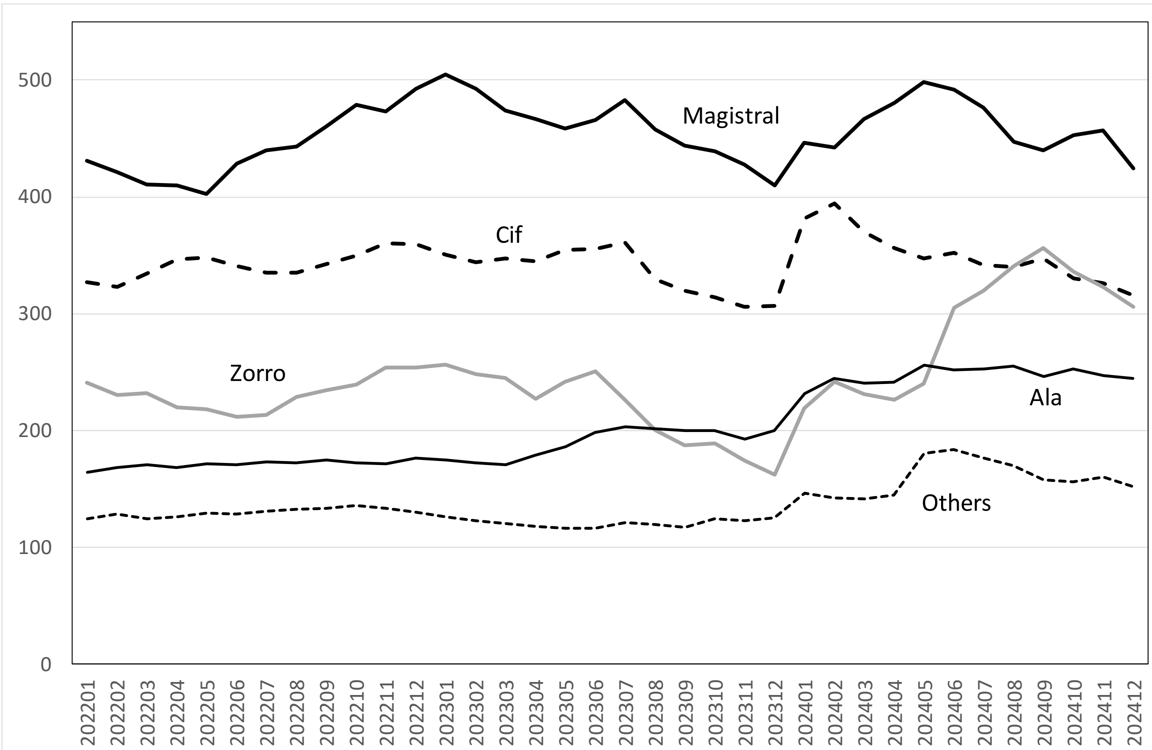
Source: Own calculation, based on data from A. C. Nielsen.

The average prices, conversely, have an increasing trend for all brands during the period 2022-2024. No doubt, this was due to the large inflationary process experienced by the Argentine economy during that period, in which the consumer price index (CPI) accumulated an increase of 1172%.[11] Another fact that can be deduced from the figures of table 1 is that dishwashing detergents have a great price dispersion in Argentina. Indeed, during the period 2022-2024, the most expensive brand (Magistral) had an average price of Arg$ 2289.81 per liter, while the average

[11] This number comes from comparing the CPI figure of December 2024 (7694.01) with the one of January 2022 (605.03), according to data published by the National Institute of Statistics and Censuses of Argentina (INDEC).

price of the detergents included into the category of "Other brands" was Arg$ 747.79 per liter (i.e., 67.3% less).

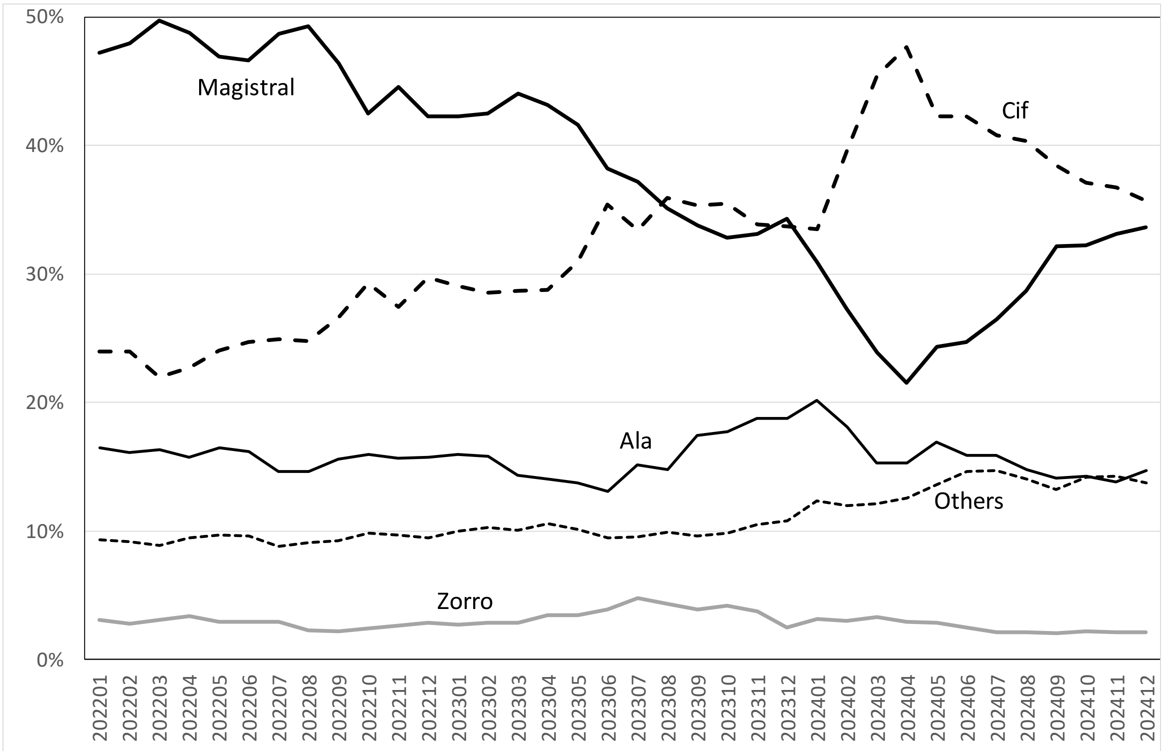
Figure 2. Average prices by brand (in Arg$/liter from January 2022)



Source: Own calculation, based on data from A. C. Nielsen and INDEC.

The phenomenon mentioned in the previous paragraph can also be observed in figure 2, in which we have depicted the monthly evolution of the different average prices by brand. To eliminate the effect of inflation, we have converted all the figures into Argentine pesos of January 2022, using the CPI as a deflator. As we can see, the most expensive brand has always been Magistral, while in the bottom part of the figure we find the line corresponding to "Others". The average price of Cif is always above the average price of Ala, while, in most of the sample, Zorro's prices tend to be somewhere between the prices of those two brands.

Figure 3. Revenue market shares by brand (in percentage)



Source: Own calculation, based on data from A. C. Nielsen.

Figure 3, finally, shows the monthly evolution of revenue market shares by brand. In it we see that the two main brands are clearly Magistral and Cif, which in different months have been the brand with a highest revenue share. Another feature that can be observed in figure 3 (and also on table 1) is that the share of the "other brands" has increased along time, from values below 10% in 2022 to values slightly above 14% by the end of 2024.

2.2. Demand and supply estimations

In this section, we will estimate demand and supply functions for the different dishwashing detergent brands identified in the previous section (Magistral, Cif, Zorro and Ala). We will also include a residual product formed by the other detergent brands (Others). Each product will have a demand function, with a logarithmic form similar to the one used for equations 4 and 5 of section 1. Each brand will also have a supply price function, whose specification is similar to the one used for equations 11 and 12. The only exception will be the supply price function for "Others", for which we will assume the absence of market power (and therefore its supply price will be defined as equal to the corresponding marginal cost). As a consequence of all this, the estimated system of equations will be the following:

$$\log(qmagis) = c(1) + c(2)*trend + c(3)*summer + c(4)*winter + c(5)*\log(pmagis/ynom) + c(6)*\log(pcif/ynom)*scif + c(6)*\log(pzorro/ynom)*szorro + c(6)*\log(pala/ynom)*sala + c(6)*\log(pothers/ynom)*sothers + c(7)*\log(qmagis(-1)) \qquad (13);$$

$$\log(qcif) = c(11) + c(12)*trend + c(3)*summer + c(4)*winter + c(6)*\log(pmagis/ynom)*smagis + c(15)*\log(pcif/ynom) + c(6)*\log(pzorro/ynom)*szorro + c(6)*\log(pala/ynom)*sala + c(6)*\log(pothers/ynom)*sothers + c(7)*\log(qcif(-1)) \qquad (14);$$

$$\log(qzorro) = c(21) + c(22)*trend + c(3)*summer + c(4)*winter + c(6)*\log(pmagis/ynom)*smagis + c(6)*\log(pcif/ynom)*scif + c(25)*\log(pzorro/ynom) + c(6)*\log(pala/ynom)*sala + c(6)*\log(pothers/ynom)*sothers + c(7)*\log(qzorro(-1)) \qquad (15);$$

$$\log(qala) = c(31) + c(32)*trend + c(3)*summer + c(4)*winter + c(6)*\log(pmagis/ynom)*smagis + c(6)*\log(pcif/ynom)*scif + c(6)*\log(pzorro/ynom)*szorro + c(35)*\log(pala/ynom) + c(6)*\log(pothers/ynom)*sothers + c(7)*\log(qala(-1)) \qquad (16);$$

$$\log(qothers) = c(41) + c(42)*trend + c(3)*summer + c(4)*winter + c(6)*\log(pmagis/ynom)*smagis + c(6)*\log(pcif/ynom)*scif + c(6)*\log(pzorro/ynom)*szorro + c(6)*\log(pala/ynom)*sala + c(45)*\log(pothers/ynom) + c(7)*\log(qothers(-1)) \qquad (17);$$

$$pmagis/cpi = c(51) + c(52)*ipjab/cpi + c(53)*ipenerg/cpi - (1-c(7))/c(5)*pmhat/cpi*(1-merger) - (1-c(7))/(c(5)+c(6)*szorro)*pmhat/cpi*merger \qquad (18);$$

$$pcif/cpi = c(61) + c(52)*ipjab/cpi + c(53)*ipenerg/cpi - (1-c(7))/(c(15)+c(6)*sala)*pchat/cpi \qquad (19);$$

$$pzorro/cpi = c(71) + c(52)*ipjab/cpi + c(53)*ipenerg/cpi - (1-c(7))/c(25)*pzhat/cpi*(1-merger) - (1-c(7))/(c(25)+c(6)*smagis)*pzhat/cpi*merger \qquad (20);$$

$$pala/cpi = c(81) + c(52)*ipjab/cpi + c(53)*ipenerg/cpi - (1-c(7))/(c(35)+c(6)*scif)*pahat/cpi \qquad (21);$$

$$pothers/cpi = c(91) + c(62)*ipjab/cpi + c(63)*ipenerg/cpi \qquad (22);$$

where *qmagis, qcif, qzorro, qala* and *qothers* are the monthly quantities for Magistral, Cif, Zorro, Ala and the other brands sold in Argentina (measured in liters); and *pmagis, pcif, pzorro, pala* and *pothers* are the average prices in each month (measured in Argentine pesos per liter). Correspondingly, *smagis, scif, szorro, sala* and *sothers* are the revenue shares of these goods in the total sales of dishwashing detergents, and *qmagis(-1), qcif(-1), qzorro(-1), qala(-1)* and *qothers(-1)* are the quantities with one-month lags.

Additionally, in this system of equations, *cpi* is the consumer price index for Argentina, published by INDEC, while *ynom* is an indicator of nominal income for consumers (measured through the so-called Monthly Estimator of Economic Activity, EMAE, multiplied by the CPI). Other indices used in our estimation are *ipjab*, which is a wholesale price index for soaps and detergents, and *ipenerg*, which is a wholesale price index for electric power.[12]

Other variables included in the system formed by equations 13 to 22 are *trend*, which is a variable whose values range from 1 to 36 (for each of the 36 observations that go from January 2022 to December 2024); *summer*, which is a dummy variable whose value is equal to one for the months of December, January, February and March (which are the Summer months in the Southern Hemisphere); *winter*, which is a dummy variable whose value is equal to one for the months of June, July, August and September; and *merger*, which is a dummy variable whose value is equal to one in 2024 (i.e., after the merger between Magistral and Zorro, due to the acquisition of the first of those brands by Dreamco).

With the results obtained from estimating this system of equations, it is possible to calculate values for the different products' elasticities. Coefficients *c(5), c(15), c(25), c(35)* and *c(45)*, for example, measure the short-run own-price elasticities for the five dishwashing detergent brands, while *c(6)* can be seen as an estimator of the elasticity of substitution between those brands.[13] Multiplying that coefficient by the average revenue shares of the products, we can obtain estimators for the different cross elasticities. Besides, all those figures can be converted into long-run values, if we divide them by one minus the estimated autocorrelation coefficient (i.e., by "*1 – c(7)*").

The last equations of the system, whose dependent variables are real prices (i.e., prices divided by the CPI), try to estimate, on one hand, the marginal costs of the different detergent brands and, on the other hand, the margins between prices and marginal costs. The part that corresponds to marginal cost is the one that has to do with the constant of the equations (*c(51), c(61), c(71), c(81)* and *c(91)*) and with the coefficients for *ipjab/cpi* and *ipenerg/cpi* (*c(52)* and *c(53)*), which here measure the real prices of the main inputs used to manufacture dishwashing detergents.

The margins between prices and marginal costs, in turn, are measured through the coefficients corresponding to the variables *pmhat*, *pchat*, *pzhat* and *pahat*, divided by *cpi*. These

[12] In Argentina, these indices are also elaborated and published by INDEC, and the same occurs with EMAE.
[13] These estimations, as all the ones performed for this article, were made using the software package EViews 12.

are instrumental variables used to replace the average prices of Magistral, Cif, Zorro and Ala, and come from estimations performed in regressions for *pmagis*, *pcif*, *pzorro* and *pala* against *trend*, *summer*, *winter* and *ynom*. Note that, in equations 18 to 21, the formulae for the coefficients that correspond to *pmhat/cpi*, *pchat/cpi*, *pzhat/cpi* and *pahat/cpi* follow the logic implied by equations 11 and 12. That is why they include the elasticity and autocorrelation coefficients from equations 13 to 16, the *merger* dummy variable, and the revenue market shares of the different brands.

On table 2, we can see the main results from the estimation of the whole system formed by equations 13 to 22, using three-stage least squares. That method is useful to control for the endogeneity of prices and market shares that appear on the equations as independent variables. The instruments used have been the variables *trend, summer, winter, merger, log(ynom), ipjab/cpi* and *ipenerg/cpi*, the lagged quantities used in equations 13 to 17, and the instrumental variables built to replace the real average prices in equations 18 to 22.

Table 2. Main results from the demand-and-supply estimation

Concept	**Coefficient**	**t-statistic**	**Probab.**
Own-Price Elasticity Magistral *c(5)*	-0.77442	-11.15463	0.0000
Own-Price Elasticity Cif *c(15)*	-0.99284	-10.94795	0.0000
Own-Price Elasticity Zorro *c(25)*	-1.28966	-11.33600	0.0000
Own-Price Elasticity Ala *c(35)*	-1.05810	-18.60477	0.0000
Own-Price Elasticity Others *c(45)*	-0.53806	-10.04620	0.0000
Elasticity of Substitution *c(6)*	0.48855	16.07923	0.0000
Autocorrelation *c(7)*	0.32267	8.77821	0.0000

As we can observe, all the products seem to have negative short-run own-price elasticities, and all of them are significant at a 1% probability level. Besides, the estimated elasticity of substitution is positive and significant, and the autocorrelation coefficient is significant and has a value between 0 and 1 (it is actually equal to 0.32267). With that coefficient, it is possible to calculate the corresponding long-run elasticities, which are the ones that appear on table 3.

As we can see, most long-run own-price elasticities (highlighted in bold typeface) have absolute values that are larger than one.[14] Income elasticities, conversely, are much lower, and their average value is equal to 0.7840. Note also that cross elasticities are all positive and smaller than one, and the higher ones correspond to the prices of the two main dishwashing detergent

[14] The only exception is the one that corresponds to the "other brands", but that is actually the outcome of aggregating numerous products, whose individual own-price elasticities are probably larger than one.

brands (Magistral and Cif). This is due to the fact that, on table 3, cross elasticities have been calculated using the estimated elasticity of substitution (reported on table 2) and the average revenue shares for the different brands (reported on table 1). Income elasticities, in turn, have been calculated applying the property of zero-degree homogeneity for the different demand functions.

Table 3. Long-run demand elasticities for dishwashing detergents

Concepto	**Pmagis**	**Pcif**	**Pzorro**	**Pala**	**Pothers**	**Income**
Demand Magistral	**-1.1433**	0.2350	0.0213	0.1139	0.0790	0.6941
Demand Cif	0.2721	**-1.4658**	0.0213	0.1139	0.0790	0.9795
Demand Zorro	0.2721	0.2350	**-1.9040**	0.1139	0.0790	1.2041
Demand Ala	0.2721	0.2350	0.0213	**-1.5622**	0.0790	0.9547
Demand Others	0.2721	0.2350	0.0213	0.1139	**-0.7944**	0.1521

2.3. Market definition

The figures reported on table 3 can be used to perform a market definition procedure based on the concept of critical elasticity. To do that, it is necessary to aggregate demands for different products, in order to obtain elasticities by firm and by category of product. For example, aggregating the demands for Magistral and Cif, it is possible to obtain a demand for high-quality detergent, and, aggregating the demands for Zorro and Ala, it is possible to obtain a demand for medium-quality detergent. Such aggregation implies to take into account all the long-run elasticities reported on table 3 (i.e., own-price, cross-price and income elasticities), and it typically leads to smaller elasticities (in absolute value) than the ones of the products that were originally combined. All this can be observed in the figures of table 4.

Table 4. Estimated long-run elasticities by category

Demands by firm	**Pdreamco**	**Punilever**	**Pothers**	**Income**
Dreamco	-1.1591	0.3489	0.0790	0.7312
Unilever	0.2934	-1.3438	0.0790	0.9714
Others	0.2934	0.3489	-0.7944	0.1521
Demands by segment	**Phigh**	**Pmedium**	**Plow**	**Income**
High	-1.0406	0.1352	0.0790	0.8264
Medium	0.5071	-1.5802	0.0790	0.9941
Low	0.5071	0.1352	-0.7944	0.1521
Aggregate demands	**Phigh**	**Pmedlow**		**Income**
High	-1.0406	0.2142		0.8264
Medium/Low	0.5071	-1.1907		0.6836
Total demand		**Ptotal**		**Income**
Total detergents		-0.7840		0.7840

The last rows of table 4 show calculations for the elasticities of demands for products that are even more aggregate. One of them is the category "Medium/Low", that pools the detergents sold under the brands Zorro, Ala and Others. The other one corresponds to the category of "Total detergents" (i.e., to the combination of the five products originally defined in our estimations).

The demands by firm are also the outcome of combining products, which in this case are Magistral and Zorro (for Dreamco),[15] and Cif and Ala (for Unilever). The own-price elasticities obtained through such aggregations (shown on the first rows of table 4) allow us to calculate the estimated profit margins for those firms (which in our case are "m_D = 1/1.1591 = 86.27%" for Dreamco and "m_U = 1/1.3438 = 74.41%" for Unilever). As we also assume that the other brands operate with a null margin, and we know that the average market shares of Dreamco and Unilever are 40.68% and 48.37%, respectively, then we can calculate a weighted average margin for the Argentine dishwashing detergent industry, which is "m = 71.09%".[16]

Plugging this margin into the critical elasticity formula (equation 1) for a price increase "r = 10%", we obtain that "Ec = -1.10/(0.10+0.7109) = -1.3565". This implies that, for a product or group of products to be a relevant market by itself in this industry, the demand of that product or group of products must have a long-run own-price elasticity whose absolute value is below 1.3565.

If we now compare the estimated critical elasticity with the estimated own-price elasticities for high-quality, medium-quality and low-quality detergents, we see that two of those segments (high and low) have elasticities whose absolute values are below 1.3565. The medium-quality segment, conversely, has an estimated long-run elasticity (η_{MM} = -1.5802) whose absolute value is above the critical elasticity threshold. This implies that the medium segment should not be considered a relevant market in itself, and it should be aggregated with another segment (e.g., with the low segment). If we look at the long-run own-price elasticity estimated for the medium/low combined category, we now see that it is equal to -1.1907, which is a number that is below the critical elasticity value.

The abovementioned outcomes, therefore, imply that the Argentine dishwashing detergent industry can be divided in two segments that possess long-run own-price elasticities below the

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[15] Note that we are here considering the situation that occurs in 2024, in which the brands Magistral and Zorro are both owned by Dreamco. As we have already mentioned, that did not occur in 2022 and 2023, when Magistral was owned by the firm Procter & Gamble.
[16] This number comes from doing "m = 0.8627·0.4068 + 0.7441·0.4837 + 0·0.1095 = 0.7109".

estimated critical elasticity, and can be relevant markets by themselves. Those segments are the high quality segment (formed by the detergents sold under the brands Magistral and Cif) and the medium/low quality segment (which encompasses all the other dishwashing detergent brands).

3. Comparison with other alternative estimations

The results obtained in the previous section, using demand-and-supply estimations for the Argentine dishwashing detergent industry, can be compared with the ones gotten under other alternative estimations. One possible comparison can be performed against the results of a demand system formed by equations 13 to 17 (system 1), without including supply price equations. That system should also be run using instrumental variables, in order to control for the endogeneity of the revenue shares for the different brands, but in principle it can be assumed that the prices of those brands (i.e., *pmagis*, *pcif, pzorro, pala* and *pothers*) are exogenous variables.[17]

Another alternative (system 2), similar to the previous one, consists of running the same system of demand functions (equations 13 to 17), but estimating them using the instrumental variables employed for the regressions of section 2.2 (i.e., considering that both prices and revenue shares are endogenous, and must therefore be instrumented through variables such as *log(ynom)*, *ipjab/cpi* and *ipenerg/cpi*).

Finally, a third alternative (system 3) is to estimate a system of demand-and-supply equations which does not impose the restriction that the gross profit margins for Magistral, Cif, Zorro and Ala be related to the corresponding demand elasticities. This implies replacing equations 18 to 21 by these other formulae:

$$pmagis/cpi = c(51) + c(52)*ipjab/cpi + c(53)*ipenerg/cpi + c(54)*(pmhat/cpi)*(1-merger) + c(55)*(pmhat/cpi)*merger \quad (23) ;$$

$$pcif/cpi = c(61) + c(52)*ipjab/cpi + c(53)*ipenerg/cpi + c(64)*pchat/cpi \quad (24) ;$$

$$pzorro/cpi = c(71) + c(52)*ipjab/cpi + c(53)*ipenerg/cpi + c(74)*(pzhat/cpi)*(1-merger) + c(75)*(pzhat/cpi)*merger \quad (25) ;$$

$$pala/cpi = c(81) + c(52)*ipjab/cpi + c(53)*ipenerg/cpi + c(84)*pahat/cpi \quad (26) ;$$

and running a system formed by equations 13, 14, 15, 16, 17, 22, 23, 24, 25 and 26. Note that now

[17] This is because, when estimating a demand system, we can assume that we are focused on the behavior of the consumers of the goods, for whom prices are exogenous variables that they take as given when they decide the quantities to buy.

the profit margins are additional coefficients (*c(54), c(55), c(64), c(74), c(75)* and *c(84)*), which are independently estimated by the regression procedure.

The results of performing all these alternative estimations, using three-stage least squares, are reported on table 5, in which we show the main coefficients of the systems and their corresponding probability values.

Table 5. Main results from the alternative estimations

Concept	System 1		System 2		System 3	
	Coeff.	**Probab.**	**Coeff.**	**Probab.**	**Coeff.**	**Probab.**
Elast. Magistral *c(5)*	-0.55590	0.0000	-0.47737	0.0000	-0.57275	0.0000
Elast. Cif *c(15)*	-0.70084	0.0000	-0.50562	0.0000	-0.75932	0.0000
Elast. Zorro *c(25)*	-1.39404	0.0000	-1.53679	0.0000	-1.38127	0.0000
Elast. Ala *c(35)*	-0.65852	0.0000	-0.59204	0.0000	-0.75688	0.0000
Elast. Others *c(45)*	-0.52882	0.0000	-0.45579	0.0000	-0.55686	0.0000
Elast. of Substitution *c(6)*	0.53131	0.0000	0.50765	0.0000	0.54422	0.0000
Autocorrelation *c(7)*	0.20508	0.0000	0.20644	0.0000	0.19905	0.0000

Based on the figures reported on table 5, it is possible to calculate long-run elasticities (dividing the coefficients by the corresponding values for "*1-c(7)*"). This generates the figures that appear on table 6, in which we have also included a column with the original results from our estimation of section 2.2 (system 0). Table 6 also shows the corresponding elasticities for the different segments that we have identified in the Argentine dishwashing detergent industry (High, Medium and Low), and the profit margins and critical elasticity values that we can calculate using the different estimation outcomes.

As can be observed, the long-run elasticity estimates under the three alternative specifications have absolute values which are, in most cases, below the ones obtained under the original estimation of section 2.2.[18] This is due to the fact that, in general, short-run elasticities are larger in the original system than in the alternative systems, and also to the fact that the autocorrelation coefficient estimated by the original system (*c(7)* = 0.32267) is larger than the coefficients obtained under the alternative estimations.

Note that table 6 shows that, under the estimations of systems 1 and 2, there are average profit margins which are above 100%. This is inconsistent with the definition of margin that we are using, since a figure larger than 100% can only be obtained in a situation in which marginal

[18] The only exception here is the coefficient for the elasticity of Zorro under system 2.

cost is negative.[19] Therefore, the critical elasticity procedure is not possible to be applied in that situation, so we must either use a different criterion to define relevant markets, or else perform another calculation to estimate profit margins (e.g., we could use accounting information from the firms).

Table 6. Long-run figures under different estimations

Concept	System 0	System 1	System 2	System 3
Own-Price Elasticity Magistral	-1.1433	-0.6993	-0.6015	-0.7151
Own-Price Elasticity Cif	-1.4658	-0.8816	-0.6371	-0.9480
Own-Price Elasticity Zorro	-1.9040	-1.7537	-1.9366	-1.7245
Own-Price Elasticity Ala	-1.5622	-0.8284	-0.7461	-0.9450
Own-Price Elasticity Others	-0.7944	-0.6652	-0.5744	-0.6952
Profit Margin Dreamco	86.27%	135.26%	150.71%	-6.74%
Profit Margin Unilever	74.41%	138.48%	186.35%	27.26%
Profit Margin Others	0.00%	0.00%	0.00%	0.00%
Average Profit Margin	71.09%	122.00%	151.44%	10.44%
Critical Elasticity	-1.3565	-0.8333	-0.6814	-5.3812
Own-Price Elasticity High	-1.0406	-0.5501	-0.3944	-0.5855
Own-Price Elasticity Medium	-1.5802	-0.9411	-0.9021	-1.0342
Own-Price Elasticity Low	-0.7944	-0.6652	-0.5744	-0.6952

If we nevertheless apply the critical elasticity formula assuming that “$m > 1$”, we will find figures whose absolute values are below one (for example, under systems 1 and 2, the corresponding values for *Ec* are -0.8333 and -0.6814). If we compare those numbers with the actual long-run elasticities estimated by those systems, we will see that the conclusions obtained in section 2.2 remain the same (that is, the high and low segments have elasticities whose absolute values are below *Ec*, while the medium segment has elasticities whose absolute values are above *Ec*).

A somehow opposite situation occurs if we use the outcomes from system 3. As, in that system, margins are estimated independently from price elasticities, it can occur that they are much smaller than their corresponding inverse elasticity figures. Indeed, in system 3 we end up with an estimation under which Dreamco is operating with a negative margin (m_D = -6.74%) and Unilever is operating with a relatively small positive margin (m_U = 27.26%). This generates an average profit margin of 10.44%, which implies a critical elasticity figure of -5.3812.

[19] Indeed, as the average profit margin *m* is defined as equal to “$(P\text{-}MC)/P$” (where *P* is price and *MC* is marginal cost), then “$m > 1$” implies “$P – MC > P$”, and that is only possible if “MC < P – P = 0”.

This critical elasticity value is way larger than the actual elasticities estimated by system 3 for the three segments in which we divided the Argentine dishwashing detergent industry, and it is also larger than the own-price elasticities for all the brands that we are considering. Under that logic, therefore, each brand (Magistral, Cif, Zorro, Ala) would be a relevant market in itself, and it would not be clear why firms like Unilever and Dreamco would be pricing those brands with relatively small or even negative margins (when they could profitably increase prices far beyond those levels).

4. Concluding remarks

The analysis performed in the previous sections shows that, in certain cases, the use of supply price estimations (to supplement demand system estimations) can be helpful in a market definition procedure based on the hypothetical monopolist test and the critical elasticity criterion. This is particularly so in cases in which, when we only estimate demands, we obtain relatively small own-price elasticities at a level of the products' brands, and this produces a failure in the implementation of the method, when we compare the actual elasticities (from different segments of an industry) with the critical elasticity figure (based on elasticities computed at the level of the supplying firms).

The inclusion of supply price equations has the advantage that it imposes certain restrictions that directly link the estimation of the firms' profit margins with the estimation of elasticities at the level of the brands. This increases the probability that the values of those margins and those elasticities become more compatible among themselves.[20]

An application of this idea appears in the empirical exercise that we have performed with data from the Argentine dishwashing detergent industry during the period 2022-2024. In it we have estimated a system of logarithmic demands, whose parameters are short-run own-price elasticities, short-run elasticities of substitution, and a coefficient of autocorrelation. That system was run with and without additional supply price equations, and the result was that our estimations improved considerably when we used supply prices (and especially when we linked the demand equations with the supply equations, through relationships between elasticities and profit margins).

In that case we ended up with the conclusion that, in the industry under analysis, we could

[20] For other advantages of the use of supply functions in the estimation of demand systems, see Berry & Haile (2021).

identify two relevant markets: one that includes the two main brands (Magistral and Cif), and another one that encompasses all the other dishwashing detergent brands sold in Argentina.

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