DEFINING THE RELEVANT MARKET OF BRAZILIAN DIESEL FUEL DISTRIBUTION IN SOUTHEAST REGION: A GEOGRAPHIC APPROACH

Resumo: Na ótica da análise antitruste um mercado relevante representa competição entre os vendedores e produtos com algum grau de substitutabilidade para os compradores, indicando o mercado apropriado a ser considerado no âmbito da defesa da concorrência. Uma definição equivocada de mercado relevante pode comprometer estudos e decisões judiciais sobre condutas anticompetitivas. O presente artigo utiliza a cointegração de Johansen com o intuito de definir o mercado relevante na distribuição de combustível diesel brasileiro na região sudeste. Os resultados indicam que o mercado relevante é a região como um todo, incluindo os quatro estados: Espírito Santo, Minas Gerais, Rio de Janeiro e São Paulo. Assim, análises de condutas anticompetitivas e suas consequências deveriam considerar os impactos em toda a região. Os resultados estão de acordo com artigos anteriores relacionados à definição de mercado relevante na distribuição de combustíveis.
Palavras-Chave: antitruste, mercado relevante, cointegração, combustível diesel, região sudeste

Abstract: From the antitrust viewpoint, the relevant market means competition between sellers and substitutes products for buyers, which indicates the appropriate market that should be considered in antitrust analysis. A wrong relevant market definition may compromise the studies and court decisions about anticompetitive conducts. In this context, we apply the Johansen cointegration test in order to define the relevant market of Brazilian diesel fuel distribution in the southeast region. The results suggest that the relevant market is the entire region, including the four states: Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo. Thereby, analyzes of anticompetitive conducts and they consequences should consider the impact on the region as a whole. Results are in agreement with previous studies related to market definition of fuel distribution.
Keywords: antitrust, relevant market, cointegration, diesel fuel, southeast region

Código JEL: K21, L11

1. Introduction

The relevant market definition is one of the most important steps in antitrust studies. At this stage, researchers and antitrust agencies are able to understand which market is been considered, its size and which products are included.

The Brazilian System of Competition Policy, composed by two governmental agencies: the Administrative Council for Economic Defense (CADE) and Secretariat for Economic Monitoring (SEAE), highlights the importance of relevant market definition. According to CADE (1998), this process encompasses two aspects: the geographical boundary and the products boundary. The first one concerns the geographical area in which firms sell and buy products and services in sufficiently homogeneous conditions related to prices, consumers preferences and characteristics. Thus, a geographical relevant market encompasses all the firms considered by sellers and buyers in price definition and market characterization. The second one concerns all the distinct products and services that are viewed by consumers as substitutes.

According to Cuiabano et al. (2017), the relevant market delimitation is an important stage because if wrong it may compromise the results and consequences of market power abuse, collusion, mergers, among others anticompetitive conducts analyzed by antitrust agencies. For instance, if the objective is to measure the market power in an industry, a restricted market definition may result in wrong estimates since buyers (gas stations in our case) can purchase other products and from other locations that are not been considered in the analysis. On the other hand, a wide market definition may include products and locations that buyers do not take into account.

Fuel markets represent a constant concern of Brazilian antitrust authorities. On resale sector a major concern is about collusions, since many cases were discovered and condemned in several cities in the last years. This fact highlights the improvement of CADE statistical and econometric methods to detect and prove collusion, as the collusive markers and cartel screening[1]. On fuel distribution one of the main concerns is about high prices and market power, since the distribution of fuels in Brazil is highly concentrated and presents entry barriers, as noted by Fernandes and Braga (2013).

In this context, the diesel fuel distribution is also worrying. According to ANP (2017), three big companies sell more than 70% of diesel fuel to resale agents, which is a high degree of concentration. Petrobras (2017) highlights that the diesel fuel in Brazil is basically used for agriculture and long distance transports, and actually there is no fuel to substitute. Since 2008 the Brazilian government requires a proportion of 5% of biodiesel on the diesel fuel composition, a renewable fuel. However, biodiesel production and marketing is low and it will take years to become a commercial product on a large scale. As highlighted by Fernandes and Braga (2013), other concern is about entry barriers in fuel markets, whereas diesel fuel distribution is regulated by government and demands a high degree of investment, including sunk costs. Summarizing, this is a highly concentrated market, with no substitutes and a high degree of entry barriers, making anticompetitive conducts more plausible.

The paper's objective is to define the geographic relevant market of Brazilian diesel fuel distribution in southeast region. According to ANP (2017), this region is the main destination of the Brazilian diesel: approximately 42% of the total amount is delivered to southeast, followed by south (about 20%), northeast (close to 18%), midwest (about 11%) and north (close to 9%). Given the importance of this region for the diesel market, it is essential to understand if the relevant market of diesel fuel in southeast encompasses the entire region or is divided by Espírito Santo (ES), Minas Gerais (MG), Rio de Janeiro(RJ) and São Paulo(SP). It will contribute with anticompetitive analysis and antitrust studies, for example a decision about to allow or not a merger, estimate a possible market power or calculate the welfare effects of collusion.

Some papers in Brazil have studied the fuel market from the viewpoint of antitrust analysis. Fernandes and Braga (2012) analyzed if gasoline and ethanol compete in the same relevant market of distribution in each Brazilian region. Fernandes and Braga (2013) studied the market power in the distribution sector of gasoline C and defined the geographic relevant market as regional. Each region needed a different analysis since they are not in the same market. Diesel is an important fuel in Brazil and little is known about its market, thus the paper intends to contribute with the literature about diesel fuel market in Brazil and southeast region relative to price studies and antitrust analyzes.

2. THE RELEVANT MARKET DEFINITION

[1] Harrington (2008) and Cuiabano *et al*. (2014) are references on the state of the art of collusive markers and cartel screening.

Antitrust agencies and researches make use of some methods to delimitate a relevant market, depending on the analyzed sector, data availability, among others factors. In general, the most commonly methods are the hypothetical monopolist test and time series analysis.

According to DEE/CADE (2010), the hypothetical monopolist test was firstly implemented by USA antitrust agencies, then others countries also adopted. From this point of view, the relevant market is defined by the smallest group of products and by the smallest geographic area in which a supposed monopolist is able to set a small but significant non-transitory increase in prices (SSNIP). However, generally this method requires disaggregated and specific data and also a robust estimation of the elasticities, which is hard to obtain. Actually, in Brazil it is used mainly when big companies want to merge and the merger impacts are unknown, requiring a more detailed analysis.

On the other hand, time series analysis are basically prices correlation and cointegration, therefore depend only on price data. As noted by DEE/CADE (2010), the main idea is the following: in a relevant market, if a region presents an increase in price, consumers will buy from others locations, which tends to reduce the price from the first region and increase the other ones. In the same way, sellers may sell their products where prices are higher. Thus, prices from different locations may be equalized by arbitrage in a certain period of time. In Cuiabano *et al.* (2017) some time series tests of relevant market definition are described, as well a set of applications done by CADE in court decisions of mergers and antitrust infringements.

There are some criticisms about time series analysis in relevant market definition. Firstly, prices from different locations or different products can be correlated not due the substitutability or arbitrage. According to Joe and Krause (2008), changes in costs and demand shifters in common may also result in correlation/cointegration. Another criticism pointed out by Joe and Krause (2008) is that these methods define the market in an economy sense instead of an antitrust sense. In general, more restricted relevant markets are defined by the latter. Nevertheless, the relevant market definition is a complex stage in which antitrust agencies try to use distinct methods whenever possible. In this context, time series analysis may be a useful tool. Fernandes and Braga (2012) and Margarido *et al.* (2007) are examples of papers that implemented time series analysis to define relevant markets in Brazil.

3. METHODOLOGY

3.1. ECONOMETRIC TOOLS

In order to define the geographic relevant market of Brazilian diesel fuel distribution in southeast region we apply a cointegration technique, the Johansen test proposed by Johansen (1988) and Johansen and Juselius (1990). According to Enders (1995), the main advantage is that this technique allows for the presence of multiple cointegrating vectors. In addition, the Johansen test is based on a Vector Autoregressive (VAR) model, thus all variables are treated as endogeneous and explained in a dynamic framework.

In a multivariate context the Johansen test can be illustrated by the following autoregressive process:

$$X_t = A_1 X_{t-1} + A_2 X_{t-2} + \cdots + A_p X_{t-p} + \varepsilon_t \quad (1)$$

In which X_t is a *(n x 1)* vector of n variables, A_1, $A_2 \ldots A_p$ are the coefficients matrix and ε_t is the vector of errors terms. Adding X_{t-1} , $X_{t-2} \ldots X_{t-p-1}$ on both sides of (1), considering the difference operator (Δ) and after some algebraic manipulation the following expression is obtained:

$$\Delta X_t = \sum_{i=1}^{p-1} \tau_i \, \Delta X_{t-i} + \pi X_{t-1} + \varepsilon_t \tag{2}$$

Where:

$$\pi = -\left(I - \sum_{i=1}^{p} A_i\right) \tag{3}$$

$$\tau_i = -\sum_{j=i+1}^{p} A_j \tag{4}$$

The expression (2) is a restricted VAR used when variables are non-stationary and cointegrated, also known as a VEC (Vector Error Correction) model. Given that variables are cointegrated, the matrix τ_i represents short-term coefficients while π contains the long-term coefficients and cointegrating vectors, composing the cointegrating equations.

The key feature is the rank of the matrix π, since it is equal to the number of cointegrating vectors. If the rank is zero then no cointegration exists after all, and if the rank is "*n*" the vector process is stationary. For intermediary cases the rank means the number of cointegrating vectors and the expression πX_{t-1} represents the error correction factor. As demonstrated by Enders (1995), the number of distinct cointegrating vectors is obtained by the significance of the characteristic roots of π. Thus, the estimates of π and the number of characteristic roots are calculated by two statistical tests:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \tag{5}$$

$$\lambda_{max}(r, r+1) = -T ln(1 - \hat{\lambda}_{r+1}) \tag{6}$$

Where $\hat{\lambda}_i$ and $\hat{\lambda}_{r+1}$ are the estimated values of characteristic roots, r are the number of cointegrating vectors and T is the number of observations. The first test is called *trace test* and the null hypothesis is that the number of distinct cointegrating vectors is less than or equal to r against a general alternative. The second is the *max eigenvalue test* and tests the null hypothesis that the number of cointegrating vectors is r against the alternative of $r + 1$ cointegrating vectors.

Cointegration among variables occurs only when the series are non-stationary (unit root process in level) and exhibit the same order of integration, since the objective is to obtain a combination of the variables that is stationary. Thus, two tests are applied to check the existence of unit roots: the Phillips and Perron (PP hereafter) and Perron tests[2]. The first one treats the autocorrelation among the errors terms in a non-parametrical way, testing the null hypothesis that the process has a unit root. The second allows for the possibility of an endogenous structural break in the unit root process. Therefore, these tests are applied before the cointegration analyses to guarantee that the series are integrated of the same order.

3.2. DATA

[2] Proposed by Phillips and Perron (1988) and Perron (1997), respectively.

The sample consists of four price series, one for each state that composes the Brazilian southeast region: Espírito Santo (ES), Minas Gerais (MG), Rio de Janeiro (RJ) and São Paulo (SP). Prices are monthly means (R$/m³) of stated prices of diesel fuel distribution, obtained on The Brazilian National Agency of Petroleum, Natural Gas and Biofuels (ANP, 2017) website. To avoid the influence of inflation on the results the series were deflated by the IPA-Industry, a Brazilian index that measures the inflation on the wholesale market of industrial products, available in IPEADATA (2017) and calculated by Getulio Vargas Fundation – The Brazilian Institute of Economics - FGV-IBRE (2017). All series are presented in logarithm.

The period is from January 2002 to May 2017, which composes a sample of 185 observations. According to Petrobras (2017), Brazilian imports of diesel fuel were highly regulated until 2001, but in January 2002 the government decided to decontrol the diesel commercialization and prices started to be defined by the market. Therefore, this period was chosen to avoid regulatory influences.

4. RESULTS AND DISCUSSION

Firstly, the descriptive statistics are shown in Table 1. They are related to the original and deflated prices (non-logarithmic).

Table 1. Descriptive statistics of ES, MG, RJ, SP diesel fuel prices, from January 2002 to May 2017

States	Mean	Standard deviation	Maximum value	Minimum value
ES	853,74	55,21	992,96	758,52
MG	844,53	54,22	961,27	745,46
RJ	826,59	59,63	932,04	691,50
SP	825,55	63,53	948,55	687,85

Source: ANP (2017) and research results.

It is worth noting that prices in RJ and SP are considerably lower than in MG and ES on the average. According to Petrobras (2017), part of the composition of diesel price is due the state-owned company policies, Petrobras, and also federal taxes. Nevertheless, part of the diesel price is explained by the reseller's margins of commercialization and regional taxes, therefore it is normal that prices differ from one place to another. For this paper it is not important that prices are similar, but rather if they demonstrate a long-term relation justified by the cointegrating vector. In other words, if they move together in the long-term.

The first step is to define the integration order of the series. Table 2 presents the unit root tests results:

Table 2. Unit root tests results of ES, MG, RJ, SP diesel fuel prices, from January 2002 to May 2017

'	PP	Perron	PP	Perron
	Level		**First diference**	
Series	t-statistic	t-statistic	t-statistic	t-statistic
ES	-2,96	-5,20	-8,97***	-9,24***

	[-4,01]	[-6,32]	[-2,58]	[-6,32]
MG	-2,69 [-3,47]	-3,90 [-6,32]	-8,12*** [-2,58]	-10,38*** [-6,32]
RJ	-2,64 [-3,47]	-3,86 [-6,32]	-7,96*** [-2,58]	-9,75*** [-6,32]
SP	-2,86 [-4,01]	-4,20 [-6,32]	-8,36*** [-2,58]	-10,51*** [-6,32]

Source: Research results.
Note: Critical values in braskets. ***Null hypothesis rejected (1% of significance)
[1] PP t-statistics are compared to the critical values presented by Mackinnon (1996), 1% of statistical significance. The lag criterion is the Newey-West Bandwith and deterministics components are included/excluded according to its significance. ES and SP include intercept and trend, while MG and RJ only intercept.
[2] Perron t-statistics are compared to the critical values calculated by the test (1% of significance). The lag criterion is the "t-sig" and the unknown breakpoints are allowed both in intercept and trend.

In Table 2 we see that all series have a unit root in level. The null hypothesis of a unit root is non-rejected by both tests considering 1% of statistical significance. On the other hand, the null hypothesis is rejected in all series in first differences, concluding that they are stationary when differentiated once, i.e., I(1). It is important to note that Perron (1997) test allows for the existence of an endogenous structural break in the unit root process, however it is a statistical fact that does not have much economic significance. The estimated breakpoints are not presented and analyzed, once in this context this test works more are as a robustness check.

As all series are I(1) it is possible to proceed with the cointegration analysis. Initially, an unrestricted VAR is estimated in order to define the number of lags included in estimates. Table 3 summarizes three lag criteria results: Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ).

Table 3. Lag criteria results

Lags	AIC	SC	HQ
0	-18,24141	-18,16963	-18,2123
1	-28,45267	-28,09378*	-28,30712
2	-28,73038	-28,08438	-28,46838*
3	-28,80174*	-27,86864	-28,42331
4	-28,69024	-27,47003	-28,19537
5	-28,65796	-27,15063	-28,04665

Source: Research results.

The SC criterion suggests one lag, while HQ information criterion suggests two lags in estimates. However, the Lagrange Multiplier (LM) test for residuals serial correlation rejects the null hypothesis of serial correlation inexistence with one and two lags, as shown in Table 4. It means that more lags should be included to correct this econometric problem. With three lags the null hypothesis is non-rejected, thus the Akaike information criterion is used. Table 4 shows the LM test results.

Table 3. LM test for serial correlation

Lags	LM statistic	Prob,
1	41,26	0,00***
2	34,92	0,00***
3	**13,54**	**0,63**
4	21,90	0,15
5	24,66	0,08
6	16,63	0,41
7	16,54	0,42
8	17,73	0,34
9	32,07	0,01
10	22,52	0,13
11	27,12	0,04
12	13,61	0,63

Source: Research results.
Note: ***Null hypothesis rejected (1% of significance)

As shown in (2) the equation that *trace* and *max eigenvalue* tests are applied is in first difference, thus the number of lags must be one less than unrestricted VAR specification, two lags in this case. Tables 5 and 6 present the cointegration estimates.

Table 5. *Trace test* results

Number of cointegrating equations	*Trace statistic*	*Critical value (1%)*	*Prob.*
0	63,74	61,27	0,01***
1	27,21	41,20	0,28
2	10,66	25,08	0,58
3	0,98	12,76	0,95

Note: ***Null hypothesis rejected (1% of significance)

Table 6. *Max Eigenvalue test* results.

Number of cointegrating equations	*Max Eigenvalue statistic*	*Critical value (1%)*	*Prob.*
0	36,53	33,73	0,00***
1	16,55	27,07	0,26
2	9,68	20,16	0,36
3	0,98	12,76	0,95

Note: ***Null hypothesis rejected (1% of significance)

The cointegrating equations are estimated with an intercept, while no deterministic component is included in the unrestricted VAR. The order of series is defined by the degree of endogeneity[3] (the order is SP, MG, RJ and ES). The *trace test* rejects the null hypothesis of no cointegrating equation with 1% of statistical significance and does not reject the others. The *Max Eigenvalue test* confirms the previous result, therefore one cointegrating equation is the most adequate.

The cointegrating equation represents the long-term relationship among variables. In a short-term some disequilibrium may occur, but the trajectory is stable in the long-term. To observe how it happens, the error correction factor (πX_{t-1}) can be decomposed in $\alpha\beta' X_{t-1}$, where α is a $(r\ x\ n)$ matrix containing the adjustment coefficients and β' is the $(n\ x\ r)$ matrix that contains the cointegrating vectors. Once there is an intercept in the error correction factor estimates the matrices dimensions are $(r\ x\ n+1)$ and $(n+1\ x\ r)$, respectively. After replacing the results the error correction factor becomes:

$$\begin{bmatrix} -0{,}05 \\ -0{,}01 \\ -0{,}03 \\ 0{,}04 \end{bmatrix} \begin{bmatrix} 1{,}00 & -0{,}73 & 0{,}81 & 1{,}42 & 2{,}30 \end{bmatrix} \begin{bmatrix} SP_{t-1} \\ MG_{t-1} \\ RJ_{t-1} \\ ES_{t-1} \\ C \end{bmatrix} \tag{7}$$

The first column vector (α) contains the adjustment coefficients that guarantee the long-term relationship. Each line is related to the respective price, i.e. the first one is related to SP_{t-1}, the second one to MG_{t-1} and so on. It means that for 1% of instability in the cointegrating relation the prices in SP adjust approximately 5% in each period of time, while the same occurs in other states. The following line vector (β') is in fact the cointegrating vector normalized for SP[4]. The long-term relationship can be expressed as:

$$SP = -2{,}30 + 0{,}73MG - 0{,}81RJ - 1{,}42ES \tag{8}$$

In (8) we can observe that the prices in MG are positively related to the prices in SP, while the prices in RJ and ES are negatively related to SP .

The previous results suggest that the relevant market of diesel fuel distribution in Brazilian southeast region is the region as a whole, since prices of SP, MG, RJ and ES are cointegrated. It means that the gas stations consider the diesel fuel in these states as substitutes (some degree of substitutability), while the distribution companies practice arbitrage and compete with each other. Therefore, studies of anticompetitive conducts should consider the impact on the entire region, including the effects on prices, deadweight loss, welfare, entry barriers, among other topics of interest in antitrust studies.

The results also confirm the conclusions obtained by previous papers related to fuel markets and antitrust analysis. For instance, Fernandes and Braga (2013) define each region in Brazil as a relevant market for gasoline distribution, and not each city or state. This is also appropriate in the case of diesel fuel distribution, which was expected since diesel fuel does not have any substitutes (unlike gasoline), so competition tends to be wide and encompasses more locations.

[3] Calculated by the Wald endogeneity test.
[4] The normalization is necessary because β' is not identified.

An important observation is if the relevant market could be defined as national. In this case, distribution firms would compete with each other all over the country and buyers would consider purchasing from all of them, no matter where firms and buyers are located. However, this is not reasonable because despite the market concentration there are some small distribution companies that generally operate in the region that is located. There are also the transport costs, which tend to be higher in long distances. It is hard to believe that a gas station located in southeast would consider purchasing diesel fuel from a distribution firm in north region. Summarizing, a wider definition than regional would include firms and buyers that are not relevant, while a more restricted definition may ignore economic agents that are important to competition.

5. CONCLUSIONS

Antitrust policy has been an important field of study in Brazil. This paper intends to contribute with the understanding of diesel fuel market from an antitrust point of view. Fuel markets represent a major concern of antitrust authorities, and while many papers focus on gasoline and ethanol markets, little is known about diesel commercialization. Since diesel is an indispensable fuel for agribusiness and long distant transportation of goods, a better understanding of this market is essential.

As aforementioned, there are some criticisms about the use of time series analysis to define relevant markets in antitrust. However, it can be a useful tool with basis on economic theory and support from previous studies. The diesel fuel distribution is a suitable market for this type of analysis, the product is relatively homogeneous and therefore tends to do not show a high degree of price differentiation regarding the product characteristics. Thereby, in this case the averages prices series are probable more realistic than in the case of heterogeneous products.

We concluded that the relevant market of diesel fuel distribution in Brazilian southeast region should be defined as the entire region. A wider definition would include irrelevant sellers (distributors) and buyers (gas stations), whereas a more restricted definition would ignore relevant agents. From the antitrust point of view this is an important result for future studies regarding mergers, collusions, market power, among others issues that encompass the southeast region. From the sellers and buyers viewpoint the importance is the following: sellers compete in the entire region, and not only inside each state; buyers respond to prices and consider some degree of substitutability in the entire region, and not just in the respective state.

For a better understanding of this market in Brazil other studies about relevant market definition in other regions are interesting. Related to southeast region, a relevant market definition allows for other types of antitrust analysis, as market power and welfare studies for example. Therefore, these are also some suggestions for futures papers.

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