LIGHT FUELS MARKET IN BRAZIL

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# Overview

The growing urgency to accelerate the energy transition has been pressuring governments and policymakers to present effective plans for a sustained long-term decrease in greenhouse gas emissions. In Brazil, some general bills aimed at fossil fuel replacement with sustainable alternative fuels have been proposed by congressmen and by the government [1]. All of them consider ethanol to remain an important component of the Brazilian transition. Therefore, a constant revisitation of the policies' effects is needed to assure market competitiveness and further enhance consumer switching to ethanol. In this context, fuel demand elasticities are an important input for policymakers. Although the subject has been explored in literature [2-5], our work uses a new database with much greater granularity, containing fuel consumption per municipality per month in the 459 municipalities for which retail prices are available. We find own-price elasticities to be 1.2 for gasoline and 1.7 for ethanol, higher than values found in previous research, indicating that Brazilian consumers may be more price-sensitive than previously thought. Cross-price elasticities were positive and significant for both fuels and also higher than previous results.

**Methods**

To estimate fuel demand, we used a time series approach with both time and individual fixed effects, accounting for constant non-observed heterogeneity between municipalities. The models were estimated using as explanatory variables fuel prices, and income. We did not include the fleet, as it is common in the literature because it was accounted for in the individual fixed effects. Our estimations used a database containing fuel consumption per municipality per month in the 459 municipalities for which retail prices are available for the 36 months of the years 2019, 2020, and 2021. The panel is unbalanced because due to technical problems, the retail price survey was not carried out in all municipalities in all months.

Volumetric consumption data was provided by ANP and is extracted from the declared total sales by fuel distributors to gas stations per municipality per month. Income was represented by GDP per capita provided by IBGE per municipality per year. Despite the lack of monthly variability, GDP was considered the best variable because it is uncorrelated with fuel demand. Other research used the amount of collected taxes per state (ICMS), for instance. However, this variable is not available per municipality and is closely correlated with fuel consumption because a significant share of those taxes comes from fuel.

The available gasoline and ethanol retail prices come from a weekly survey contracted by ANP and carried out by researchers in a sample of gas stations located in 459 selected municipalities. Prices were taken as a simple monthly average per municipality. The gasoline prices were considered exogenous mainly due to the pricing policy adopted by Petrobras during the investigated period (2019-2021). In this interval, fossil gasoline sold by Petrobras to distributors in Brazil was priced according to the import parity price (IPP) plus a price margin to remunerate risks inherent to the operation [5]. Considering that, first, Petrobras had a very significant market share -- 80% in 2019, 77% in 2020, and 82% in 2021 [6], and, second, that the gasoline blend was composed of 73% fossil gasoline, Petrobras pricing policy is a major factor determining the gasoline retail price.

Ethanol pricing is completely different because market forces are at work in the sugarcane/ethanol industry. In the period 2020-2021, production market shares were pulverized among 255 producers, the largest one responsible for no more than 6% of total ethanol production [6]. As expected not only because of the ethanol blend to gasoline but also because of the way ethanol is priced, ethanol prices are correlated to gasoline prices. This issue will be treated with an instrumental variable approach.

We opted not to deflate prices since they are connected to international prices and exchange rates rather than to the general price increase in the national economy. Moreover, all the analysis is carried out within the same market. To avoid the endogeneity caused by the naturally endogenous cycle between supply and demand, we used lagged prices both for gasoline and ethanol.

# Results

We found the following price and income elasticities for gasoline and ethanol.

|  |  |  |
| --- | --- | --- |
|  | (1) | (2) |
|  | Gasoline demand | Ethanol demand |
| Gasoline price | -1.234\*\*\* | 1.352\*\*\* |
|  | (0.0459) | (0.104) |
| Ethanol price | 0.830\*\*\* | -1.738\*\*\* |
|  | (0.0234) | (0.0530) |
| Income | 0.141\*\*\* | 0.199\*\*\* |
|  | (0.0145) | (0.0328) |
| Constant | 15.49\*\*\* | 13.80\*\*\* |
|  | (0.0649) | (0.147) |
| *N* | 11,938 | 11,924 |
| *R*2 (within) | 0.633 | 0.545 |

Own-price elasticities were found to be -1.2 for gasoline and -1.7 for ethanol, both higher than values found in previous research [2], indicating that Brazilian consumers may have become more price-sensitive than previously. Ethanol demand is more affected than gasoline by its own price, in line with the vast empirical literature that finds that ethanol's own price elasticity is higher than gasoline's.

Cross-price elasticities were positive and significant for both fuels. Given the composition of the circulating fleet with about 90% of flexible-fuel vehicles [7] and the persistence of ethanol incentive policies and its widespread use, it is expected that, by now, ethanol and gasoline are considered substitute goods in the light fuel market in Brazil. Ethanol demand is more affected by gasoline prices than the other way around.

Overall, gasoline demand is less affected by fuel prices than ethanol demand. This result may point to the conclusion that a share of consumers is resistant to switching to ethanol and, even in favorable price conditions, they choose gasoline instead of ethanol [8].

Both income elasticities are positive and significant: 0.14 for gasoline and 0.20 for ethanol. Therefore, an increase in income results in an increase in ethanol consumption larger than in gasoline consumption.

Finally, in both fuel demand model estimates, the constants are significant and were found to have high values, indicating that factors other than prices and income are important to explain fuel demand.

**Conclusions**

Ethanol will remain an important component of the Brazilian energy transition from fossil fuels to sustainable alternatives. Therefore, it is important to keep its incentive policies under continuous scrutiny. The fuel demand model with more granulated data indicated that both gasoline and ethanol prices may be more determinant than previously thought, which confirms the importance of ethanol tax exemption and other policies to increase its market competitiveness. The significance of the individual fixed effects in the model also points out that other factors may be significant in explaining fuel consumption, which deserves further research.

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