PRICES AND COMMERCIAL RELATIONSHIPS IN THE NATIONAL FUEL MARKET

Marta Cristina Marjotta-Maistro[1]
Geraldo Sant'Ana de Camargo Barros[2]

Abstract: In January of 2002 the fuel sector entered definitively the free market. Fuel prices from refineries stopped being regulated and importation of derivatives of oil by private companies was allowed. Ethanol prices had been freed since the end of the 1990's. The aims of this study are: to characterize the functioning of the fuel market identifying the main factors that interfere on decision-taking of its agents; to estimate equations of demand for gasoline C, supply of anhydrous ethanol and gasoline and to figure the elasticities of transmission of prices. Results have shown inelasticity in relation to the income and to the price of the demand for gasoline and inelasticity-price for the supply of anhydrous ethanol and gasoline A. Considering the transmission elasticities, it was concluded that an increase in the demand for gasoline C tends to increase the price of anhydrous ethanol more than proportionally to the price of gasoline C; the price of the anhydrous ethanol will tend to vary more than proportionally to the price of gasoline C in case of shocks of supply of anhydrous ethanol and, in the case of variations in the supply of gasoline A, the prices of the anhydrous ethanol and of gasoline C tend to vary in opposing directions.

Key words: anhydrous ethanol; gasoline; deregulation

1. Introduction

Prices structure of oil derivatives were showing fairly complex due to the way the government led the formation of the price of national

[1] Researcher from Center of Advanced Studies of Applied Economics (CEPEA/ESALQ/USP). E-mail: mcmarjot@esalq.usp.br

[2] Full Professor of the Economics, Management and Psychology Department, ESALQ/USP – Scientific Coordinator of CEPEA/ESALQ/USP. E-mail: gscbarro@esalq.usp.br
Received in June, 2002 and approved in February, 2003

fuels, that is, keeping in some levels of market the prices under regulation and in others, free trade. The prices practiced in the refineries (that are, paid for the deliverers) were regulated (adjusted) under decrees. As for the sales prices practiced by the deliverers and resale prices practiced by gas stations (prices to the final consumer) were set free, including the oil diesel prices (last price to be set free). The hydrated ethanol and the anhydrous ethanol, also used as fuel, had their prices freed during the 1990's.

From January of 2002 the fuel sector started to operate totally under free market, being that prices practiced at refineries stopped being regulated and importation of oil derivatives by private companies was allowed. This way, discussions become relevant in order to identify what might be the possible impacts of these changes on prices and supplying of fuel.

In this new context, of free trade, the following questions arise: how were fuel prices formed and how will they be formed from now on? How do these changes affect the final consumer? What are the main factors that stimulate the fuel demand from the final consumer?

In the first place, it is aimed to characterize the functioning of these markets and to identify the main factors that interfere the decision-taking of their agents. In a second stage, supply and demand equations are etimated which take in account the interrelation between the gasoline and fuel anydrous ethanol markets. The period reached for the analysis ranges from 1995 to 2000, a period marked for intense changes either in the ethanol or in the gasoline commercialization. For Middle-South region of Brazil, monthly data are taken into consideration.

This article is divided into 7 items considering this Introduction. In Item 2 the main characteristics of the national fuel market will be presented. After, in Item 3, a brief Review of Literature is made focusing on the studies that covered subject as the same of this article. The Methodology and the Empirical Model are described in Item 4. Results, main Conclusions and the Bibliographical References used in this paper are presented in Items 5, 6 and 7, respectively.

2. Characterization of the Brazilian Fuel Market

Both the national oil derivatives sector and the ethanol and sugar sector have historically been characterized by the high degree of governmental intervention. Fernandes and Castro (1984) state that the fuel prices control policy aimed, simultaneously, to reach multiples objectives, being them of economic, energetic, social and tributary character. This way, there were complex centered systems of administration. To Fantini et al (1993), prices of oil derivatives in the country would have a double purpose: to remunerate companies (public and private) which operate in the production, distribution and commercialization of the products and to serve as instrument of governmental policies of economic and energetic character.

During the period from 1938 to 1990, the guidelines of prices policy of oil derivatives commercialized in the domestic market were: price control in accordance to the interests of the national economy; assurance of success for the oil refining national industry and the practice, whenever possible, of uniformed prices uniforms all over the country. After 1990, the prices structure of these derivatives was established in order to provide costs coverage of the various economic agents involved in the production, distribution and commercialization of these products (refinery, distribution companies and gas sations). However, over this period some measures of liberalization character were adopted, such as the release of liquid fuels prices at gas stations, fixing only, its maximum values; the release of prices practiced by deliverers and/or retailers for products like lubricant oils; the release of prices practiced by refineries for special or experimental products, which showed minor participation in the domestic market of oil derivatives.

According to Fernandes and Castro (1984), the prices structure for oil derivatives regarded, in the first place, the establishment of average price for products derived from the processing of 1 barrel of oil, aiming to assure coverage for the related costs and the yield for the refinery. The costs determinations were made through 4 groups of expenditures: group I) costs in relation to the oil price in the

international market and other imported consumption materials and to the exchange rate; group II) costs deriving from expenditures with staff; group III) variable costs in accordance with the internal conjuncture of country e; group IV) depreciation, amortization and remuneration of capitals invested in the refining sector.

The general costs structure described in literature has not been modified; however, the formulations for gasoline A prices adjustments at the refinery and the systematic of collecting incident fuel taxes have undergone changes over time. The last correction formula for prices correction took effect in 2001, aiming the market release in 2002.

The price correction at the refinery was done as follows: The operational price was formed by the operational price of the previous month, by the variation of quotations in the oil international market (type Brent and WTI) and by the variation of the exchange rate. This price will compose, along with taxes, the price dictated by the government, the so-called "entrance price". This price was added to the price paid by the deliverers for gasoline A at the refinery.

In the sales price formation for gasoline A there was a parcel called Specific Parcel of Price, that generated resources of responsibility of the National Treasure and was defined as being the price difference of derivatives delivered to the delivery fuel companies and the effective price; this parcel worked as a "shock absorber" once it did not allow that sudden oil price variations in the international market and the exchange rate were immediately repassed to domestic prices.

Once in possession of the gasoline A, the deliverer would compose the price of gasoline C sold to the retailers, considering the percentages of the anydrous ethanol mixture stablished by the government. The percntage of anydrous ethanol added to gasoline to compose gasoline C has been changing along the years. Until 1992 the percentage of anydrous ethanol in gasoline was of 14%. Since then, until 1998, the percentage increased to 22%. In 1998, it increased to 24% and in 2000 to 20%. The expectative of increase in ethanol production in the harvest of 2001/02 led again a change in the percentage of mixture to 22%, from May 2001 and, from January 2002, this percentage was changed again to 24%. It is noticed that the

decisions related to changes in these percentages are made taking into account either the expectative of ethanol production or the availability of the product, in view of the price stability.

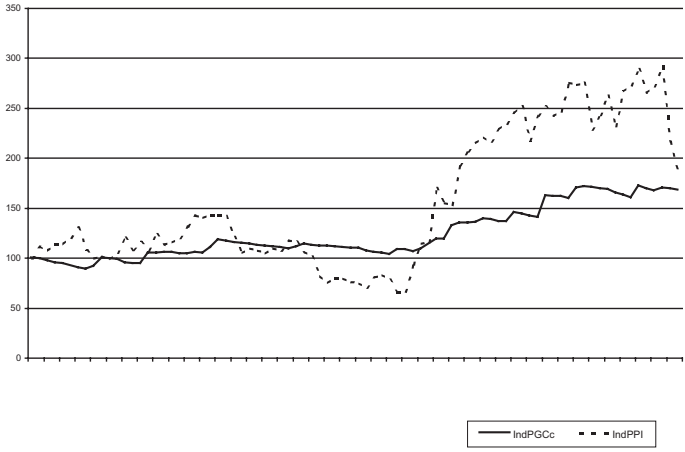
It is noticed, therefore, that, through the mechanism of gasoline price formation at the refinery, the government was responsible for the costs difference between the oil imported by Petrobras to be refine in the country and the prices at which gasoline A and C were sold. Increases in prices of the imported oil barrel were not entirely repassed to gasoline final consumer, and this way, it was aimed to keep the gasoline market stable for the final consumer. Picture 1 shows the evolution of prices indexes of imported oil and gasoline C for retail which allows to visualize this "softening". In periods when the variation in the oil price was fairly significant, like between the months of January and April of 1999 and between the months of May and September of 2000 (with lower intensity), the same behavior in the gasoline C prices was not noticed. It is interesting to observe that the difference between the prices has reduced once the price of gasoline C started to be adjusted more frequently, possibly, as way to, gradually, eliminate the costs absorbed by the government due to differences between the price of imported oil and the price of the gasoline practiced in the domestic market.

Aiming to make opening of the fuel sector feasible, after 2002, new systematics of taxation for oil derivatives and of ethanol fuel were implemented, as much for the commercialization in the domestic market as for imported products.

The Law nº 10.336 of December 19th, 2001 which instituted the Intervention Contribution on Economic Dominion (CIDE), in replace of Specific Parcel of Prices, and incident on the importation and fuels commercialization, also instituted that the sum collected from the new contribution would have to be destined, among other ends, to the payment of subsidies to prices or transport of ethanol fuel, natural gas and oil derivatives; to the financing of evironmental projects related to the oil and the gas industry; and to the financing of transpot infra-structure programs.

With the release of fuel importations and the end of gasoline price control at refineries, the government expected that a reduction

of 25% in the price at refineries would lead to a fall of 20% in the retail price. The reduction was way smaller, however, which calls for inquiry, in the effective conditions, how price reduction at the refinery would interfere on the supplying and prices of gasoline A and anydrous ethanol. It is interesting to observe, also, how the consumer reacts to a fall of fuel prices. What other factors interfere on the consumer decision-taking?



Picture 1 – Imported oil barrel index evolution (IndPPI) and of gasoline C price to the final consumer in São Paulo city (IndPGCc). (January 1995 = 100).
Sources: SECEX, ANP, FIPE

To evaluate the impacts on the ethanol market it is interesting to consider the market structure and the price formation such fuel.

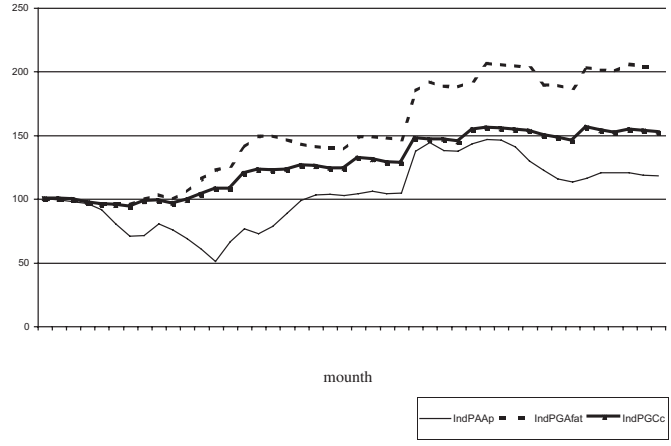
In the period when ethanol fuel prices were fixed, as well as sugar cane and sugar prices, the Sugar and Ethanol Institute used of a methodology that started, basically, from the reports of production costs of these products. From the sugar standard crystal prices it was determined the basic prices of the alcohol aiming establish a value parity between sugar and ethanol in a mill having an attached distillery. The parity was fixed by decrees from the, on that time, Ministery of

Industry and Commerce and of the one of Mines and Energy. From this value, parity values for hydrated and anydrous alcohol were derived, taking account their alcoholic characteristics.

The prices to the final ethanol consumer were formed from the prices paid to producers plus freight, mixture (in case of anydrous ethanol) and taxes costs. Specifically in case of anydrous ethanol, the price to the final consumer was embedded in the gasoline price. This way, there would have a gap between the cost of the anydrous placed in the center of mixture and its invoicing price in this center. This gap was collected to Petrobras (responsible for all the acquisition of anydrous) and used for keeping strategical ethanol stocks.

The prices of anydrous and hydrated ethanol to the producer were freed from May 1997 and February 1999, respectively.

The inter-relation among prices of gasoline A, gasoline C and anydrous ethanol is shown in Picture 2. It is noticed that the prices of these products evolved in a similar way, except 1998, when the newly-freed anydrous market presented unstable.



Picture 2 – Evolution of Anydrous Ethanol prices to the Producer of São Paulo State (IndPAAp), of Gasoline C to the consumer in São Paulo City (IndPGCc) and of the Price of Gasoline A Invoicing at the Refinery (IndPGAfat). (May 1998 = 1000) Sources: CEPEA; ANP; FIPE.

It is noticed a high level of concentration in the commercialization in the ethanol market. In the harvest of 2000/01 of the Middle-South region, the five biggest groups commercialized 63% of hydrated ethanol and 56% of the anydrous ethanol produced. These groups grew stronger from the harvest of 1998/99 in a period when there was excess of ethanol in the market, which brought down prices of the product. However, the concentration in sales of ethanol has already reached higher levels. At the end of the harvest of 1998/99, the Brazilian Ethanol Stock Exchange (BBA), established with the aim to commercialize with exclusiveness and by means of agreements the ethanol produced by 181 operating units in the Middle-South region, was responsible for 85% of the commercialization of the produced ethanol fuel. The Brasil Álcool S.A (B.A) was created in March, 1999 with the purpose to organize ethanol sales to the external market. Both companies, BA and BBA, have been extinguished.

Regarding fuel purchasing, fuel deliverers, associated to the National Union of the Lubricant and Deliverering Fuel Companies (SINDICOM) are the ones that present the major participation in the ethanol fuel commercialization in the domestic market. The SINDICOM is composed by 82 gasoline and ethanol collecting bases spread nationwide, being that 12 are located in São Paulo State (which represents 15% of the total). These bases make use of an infra-structure and of a logistic system that allow the use of road, railroad and waterway transport for collecting and distributing fuel, allowing, thus, commercial advantages towards other companies.

Until the mid 1990's, these companies were the only ones to operate in the country, that is, there were 8 major deliverers commercializing ethanol. However, from 1995 on, when the sector of fuels started to be gradually freed, countless new small and medium deliverers started to spring up, which resulted in a number higher than 200 companies (according to registers at the National Agency of Oil). However, the 5 major deliverers were responsible for the commercialization of approximately 63% of the anydrous ethanol and 53% of the hydrated ethanol of the region and the 30 major deliverers

commercialized almost the totality of the product: more than 90% of the anydrous ethanol and 86% of the hydrataed ethanol, along the year of 1999.

The participation in the ethanol commercialization, mainly of hydrated, of major deliverers has been reducing along the years. According to the Sindicom (2001), 40% of hydrated was negotiated by the associated companies, in 2000. Until the end of the year 2001, this percentage would tend to reduce to 10%. This behavior would be related to the lack of organization and fiscalization, on the part of the government, the systematics that has been adopted for collecting of incident taxes on the fuel ethanol.

The gas stations are distributed all over the country, totaling around 29,000 establishments.

Since 1999, the government has also participated in the commercialization through auctions (purchase and sale) that carried out by Petrobras, as much in the Middle-South region, as in the North-Northeast. The total volume of fuel ethanol sold by the government between December, 1999 and February, 2001 was of about 660 thousand cubical meters.

3. Empirical Evidences in the Fuel Market

In national and international literature it is possible to find several studies that address questions concerning the fuel market. Among them it can be cited Assis & Lopes (1980) and Dahl & Sterner (1991). These studies, in a general way, aimed to identify which are the indicators of oil derivatives consumption. The main discussions are based on estimates of price and income elasticity from the demand for fuels, as much in the short terms as in long terms.

Assis and Lopes (1980) aimed to evaluate the behavior of gasoline and diesel oil consumption between 1970 and 1977 and to obtain estimates of income and price elasticity for short and long terms, for Brazil. The estimates were obtained by using annual data and by using the econometrical technique called "*pooled regressions*". The results obtained indicated as much low price elasticities of the demand

for gasoline and diesel oil (-0,2 and 0, respectively), as low sensitivity to variations in the income for gasoline consumption (0,9). For diesel oil , the consumption revealed sensible to the variation in the income, with exception for the region North. In face of these results, the authors concluded that there was a need for the elaboration of more efficient policies of consumption containment for gasoline and diesel oil other than prices policies.

Dahl and Sterner (1991) searched approximately a hundred papers on gasoline demand and noticed that there distinct studies that seem to have presented contradictory results. However, these results, in fact, were generated from the use of different model forms and different sets of data. The authors classified the studies in different categories distinguishing among the models that used (or not) the variable vehicle stock as explicative and among static and dynamic models. In these models there were combinations between vehicles stocks and gaps. Following these criteria it was possible to identify nine categories, or types of models, for the function of demand for gasoline.

According to the authors, after this stratification, despite the different types of models, there is a certain degree of consistency among the results. To carry out comparisons, the authors focused on the estimates for price and income elasticities for short and long terms.

The types of data used were time series (ST) or cross section (CS), being that, for the time series, some periodic cycles were observed, that is, monthly, quarterly and yearly data. For the figures of the models, different techniques were used, having been identified that the estimates for unique equations was the most common verified. Chart 1 shows the nomenclature and the average results for price and income elasticities for gasoline demand (short term - CP and long term - LP) analyzed by the authors, as well as the category to which the model belongs to, the types of data and their periodic cycles. Despite the different magnitudes in the values of the price and income elasticities from the demand, in most cases, the demand is inelasty as much in the short term as in the long one.

Chart 1: Summary of the average elasticities – price and income – for the demand by categories

Models Types	Datas	Price Elasticity		Income Elasticity	
		CP	LP	CP	LP
STAT (Static Model)	ST	-0,53	-0,53	1,16	1,16
STAT	ST	-0,29	-0,29	0,52	0,52
LE (Lagged Endogenous)	CSST/ST	-0,24	-0,80	0,45	1,31
LE1q	CSST/ST	-0,13	-0,28	0,44	1,02
LE4q	ST	-0,14	-0,59	0,20	0,75
LE1m	ST	-0,20	-0,23	0,58	0,85
LE12m	ST	-0,19	-0,88	0,22	0,64
VEH (Simple Vehicle Model)	CSST/ST	-0,31	-0,31	0,52	0,52
VEH	ST	-0,42	-0,42	0,18	0,18
VCHAR (Vehicle Characterists Model)	CSST/ST	-0,16	-0,16	0,29	0,29
VCHAR	CSST/ST	-0,32	-0,32	0,17	0,17
VCHAR	PAINEL	-0,52	-0,52	0,41	0,41
VCHAR	ST	-1,01	-1,01	0,76	0,76
V-LE (Vehicle/Lagged Endogenous)	CSST/ST	-0,12	-0,29	0,38	0,60
VU-LE (Vehicle Use Lagged Endogenous)	CSST	-0,17	-1,05	0,14	0,87
V-OL (Vehicle/Other Lag)	CSST/ST	-0,08	-0,97	0,57	0,57
LE-OL (Lagged Endogenous/Other Lagged)	ST	-0,22	-0,94	0,39	1,09
VU-LE	ST	-0,41	-0,77	0,42	1,11

Source: Adapted of Dahl & Sterner (1991), page: 206
(1) The subscripts *q* and *m* indicate the periodic cycles of data series used in the models, symbolizing quarterly or monthly data, respectively.

4. Methodology

The theoretical model of this study is based on Gardner (1975), that presumes perfect competition and instant balance as much in the input market as in the final product one. For the analysis of the anydrous ethanol market, it is considered an adaptation of this model and the analyses of Barros (1987). Thus, the final product *x* is gasoline C, the

anydrous ethanol is the raw material, and gasoline A is the input of commercialization *b*.

Although it is known that the ethanol market is not competitive in itself, in a preliminary approach of the analysis this presupposition is made. The following functions represent the model:

$$x = f(a, b) \quad (1)$$

$$x = D(P_x, N) \quad (2)$$

$$P_b = P_x f_b \quad (3)$$

$$P_a = P_x f_a \quad (4)$$

$$P_b = g(b, T) \quad (5)$$

$$P_a = h(a, W) \quad (6)$$

Where: (1) represents the production function of the final product (of gasoline C), which is estimated to possess constant returns to the scale; (2) represents the demand function of the final product (of gasoline C in the retail market), being P_x retail price and N one exogenous variable (income, for example); (3) and (4) represent price equalities of the inputs (of gasoline A and anydrous ethanol) to their values of the marginal product, necessary condition for profit maximization of enterprises; (5) and (6) represent the anydrous ethanol and gasoline A supplies, respectively. T and W represent exogenous variables (for example, T = taxes; W = weather).

To simplify, the other producer's costs are ignored, such as, labor, capital, etc. To make the graphical analysis of the market possible, the substitution elasticity between the gasoline and the anydrous ethanol is considered equal zero, that is, the final product is produced in fixed proportions of both inputs.

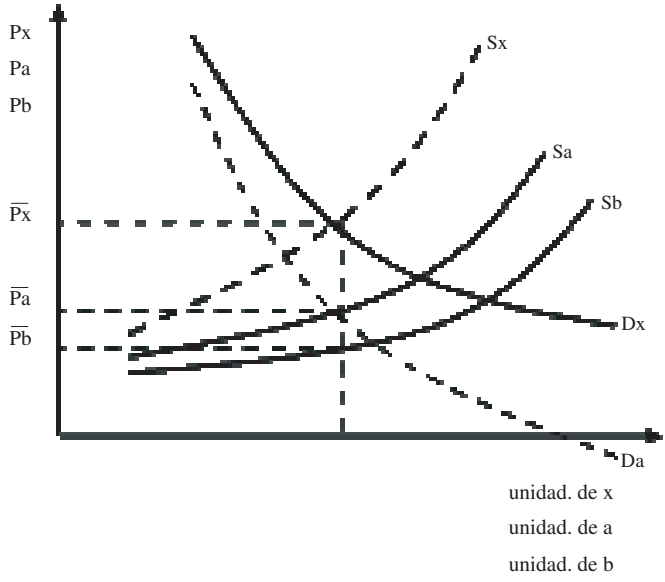
The curves of gasoline C supply (Sx), of the demands derived from anydrous ethanol (D_x) and from gasoline A (D_b) can be obtained graphically, as shown in Barros (1987). It is assumed that each unit of gasoline C can be produced using 0,2 unit of anydrous and 0,8 unit of gasoline A, that is, anydrous ethanol and gasoline A are used in ratio 1

to 4. Picture 3 shows the curves related to the demand for gasoline C (D_x), demand for anydrous ethanol (D_a) and the curves of anydrous ethanol supply (S_a) and gasoline A supply (S_b) and gasoline C (S_x), separately.

The scales in the horizontal axis of the graph represented in Figure 3 must be established in a way that the same corresponding interval the 0,2 unit of anydrous corresponds to the 0,8 unit of gasoline A and the vertical axis must indicate the price of 0,2 unit of anydrous and of 0,8 unit of gasoline A. In competition and given the fixed ratio between the inputs, the price of offer for gasoline C, for any amount produced , will be equal to the sum of the corresponding price of 0,2 unit of anydrous plus the price of 0,8 unit of gasoline A. This way, the curve of gasoline C supply (S_x) will be the vertical adding of the two curves of inputs supply. The intersection of D_x and S_x will give the price and the amount of balance of x and simultaneously it is obtained the prices of offers of 0,2a and 0,8b .

The demand derived for one of the inputs (anydrous ethanol, for example) is obtained subtracting vertically from the demand for the final product, the supply of the other input (in this case, of gasoline A). Thus, to get the demand derived from anydrous ethanol (D_a), it must be taken the vertical distance between Dx and Sb, as the demand price corresponding to each amount of anydrous ethanol, as it is represented in Picture 3. The intersection between S_x and D_x determines the price and the amount of balance of gasoline C. Vertically, below this point there is the balance for the raw material market.

Barros (1987) points out that the presupposition of the presence of competition in the Gardner model and the limitation caused by this presupposition must be examined. In the case of ethanol, there is reasonably concentrated market, however, the Gardner model has revealed robust enough to forecast adequately changes in prices and amounts even in non-competitive markets. The analysis could, evidently, at the cost of higher complexity, be extended formally to non-competitive situations.



Picture 3 – Graphical analysis of the model proposed to the fuel market
Source: Adapted from Barros (1987)

In the light of this model it is also possible to evaluate what occurs to the relative prices of anydrous ethanol, of gasoline A and of gasoline C, when it variations occur in the demand for gasoline C or in the supply of anydrous or gasoline A.

Consider an increase in the demand for gasoline C in reply to a variation in the income. Graphically a displacement of D_x and of D_a to the right will occur, keeping the vertical distance between them, once that S_b remained unaltered.

In these conditions the prices of gasoline C and the anydrous will increase. To evaluate which price will increase more than proportionally than the other it must be considered the supply elasticities of the anydrous ethanol (e_a) and of gasoline A (e_b). If, for example, ea is smaller than eb, the relation between gasoline C and anhydrous price will reduce, given that the increase in the price of the

anydrous ethanol will be more than proportional to the increase in the price of gasoline C. However, if the price elasticities of supply are equal the relation between the prices will remain unchanged.

The prices transmission elasticities were also established by Gardner. In this context, it is understood like transmission elasticity the relative variation of the price to the anydrous ethanol producer with the relative variation in the price of gasoline C to retail.

This elasticity will present different values whenever occurs a variation in the demand for gasoline C or in supply of anydrous ethanol, or even, in the supply of gasoline A. The derivation of formulas for the figure of the elasticities can be found in Gardner (1975).

The formula of elasticity for variations in the gasoline demand C is given by (7):

$$E_{PxPa} = \frac{(\sigma + k_a e_b + k_b e_a)}{\sigma + e_b} \qquad (7)$$

where: e_a represents the price elasticity of anydrous ethanol supply; e_b represents the price elasticity of gasoline A supply; $k_a = \frac{aP_a}{xP_x}$ represents the parcel of the sugar and ethanol sector in consumer's expenditures; represents the parcel of supply of $k_b = \frac{bP_b}{xP_x}$ gasoline A in consumer's expenditures; represents the elasticity of substitution between and *a* the *b*.

The formula of elasticity for variations in supply of anydrous ethanol is given by (8):

$$E_{PxPa} = \frac{[k_a(\sigma + e_b)]}{[e_b + k_a\sigma - k_b\eta]} \qquad (8)$$

Where: h represents the e price lasticity of the demand for gasoline C.

The formula of elasticity for variations in supply of gasoline A is given by (9):

$$E_{PxPa} = \frac{(\sigma + e_a)}{(\sigma + \eta)} \qquad (9)$$

In the situation that occurs reduction of anhydrous supply, E_{PxPa} will be less than the unit in case the price elasticity of anhydrous supply be bigger than the price elasticity of demand of gasoline of retail.

Normally ea is smaller than eb, then EPxPa will be smaller than the unit for situations of variation in the demand of gasoline C. For situations in which a reduction in offer of the anydrous ethanol occurs, EPxPa will be also smaller than the unit, in case the price elasticity of anydrous supply be higher than the price elasticity of the gasoline demand to retail.

In this study three distinct periods were considered for the calculation of price transmission elasticities from the estimated parameters in the econometrical model. Period 1 ranges from January, 1995 to May, 1998, when the percentage of anydrous in the gasoline was of 22%. Period 2 ranges from June, 1998 to August, 2000 and the percentage changed to 24% and, finally, period 3 ranges from September to December, 2000 with percentage of 20% of mixture.

4.1 Empirical model

The proposed model is represented by three functions: the one of demand for gasoline C to retail and two functions of supplies, one representing the supply of anydrous ethnol and the other the supply of gasoline A, as follows below:

$$Dx_t = \theta_0 + \theta_1 Px_t + \theta_2 RM_t + \theta_3 TD_t + \theta_4 POD_t + \theta_5 FR_t + \varepsilon_t \qquad (10)$$

$$Sa_t = \alpha_0 + \alpha_1 Pa_t + \alpha_2 PAC_t + \alpha_3 PAH_t + \alpha_4 PC_t + \mu_t \qquad (11)$$

$$Sb_t = \gamma_0 + \gamma_1 Pb_t + \gamma_2 TC_t + \gamma_3 PPI_t + \xi_t \qquad (12)$$

Where: D_x represents the amount of gasoline C demanded; P_x the gasoline C price to retail; RM the average income; TD the unemployment rate; POD the diesel oil price to the consumer (retail); FR the fleet of vehicles that run on gasoline; S_a the amount of anydrous ethanol offered by the producer; P_a the anydrous ethanol price to the producer; PAC the sugar price in the domestic market; PAH the hydrated ethanol price to the producer; PC the ton of sugar cane price; S_b the offered amount of the gasoline A in the refinery; PPI the imported oil price; TC the exchange rate (R$/USS); P_b the invoicing of the gasoline A price in the refinery.

As salient previously, for the theoretical analysis of the fuel market (anydrous and gasoline) it was used an adaptation of the model of Gardner (1975) and of the analyses of Barros (1987). Of this form, was possible to construct to one theoretician model that allowed to evaluate the consequences of the competitive balance in the anydrous ethanol market and gasoline C. The empirical model was constituted of three equations represented by (10), (11) e (12). One notices that in the Figure 3 the full lines represent the mannering functions of the model and the dotted lines the derived functions.

The equation (10) represents the function of demand for gasoline C to the retail; (11) it represents the function of supply of the anydrous ethanol of the producer; (12) it represents the function of supply of the gasoline A in the refinery. The equations (11) and (12) jointly give to origin the function of supply of gasoline C for the fuel deliverers, and the equations (10) and (12) give to origin the function of demand for the anydrous ethanol.

One expects that the variables income, oil diesel price to the consumer and fleet of vehicles present direct relations with the gasoline demand. The variables gasoline C price to the consumer in the retail and tax of unemployment must become related inversely with the gasoline demand C in the retail. Supply of anydrous ethanol expects that the relative impacts to the variable sugar price in the domestic market, hydrated ethanol price to the producer and sugar cane price are negative, while the referring impact to the anydrous ethanol price must be positive. Considering the supply of gasoline A, one expects

that the imported oil price and the exchange rate present inverse relations with supply of gasoline A, while the gasoline A price in the refinery positively is related its supply.

The equations of demand of gasoline C to the retail, supply of gasoline A in the refinery and supply of anydrous ethanol to the producer were esteem jointly by method SUR - Seemingly Unrelated Regression, admitting that the errors of the equations can be related. The test of Lagrange was calculated to verify the existence of contemporary correlation between the equations. All the variables were considered in the logarithmic form. The description of the series of data used in this study is in Appendix 1.

5. Results and Discussion

The results gotten for the estimates of the equations (10), (11) and (12) are presented to follow. The values of statistics t are in parentheses below of the coefficients (elasticities) esteem.

The coefficients steem for the demand of gasoline C were:

$$\hat{D}x_t = -3{,}110 - 0{,}155Px_t + 0{,}431RM_t - 0{,}002TD_t + 0{,}072POD_t + 0{,}867FR_t \qquad (14)$$

(-1,810)** (-1,838)** (4,496)* (-0,075) (0,573) (7,790)*[1]
$R^2 = 77{,}61\%$ $d_w = 2{,}35$

The results for the estimate of the equation of supply of anydrous ethanol were:

$$\hat{S}a_t = 14{,}048 + 0{,}084Pa_t - 0{,}312PAC_t - 0{,}042PAH_t - 0{,}126PC_t \qquad (15)$$

(27,516)* (0,48) (-3,021)* (-0,294) (-1,453)
$R^2 = 42{,}03\%$ $d_w = 0{,}84$

[1] * Level significance equal to 1%
** Level significance equal to 10%

The results for the estimate of the equation of supply of gasoline A were:

$$Sb_t = 9{,}301 + 0{,}098Pb_t - 0{,}022TC_t - 0{,}046PPI_t + 0{,}350Sb_{t-1} \quad (16)$$

(9,639)* (1,782)** (-0,339) (-1,623)** (5,27)*

$R^2 = 40{,}76\%$ $d_h = 1{,}08$

The result of the test of Lagrange to verify the correlation existence among the errors of the equations was 147,88. For 6 degrees of freedom and level of significance of 1%, the critical value of the distribution of c^2 is 16,81. Therefore, the null hypothesis is rejected and is considered that exists contemporary correlation among the errors of the equations of the model, justifying the use of method SUR. Beside, this method revealed adequate to the considered study, that is, to relate variable that apparently would not have no correlation. As in the case of the market of fuel it was necessary to relate variables that they would be explaining the behavior of supplies and of the demand in different sectors (sugar and ethanol sector for the ethanol and of derivatives of oil for the gasoline), method SUR was indicated.

An examination of the results presented in the equations (15), (16) and (17) showed that, in general, the coefficients of the exogenous variables presented signals in accordance with the waited one. Of this form, it is analyzed that the esteem model apparently caught in correct way the existing relations in the fuel market, in a period marked for the transistion of the sectors in direction to the free market.

Another exception that must be made with relation to the results says respect to the possible consequences that the presence of autocorrelation residues can have on the esteem coefficients. In accordance with Kmenta (1978), this problem does not eliminate the properties of not-tendenciosity and consistency of the estimators, losing, however, the efficiency characteristics. Soon, the statistical tests must be evaluated with certain caution.

One expects that on the evolution of the liberalization of the market of derivatives of oil, be possible the constitution of a database free of the direct influence of government (price controls) e, therefore, to the step that these data start to reflect more the performance of the forces of free

market, the joined econometrical problems can be contouring.

For the gasoline demand C, all the esteem coefficients presented the waited signals. The result gotten for the income elasticity of the gasoline demand is in accordance with the studies found in literature, which the demand revealed to inelasty front the variations in the income of the consumers. The relation with the oil diesel was little expressive, what it can be justified by the fact of that the oil diesel is more used for the load transport, while the gasoline in light vehicles, then these fuels are not raised degree of substitution between itself.

In the equation esteem for supply of anydrous ethanol the signals of the coefficients were also gotten in agreement the waited one. The price inelasticity of supply of anydrous ethanol can be related to the fact of that the ethanol producer, for a long period, was not intent to the signals of market to modify its offers, therefore the government guarantee the purchase of all the production to a price previously established. Therefore, it was waited that the producers did not answer immediately to the stimulatons of price. One also notices that the values of the relative coefficients to the hydrated ethanol price to the producer and of the sugar are relatively small, what it indicates low sensitivity of the producer in modifying the mix of production. Considering the period of analysis (after 1995) as transitory for the adaptation to the market forces that in general influence the ethanol and fuel market in specific, such results can be understood.

The results of the estimates for the function of supply of gasoline A must be analyzed with some caution therefore, this market were total controlled for the government. With these estimates, therefore, it was looked to apprehend which was the systematics of adjustment of the prices. Thus, they reflect the strategy of the government for the product. The relations among the variable are in agreement with waited, or either, direct relationships betweeen the gasoline A price and inverse relations between the imported oil price and the exchange rate (R$/USS). These two last variables were considered as cost, then, positive variations in its magnitudes tend to impact negative on supply of gasoline A. Must also be standed out, that, until January of 1999, the exchange rate was practically remained steady.

The Brazilian government has adopted a systematics of control of the variations of the exchange rate (and also the international oil pricesl) on the prices of fuels internally. This systematic one was kept for the price control of invoicing of the gasoline A in the refinery and for the differential with the paid price of accomplishment Petrobra's to cover the costs with the importations of oil. In this direction, again, a curve of gasoline A supply is inelasty in relation to the price of the gasoline A and little influenced by variations in the price of the imported oil.

The values considered for the calculation of the price elasticities and the results for the three periods are presented in Charts 2 and 3, respectively. The results of Chart 3 were gotten from formulas (7), (8) e (9).

It is interesting to detach that the evolution of the relative price between anydrous ethanol and gasoline C has influenced the percentage of adopted mixture. A reduction in the relative price led to the increase of 22% for 24% in the mixture. Or either, when the anhydrous price diminished, a bigger amount of this product passed to be added to the gasoline, with intention to possibly reduce the fuel price to the final consumer. On the other hand, with the increase of the anydrous price from harvest 2000/01, the percentage of mixture was scrumbled for 20%. Another relevant point is that the changes in the mixture have been used as form to balance supply and ethanol demand in periods of bigger availability of the product in the domestic market.

Chart 2. Values considered in the calculations of the elasticities of transmission of prices

Periods	*Relative Prices* $(P_a/P_x)^1$	K_a^2	K_b^2
1. From January/95 to May/98	0,5964	0,1312	0,3658
2. From June/98 to August/00	0,3714	0,0891	0,4003
3. From September/00 to December/00	0,4439	0,0888	0,4878

1. average values for the respective periods.

2. average values for the respective periods, considering the percentage of effective mixture

Chart 3. Elasticities of transmission of prices (E_{PxPa}) considering different shocks for the three periods.

Periods/ Variations	*Variatios in* D_x	*Variations in* S_a	*Variations in* S_b
Period 1	0,4447	0,0831	-0,5419
Period 2	0,4322	0,0546	-0,5419
Period 3	0,5069	0,0501	-0,5419

Source: Data from search

These results show that given an addition in the gasoline demand C then for each percentile point of increase in the anydrous price it would correspond an increase in the price of 0,4447% gasoline C having considered period 1; of 0,4322% in period 2 and 0.5069% in period 3. These results already were waited given that e_a was minor that e_b.

It assumes a reduction in supply of anydrous ethanol, then for each percentile point of increase in the anhydrous price, the gasoline C price will increase in 0,0831% considering period 1; 0,0546% in period 2 and 0.0501% in period 3.

Finally, it assumes a reduction in supply of gasoline A, such that its price raises and impact on the anydrous and of the gasoline C prices. For each percentile point of fall in the anhydrous price, the gasoline C price will increase of 0,54%. The cost of acquisition of the gasoline A would be repassed for the final consumer while the purchases of anydrous would be scrumbled, diminishing its price. This result was found for the three periods.

It is interesting to stand out that the relation among the expected values of the price elasticities of supply of anydrous and of the gasoline A and the price elasticity of the demand for gasoline C of the retail was observed. That is, the result for the price elasticity of supply of anydrous ethanol was minor that the value of the price elasticity of supply of

gasoline A the and, this, in turn, it was greater that the value gotten for the price elasticity of the demand for gasoline C of the retail. These results took the values of elasticity of transmission lesser

that the unit, either for situations of variations in the gasoline demand C or supply of anydrous ethanol.

6. Conclusions

It evidenced that the gasoline A and anydrous ethanol supplies revealed small sensible the variations in the prices, or either, were found inelaticies curves. In the case of the anydrous ethanol, this result can be associated to the fact of that the producer price was only set free in 1997 middle. Until then, the producer had the guarantee of sale of its production to an pay-established price, then the market signals through the price were inefficacious. The same it occurred for the gasoline A, given that the price of invoicing of this fuel was determined by the government until the beginning of 2002, the government also controlled supply of the product.

In supply of anydrous ethanol, the coefficient of the sugar price was significant and acted more if comparative with the hydrated ethanol price. This result seems to indicate that, front to the uncertainties of the hydrated ethanol market and the biggest relative stability of the sugar market, the producer would be observing more the sugar market to compose its mix of production.

In relates to the demand of gasoline C, the results indicated that the demand is not very sensible in such in relation the variations in the price as in the income. These results come to the meeting of that it could be evidenced in the previous works. The fleet of cars the gasoline showed to possess greater influence on the demand, possibly the effect of an increase in the income on the gasoline consumption occurs via increase (or acquisition) of the fleet of vehicles moved to the gasoline.

Finally, considering the gotten results, it can be tried to evaluate which the impacts of the first measures adopted in the fuel market its opening in the beginning of 2002. Among these measures were one the reduction of price in the refineries in 25%.

The gasoline A has represented about 47,5 % of the average price of gasoline C, taking the case of the city of São Paulo and considering a ratio of 24% of anydrous ethanol in the gasoline C.

Without alteration in the other components of cost of this gasoline, the reduction to the retail would have to be around 12% (0.475 x 25 = 11.88%). This reduction in the gasoline C price in the retail would have a small effect of increase in its consumption: about 2%, because this product, short-term, has a sufficiently inelasticy demand to the price changes. This increase in the consumption would provoke a substantial increase in the price of the anydrous ethanol: about 20%, because this product has supply that, also in short term, is too much inelasticy. As the anydrous ethanol is equivalent about 10% of the price of the gasoline, the reduction of gasoline C price would be about 10%. Does not forget that, for such reduction to materialize itself, it would be necessary to consider the questions taxes, since the base of collection of the ICMS (Imposto sobre Circulação de Mercadorias e Serviços) on fuels differs for each state and tends to be bigger that the prices practised in the consuming market.

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APPENDIX 1: Description of the data series used in this study

The demanded amount of gasoline C consists of sales of gasoline C (in cubical meters) in the region Middle-South and was gotten together the National Agency of Petróleo (ANP). The series of gasoline C price from of the survey of prices of this product in the retail effected by the Foundation Institute of Economic Research (FIPE) for the city of São Paulo. The relative series the average income (in Reais) and tax of unemployment of the busy people with 15 years or age in the regions metropolitans of São Paulo and Rio De Janeiro were gotten together to the Brazilian Institute of Geography and Estatistic (IBGE).

The series of oil diesel price to the consumer (R$/litro) was gotten together the Getúlio Vargas Foundation (FGV). Up to 11/15/1997 the series of prices are to the city of Rio de Janeiro, to leave of this date passes to relate to the allowed maximum price for the city of São Paulo.

Relative the monthly information to the fleet of cars the gasoline (in units) was constructed in accordance with the following procedure: breaking of annual data of the fleet of national cars for type of fuels, gotten together to the GEIPOT[2] and of monthly data on sales of national gotten together to the National Association of the Manufacturers of Vehicles Automotors (ANFAVEA) it was possible to calculate the tax of annual depreciation of the fleet of vehicles. For example, for the year of 1995, the tax of annual depreciation was

[2] For the annual fleet of 1994 in some states it did not have available information for type of fuel, then it was used of the structure of fleet of the years of 1995 or 1996 to complete the 1994 fleet.

gotten by means of the quotient of the difference between annual sales of 1995 and the relative increase of the fleet of automobiles of 1994 for 1995, on the annual fleet of 1994. Of ownership of annual depreciation it was esteem depreciation of the monthly fleet[3].

Thus:

Monthly fleet of the month i = fleet of mês$_{(i-1)}$ *+ month sales*$_i$ *(dm*frota of mês*$_{(i-1)}$*)*

For the years of 1998, 1999 and 2000 a tax of average monthly depreciation of the three previous years was used. This procedure was necessary because the increase observed in the fleet in last the three verified years was superior to sales in the same period, what it would tend to indicate an appreciation of the fleet.

The series of data that represents the supply of anydrous ethanol consists of the ratio of anydrous mixed with the gasoline A for the attainment of gasoline C (in cubical meters) in the region the Middle-South and was gotten from the percentages of mixture in validity in the period of analysis. Thus, from January of 1995 to May of 1998, the anydrous ethanol represented 22% of gasoline C, from June of 1998 to August of 2000 this percentage passed to 24% and from September of 2000 to December of 2000, 20% of gasoline C was anydrous ethanol.

The series of the anydrous ethanol to the producer and of the hydrated ethanol prices (prices of invoicing in R$/litro) were gotten together to Petrobra's for the periods where the prices of the two types of ethanol were controlled. For the period from May of 1997 to December of 2000, Monthly Index of Price of Anydrous Ethanol and the Hydrated Ethanol was considered for the producer of the state of São Paulo divulged for the Center of Advanced Studies in Applied Economy (CEPEA/ESALQ/USP).

The series of the sugar price to the producer in the domestic market (R$ by bags of 50 kg) was constructed from referring data to

[3] In accordance with the following formula $dm = (1+d_a)^{1/12} - 1$ which, d_m represents monthly depreciation, d_a of the annual depreciation.

the Index Price of the Crystal Sugar for the producer of the State of São Paulo divulged for (CEPEA) for the period from April of 1997 to December of 2000. For the period from January of 1995 to March of 1997 was used the Index of Prices in the Attacked divulged by the Getúlio Vargas Foundation to chain the series of sugar prices. The series of the ton of sugar cane price (R$/ton) was that one divulged by the Getúlio Vargas Foundation.

The series of data that represents the offered amount of the gasoline A consists of the ratio of gasoline the one that composes gasoline C (in cubical meters) in the region Middle-South and was gotten from the percentages of mixture anydrous and gasoline A for the attainment of gasoline C in validity in the period of analysis. Thus, from January of 1995 to May of 1998, the gasoline A represented 78% of gasoline C, from June of 1998 to August of 2000 this percentage passed to 76% and from September of 2000 to December of 2000, 80% of gasoline C was gasoline A.

The prices of invoicing of the gasoline A in the refinery (in R$/litro and without considering the aliquot ones of ICMS) were gotten together the National Agency of Petróleo (ANP).

The serie relative to exchange rate is the average cotation of sale dolar (R$/US$) divulged by Central Bank of Brazil.

The series of the barrel of imported oil price (R$/barril) was gotten together the ANP for the period from January of 1995 to December of 1998 and together one to the Secretariat of Foreign Commerce (SECEX) for the period from January of 1999 to December of 2000.

The relative series to the gasoline A price in the refinery, of gasoline C to the consumer, of the anydrous ethanol to the producer, of the hydrated ethanol to the producer, of the sugar cane, the sugar in the domestic market, of the exchange rate, the imported oil, the income average and the oil diesel the consumer were deflacionated by the Index Generality of Prices – Internal Availability (IGP DI) calculated by the Getúlio Vargas Foundation, being thus, the series of prices are of actual values of December of 2000.