Eixo Temático: Estratégia e Internacionalização de Empresas

HOW NEW BRAZILIAN ECONOMIC POLICIES CAN CHANGE THE FUEL SECTOR?

COMO AS NOVAS POLÍTICAS ECONÔMICAS BRASILEIRAS PODEM MUDAR O SETOR DOS COMBUSTÍVEIS ?

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ABSTRACT

This paper aims to investigate the impact of macroeconomics variables and policies to encourage cars sales (PECS), over fuel consumption. Using panel data, we analyze nine years of fuel consumption for 26 Brazilian states plus Brasilia. Our main results indicates that income is a very important variable and cannot be replaced by GPD as was done in previous studies, PECS have a positive effect on gasoline demand, and the substitutive effect between gasoline and ethanol is becoming stronger.

Keywords: Fuel consumption, economic policies, macroeconomic variables.

RESUMO

Este trabalho tem como objetivo investigar o impacto das variáveis macroeconômicas e políticas para incentivar as vendas de carros (PECS) , sobre o consumo de combustível . Usando dados em painel , analisamos nove anos de consumo de combustível para 26 estados brasileiros mais Brasília. Os principais resultados indicam que o rendimento é uma variável muito importante e não pode ser substituído por GPD como foi feito em estudos anteriores , CPE tem um efeito positivo sobre a procura da gasolina , e o efeito substitutivo entre gasolina e etanol é cada vez mais forte .

Palavras-chave: O consumo de combustível, as políticas económicas, as variáveis macroeconômicas.

1. Introduction

The fuels sector deserves especial attention of economics policy makers in every country, its strategic relevance and the way it affects the living costs make this sector one of the most important for Brazilian economy. Brazil has (has been taking ou has taken) taking a leading role on the world stage of fuels, the discovery of large oil reserves in the pre-salt layer and the possibility of large scale production of biofuels like ethanol shows some of the opportunities for this economy.

Furthermore, the growth of Gross domestic product (GDP) and family income gave more consumption power for the population. As a way to combat the successive economic crises, Brazilian government started a policy to encourage cars sales (PECS), reducing taxes and in consequence lowering car prices. This policy allowed successive record car sales, what in turn can bring reflexes, improving fuel consumption and elevating others indicators as inflation rate.

Several governmental policies allowed the stabilization of ethanol production (Hira and Olivera – 2009) and the popularization of "flex fuel" technology. Since 2003, most consumers can choose freely between gasoline or ethanol without do any additional modification in the car engine. The "Flex fuels" fleet exceeds 17 million vehicles and keeps increasing, it is expected to reach 63% of the national fleet until 2015 (National Association of Automotive Factories – 2011). Besides, the production and utilization of Brazilian bioethanol have showed favorable energy and carbon balances (Blottnitz and Curran 2007).

According to National Petroleum Agency (NPA-2011), Brazil produced 28,2 million cubic meters of ethanol in 2010, being the second largest producer, behind the United States (and the first of sugar-cane ethanol). So it is easy to see how important can be this fuel behavior for Brazilian economy. Gasoline also occupies a prominent role in the Brazilian transportation scenario with 35.492 million cubic meters of gasoline sold in 2011. (NPA-2012).

Thus, this article aims to understand how new Brazilian economic policies can change the fuel sector. We analyze the dynamics of prices and consumption between the two main Brazilian fuels, taking into account the characteristics of great expansion of the "flex fuel", its relationship with per capita GDP, household income and with policy of encouraging cars sales (PECS) by reducing the Tax Under Manufactured Products for national cars.

Results show a positive effect of GDP Growth, household income and PECS over fuels consumption. Furthermore, we confirmed an asymmetrical substitutive relation between gasoline and ethanol. Thus we have several parameters for the Policy Makers make decisions about the Brazilian fuel market, contributing to the literature by demonstrating how recent changes in macroeconomic variables affect the Brazilian fuel sector, and how policies can boost consumption can affect this strategic sector.

This paper is structured as follows. Section 2 provides a review of the selected studies and aims to demonstrate different ways to analyze this issue. In Section 3 we describe the data and period analyzed, and present the econometric model developed in this paper. The application, estimation and comparison with previous studies are presented in Section 4 with some tables and figures. In Section 5 we draw some important policy conclusions about the relation between the fuel sector and Brazilian economy.

2. Review of selected previous studies

There are an extensive literature about the relationship between gasoline and GDP (as a proxy for household income). Bueno et al. (2003) analyzed the period between 1974 and 1999 estimating the income and price elasticity of the demand for gasoline in Brazil. They extend previous researches (e.g. Bentzen, 1994; Eltony and Al-Mautairi, 1995) by estimating the cross-

price elasticity between ethanol and gasoline. In this article, the author found evidences of quadratic trends and co-integration at a 15% level between gasoline and, income and price. Using a Vector Error Correction model (VEC), his results reveal that gasoline demand is inelastic with respect to price and income, and a low value for cross-elasticity between ethanol and gasoline. Were used annual data, totalizing 25 observations, this may be reflected in the estimates considering that this is a time series.

We must to remember that before 2003 there were no "flex fuel" cars, it means was impossible to alternate between gasoline and ethanol. Since then, every engine build in Brazil has this technology, and it drastic changed the Brazilian car fleet, now the consumer can alternate the fuel freely, with any additional costs.

Besides, Brazilian economy is in a completely different situation now, family's income is bigger than ever and the middle class represents more than 50% of population. GPD grew around 3.6% per year at last decade, especially after 2010 when GPD grew 7.5%, much more in comparison to around 2% of 1990's (IBGE). Furthermore, as a way to combat the global crises, Brazilian government started a policy of encouraging cars sales (PECS), by reducing taxes and for consequence the cars prices. All those changes provide a new scenario for fuel prices behavior.

Using panel data and dynamic general method of moments (GMM), Li, R. and Leung, G. (2012) study the influence of real GDP, of 17 Chinese provinces selected to have in common the "one province one price" policy, in the gasoline consumption. They found a highly price inelastic behavior in the period since 2003 to 2009, that can be explained by the rapid growth in household income and the *1994 Auto Policy*. Panel data is a good alternative, considering GDP is annual data, otherwise might be few observation for time series estimations. Different from Bueno et al. (2003) and Li, R. and Leung, G. (2012), we did not use GDP as proxy to income, considering the possibility of different impacts, GDP and average household income were considered as two different variables.

Pacini, H and Silveira (2011) improved previous studies analyzing the consumer behavior in relation to gasoline and ethanol since the emergence of "flex fuel" cars in Brazil and Sweden. They found that Brazilians consumer can opt for ethanol even when this was not the optimal economical choice.

Applying static and dynamic systems of demand equations, Looty, M et al. (2009) estimated the price and income elasticity in the period of 1970-2005, for different kinds of fuel in Brazil. The results suggest a relation of substitution between gasoline and ethanol. Here again the period has a determinant impact on the results, at 2003 the "flex fuel" technology was being introduced in the market and its real impact may be cannot be observed yet especially considering the yearly periodicity of the used data.

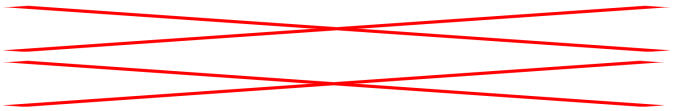
We must remember that Brazil is a large country, and the consumer behavior is different from one region to another, due to culture, production costs, and so on. Considering that, Freitas and Kaneko (2011) studied the regional demand of ethanol in Brazil dividing between Center-South (CS) region and North-northeast (NN) region. This approach gives the opportunity to compare the ethanol consumption with local income. Through data panel analysis, their results appoint to a similar pattern for both regions and higher prices at NN. In other words, despite the income difference between regions, this does not reflect at the ethanol consumption, and characterize an inelastic demand. This approach can be a good alternative for local policy but disregards GDP impact and the policy of encouraging cars sales started in 2008.

As can be observed there is an extensive literature about the relation among GDP, income, gasoline and ethanol. At the same time we can note a gap of recent studies considering the actual Brazilian economy situation, the appearance of "flex fuel" technology (and his impact in a period longer than eight years) and how the PECS can affect fuel prices.

3. Econometric Methodology

Were analyzed annual GDP, household income, and the average price of gasoline and ethanol for the 26 Brazilian states plus the Federal District (capital) in the period of 2001 to 2010. As exposed, since to 2001 Brazilian GDP and income presented o consistent growth and people gained more consumption power. Besides, the popularization of "flex fuel" technology since 2003 brought a new perspective to fuel sector, and gave chooses power for the consumer.

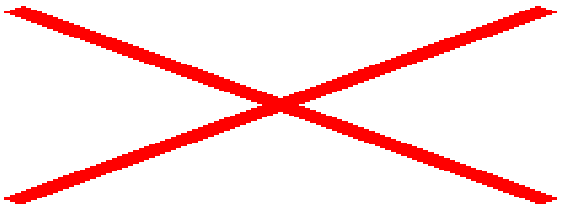
We model gasoline and ethanol demand as a function of its own price, ethanol (or gasoline) price, income and GDP (all variables in log-return) and the policy of encouraging cars sales. After differentiating the series they are tested using Aumented Dickei-Fuller with GLS constant (ADF-GLS) to confirm the absence of unit root in differenced series (results are presented in table 1).


, (1)

(2)

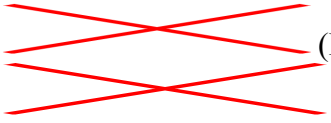
Where *g* and *e* refers to annual gasoline and ethanol consumption in cubic meters, "*gp"* and *"ep"* are the gasoline and ethanol prices per liter, "*I"* is the household income, "*GDP"* represents the Real GDP and the *dummy variables* indicate the period when the PECS is active. This policy was created in December of 2008 as a form to combat the effects of global crises. It consists in remove the Tax Under Manufactured Products for national cars over a period and in consequence to lower cars prices. So, we considered its value "0" before 2009 and "1" since then. Despite this policy had ended up in early 2010 and being restated in 2012, we considered all this period as "1", in view of the cars sold in this period remains in circulation and consuming fuel.

Breush-Pagan test is used to decide which model is most appropriate: the pooled model (H_0) or the random effects model (H_A). The Breush-Pagan test is a LM test given by the following relation:


(4)

If LM >  the pooled model is rejected in favor of the model with random effects.

Hausman test is used to test for Fixed effects against Random effects. The test is as follows:


(Random effects)

(Fixed effects)

The Hausman statistic is obtained as follows:


(3)

Where,  is the vector of estimators of fixed effects model,  is the vector of estimators random effects model,  and  is the variance-covariance matrix of the estimators  and  respectively and "*k*" is the number of regressor. We also used a Robust standard

errors model to prevent heteroskedasticity and Variance Inflation Factors (VIF) test to confirm non-collinearity.

Table 1: Dickey-Fuller (GLS) test

Variable	Inverse chi-square (p-value)	Inverse normal test (p-value)	Logit test (p-value)
ld_income	0.0000	0.0000	0.0000
ld_GDP	0.0000	0.0000	0.0000
ld_cons_gas	0.0000	0.0000	0.0000
ld_gas_price	0.0000	0.0000	0.0000
ld_cons_eth a	0.0000	0.0000	0.0000
ld_price_eth a	0.0000	0.0000	0.0000

H0: all groups have unit root

4. Results

Summary statistics of log-returns of the data used in this study is presented in table 2. For the standard deviation and kurtosis analyses we can perceive that ethanol price and consumption is more volatile than gasoline, what is consistent with the introduction of "flex-fuel" technology, since the consumers began to use it regularly what did not happen before. This behavior is easily observed when analyzing the behavior of series **(**figure 1**)**, both consumption and ethanol prices are more volatile than those of gasoline.

Table 2: Summary statistic

Variable	ld_income	ld_GDP	ld_cons_gas	ld_gas_price	ld_cons_eth a	ld_price_eth a
Mean	0.03457	0.04273	0.06030	0.04432	0.13461	0.064671
Median	0.03913	0.03575	0.04824	0.01388	0.11204	0.046450
Minimum	-0.29738	-0.13941	-0.11109	-0.06095	-0.7437	-0.22890
Maximum	0.32582	0.51267	0.31297	0.21503	1.0965	0.41855
Stand. Dev.	0.08011	0.07615	0.07418	0.07006	0.3117	0.13406
Skewness	-0.2341	2.1171	0.54134	0.99797	0.1375	0.20784
kurtosis	2.5911	9.9524	0.22697	-0.09749	0.2391	-0.70567

The volatility in ethanol prices and demand must be taken into account for energy policy makers, since the consumers buy "flex-fuel" cars, they hope to fuel their cars with ethanol when gasoline is more expensive. However, if the price is not stable, they may become frustrated and lose interest in this technology, defeating the purpose of popularizing ethanol, as it has already occurred earlier in the 1980s, making ethanol ceased to be used as vehicle fuel.

Figure 1: Series behavior

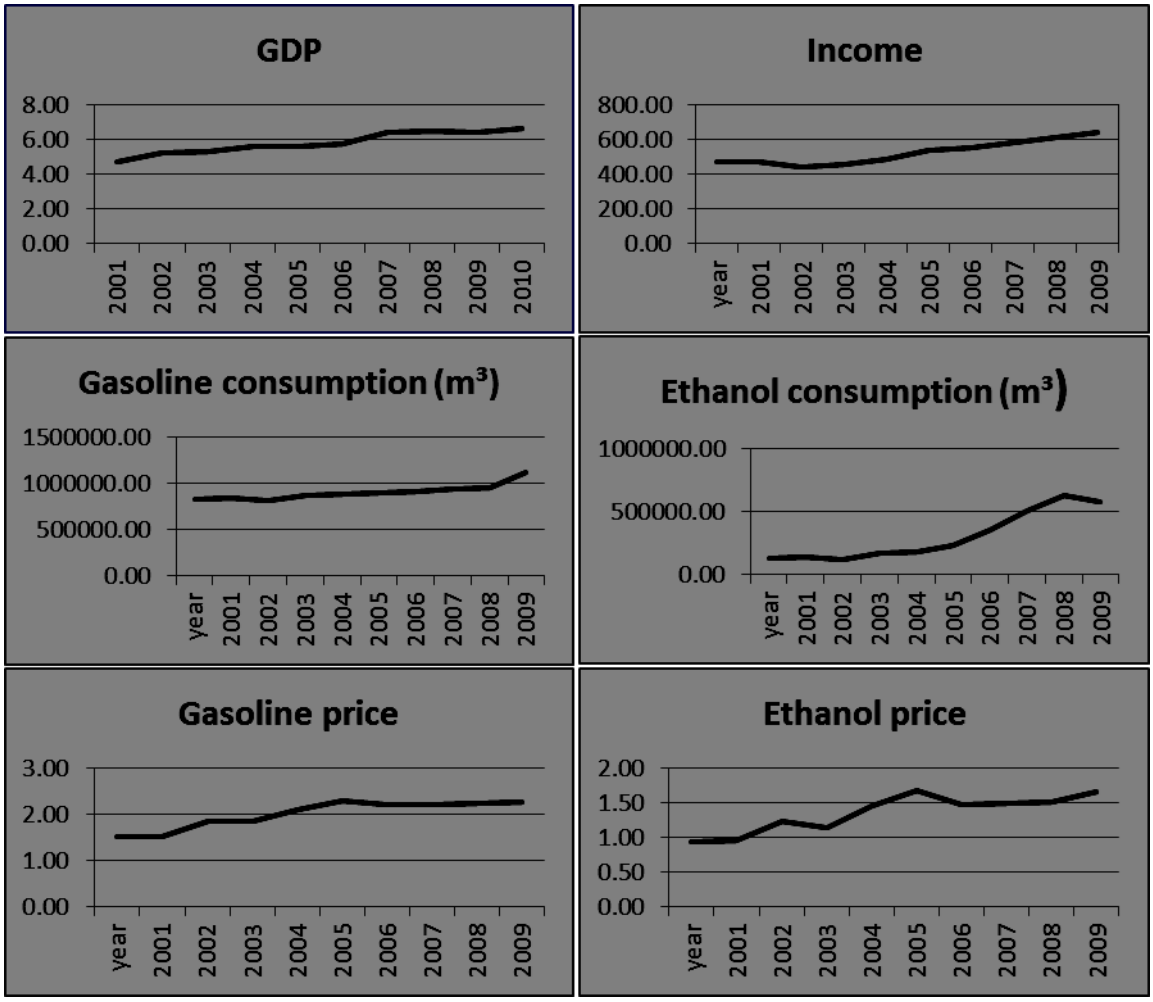


Table 3 presents the results of Breusch-Pagan and Hauseman tests. As can be observed, the fixed effects present the best fit for gasoline consumption model. However, the pooled model presents superior adjustment to ethanol demand.

Table 3: Breusch-Pagan and Hauseman tests

Model	Breusch-Pagan test	Hauseman test
Gasoline Regression	10.2997 (0.0013)*	18.315 (0.0054)*
Ethanol Regression	2.64078 (0.1041)	8.04757 (0.2346)

Estimation results show a substitution effect between gasoline and ethanol, evidenced by negative relations between ethanol and gasoline consumption (table 4), it means, an increment in ethanol consumption reduces the gasoline demand. This analysis is reinforced by the negative relation between gasoline consumption and gasoline price, in other words, when those prices rise, the consumer can alternate to ethanol and decrease the pressure over gasoline consumption lowering prices. This characteristic is completely consistent with "flex fuel" technology, once it is possible to alternate between ethanol and gasoline without additional costs, consumers got the power to choose the most economical alternative.

Table 4: Regression results for gasoline consumption (fixed effects)

	Coefficient	**std. error**	**t-ratio**	**p-value**
const	0.0821280	0.0043	18.93	0.000*
Dummy	0.0364878	0.00557	6.550	0.000*
ld_income	0.0949952	0.03766	2.522	0.0124**

ld_gasoline_price	-0.534136	0.0587	-9.084	0.000*
ld_ ethanol_cons	-0.0749033	0.01223	-6.124	0.000*

Notes: R-squared = 0.516944 and Adjusted R-squared = 0.447936
* and ** Denotes statistical significance at 1% and 5% levels respectively.

As any other country, Brazilian economic growth is related with energy consumption. The income growth is positive related with gasoline demand consumption, what is consistent with propose by Li, R. and Leung, G. (2012). But the fluctuation of income does not have strong impact on gasoline demand, which have inelastic behavior. However, changes in income can be transferred almost entirely to ethanol consumption. This is a very important observation, especially considering that previous studies considered GDP as a proxy for income, considering the real effect of income over fuel consumption. At the same time GDP is not significant for gasoline and ethanol demand, disagreeing with previous studies such as Bentzen, (1994), Bueno (2003), Eltony and Al-Mautairi (1995).

The substitution effect is confirmed when we analyzed the ethanol consumption (table 5) and corroborates with Looty, M et al. (2009) results. The gasoline consumption and ethanol prices have a negative effect on the ethanol demand. It is important to note that the substitution effect occurs with different intensity for both fuels. Ethanol demand is more elastic then gasoline, which is probably related with the existence of a great number of cars without "flex fuel" motors, and uses only gasoline, what does not happen with ethanol, this way gasoline is ways a substitute to ethanol, but the reverse does not always occur.

Table 5: Regression results for ethanol consumption (pooled)

	coefficient	**std. error**	**t-ratio**	**p-value**
const	0.374222	0.0302393	13.20	0.000*
ld_income	0.945037	0.135499	6.821	0.000*
ld_ gas _ cons	-1.61426	0.165428	-7.084	0.000*
ld_ etan _ price	-1.63382	0.121976	-13.47	0.000*
ld_etan_price _1	-0.731435	0.118452	-7.116	0.000*

Notes: R-squared = 0.536581 and Adjusted R-squared = 0.527405
*Denotes statistical significance at 1% level.

Thus, this strong substitutive relation between ethanol and gasoline is different of the obtained by Bueno et al. (2003), and reveals a market change occasioned by the introduction of this new technology. Table 6 presents Variance Inflation Factors and confirm the absence of collinearity and table 7 presents the White's test which discards the presence of heteroskedasticity for both models.

Table 6: Variance Inflation Factors

Gasoline regression		**Ethanol regression**	
Dummy	1.318	Dummy	1.297
ld_income	1.093	ld_income	1.051
ld_GDP	1.265	ld_ gas_cons	1.358
ld_gasoline_price	1.635	ld_ etan_price	1.217
ld_ ethanol_cons	1.411	ld_etan_price _1	1.191

Notes: Values > 10.0 may indicate a collinearity problem

Table 7: White's test for heteroskedasticity

Model	Test statistic	p-value
Gasoline regression	19.9836	0.395565
Ethanol regression	17.7106	0.474866

H_0: heteroskedasticity not present

Table 8 shows a comparison between our results and those of Bueno et al. (2003) and Li, R. and Leung, G. (2012) and highlights that Brazilian gasoline market is less elastic in relation to income than the Chinese (considering that Li, R. and Leung, G. (2012) use GDP as proxy for income. The gasoline price-elasticity is related from found in Bueno (2003), however, ethanol seems to present an elastic-price behavior, what is consistent with standard deviation analysis.

Table 8: Comparison with previous studies (gasoline/ethanol)

Study	Country	Period	Income Elasticity	GDP per capita	Price elasticity	Ethanol demand-crosselasticity
Present Study	Brazil	2001–2010	0.095/0.94	ǂ	-0.53/-1.63	-0.07
Alves and Bueno (2003)	Brazil	1974-1999	-	0.12	-0.46ǂ	-
Li, R. and Leung, G. (2012)	China	2003-2009	-	1.10	-0.17ǂ	-

ǂ indicates insignificance at any conventional significance level.

Thus, changes in ethanol prices have serious effect on its demand, at the same time ethanol demand cross-elasticity highlights its usefulness as alternative fuel. Those results show the relevance of energy sector for national development, once it is necessary to guarantee fuel supplies with reasonable costs. In this scenario Brazil can take an important advantage since it has available substitute fuels from different sources

The significance of the dummy suggests that PECS have impact on gasoline demand. We can observe a positive effect of this police on gasoline consumption what is consistent, since more cars are sold more fuel is consumed. As mentioned before, PECS was created to encourage consumption and to stimulate internal market, its positive effect over gasoline price is an important reflex, once variation in fuel prices are computed in the calculation of life costs and inflation rates. At the same time, the PECS seems to have a negative effect on ethanol demand. This can be justified for two different points of view. First, the substitutive effect can be present, and consumers prefer to fill their cars with gasoline. An alternative explanation is the ethanol seasonality, that is not captured for the model, influencing this coefficient.

5. Conclusions

Brazilian fuel market passed by a lot of changes in the last decade, the popularization of "flex-fuel" seems to be determinant in the dynamics of prices and consumption. Besides, the economic growth and the implementation of policies to encourage the purchase of cars started a new period in this sector.

Gasoline and ethanol come across as substitutes in different intensities as gasoline consumption affects the ethanol in higher intensity. However ethanol consumption do not have the same power over gasoline consumption, this can be explained by car fleet characteristics

and by ethanol price volatility, especially the latter shall draw attention, since in the past, problems to stabilize supply and prices were responsible for the failure of ethanol as an alternative fuel.

Another important contribution of this study is the relation of fuel consumption, household income and GDP. This positive relation with income highlights the impact of this variable over fuel consumption. At the same time, GDP is not significant, disagreeing of previous studies. We must take into account that Brazilian economy is passing to a new era, and population is getting more consumption power and this will pressure fuel demand. Here ethanol turns out as an alternative to hold fuel price increases.

As expected the PECS had a positive effect on gasoline demand, what shows the efficiency of this policy in promotes consumption, encouraging automotive industry and for consequence fuel demand. However this effect must be observed carefully, once increases in fuel prices adds to the cost of living and is computed in the inflation rates, always a concern to policy makers.

The paucity of data related of price and consumption of fuels and the frequency of disclosure of GDP and household income in Brazil limits the use of more advanced models, disregards seasonal effects present in ethanol production. Nevertheless, this approach offers a good base for market analysis and for policy makers to observe the impact of PECS and take decision about stabilization policies so necessary to fix ethanol as an alternative fuel.

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