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Abstract

We estimate the price elasticity of demand for gasoline in a price-taking economy. Specifically, we calculate the short and long run elasticity for the three main types of fuels used in the country. For higher octane gasoline, we obtained an elasticity between -0.58 and -0.30 in the short term, while in the long run, the results were in the range of -0.58 and -0.51. These results tend to be slightly above the elasticities for other countries in the region. However, for the remaining two fuels, the elasticities are in the range found by other research. In the short run, the elasticity of gasoline with lower octane levels was between -0.19 and -0.08, in the long run, it was between -0.15 and -0.10. The elasticity for diesel in the short term is zero, while in the long term it was between -0.13 and -0.005. Our results can inform policymakers from Costa Rica and from other small, non-oil-producing economies, about the distributional and revenue effects of gasoline prices and taxes.

Keywords: instrumental variable, gasoline demand elasticity, Costa Rica.

1. Introduction

Most countries in the world have experienced growth in their vehicle fleet and an overload on the public transportation system, which exacerbates the negative externalities associated with the use of gasoline and vehicles. Some of the typical externalities relate to road congestion, accidents, noise, and environmental pollution. To solve the problems derived from fuel use, institutions can implement corrective measures such as carbon taxes or taxes on environmental pollution (Kamruzzaman & Mizunoya, 2021; Parry et al., 2014; Georgina Santos, 2017; Zimmer & Koch, 2017).

However, to establish a tax that guarantees the desired corrective effect, it is necessary to consider how consumers would respond when the final price of a good varies. In other words, it is useful to know the elasticity of gasoline in the country in which the measure is to be applied. Thus, in this paper, we estimate the price elasticity of demand for the three main transportation fuels in Costa Rica, i.e. high-octane level gasoline, low-octane level gasoline, and diesel. Costa Rica is a small and open economy, which does not produce or refine oil, and has no capacity to influence international fuel purchase prices.

Historically, in the country high-octane level gasoline has been the most expensive gasoline. Due to the more powerful additives, this gasoline has 95 octane levels and is therefore recommended for large-cylinder capacity automobiles. The octane level measures gasoline's antiknock property, which is gasoline's resistance to not detonate prematurely due to the mixture of air and gasoline. Low-octane level gasoline has a lower price than the previous gasoline and is recommended for vehicles with low power, due to its 91-octane level. Diesel is an easier fuel to refine than previous types of gasoline, thereby it is cheaper to produce. In addition, the chemical composition of diesel allows it to have a higher yield per liter. It works in vehicles with diesel motors, thus in Costa Rica, its use is associated with the transportation, industrial, and electricity generation sectors.

Elasticity is a basic and very useful tool that measures the sensitivity of the quantity demanded by consumers due to changes in price. From there, it allows quantifying the effects that the implementation of taxes can have on the quantities demanded and tax collection. More general, elasticities constitute a useful input for the analysis and proposal of public policies that influence both the taxation and price of fuels and thus, their consumption.

Hence, this research overcomes the lack of information on the elasticities of gasoline and diesel, which has limited the scope of energy studies in the country for years. More importantly, the results obtained can be representative and used by developing countries with small economies, since the literature for developing countries focuses on larger economies such as Mexico or Brazil. In addition, we use instrumental variables, which solves endogeneity problems and ensures that the elasticity estimates are consistent and efficient.

To conduct the research, we gather data from 2000 to 2017 and considering the endogenous nature of the dynamics between price and consumption, we decide to use the instrumental variable method to reduce possible biases in the estimation. The international reference price is chosen as the instrument because it is reasonable to expect that local demand for gasoline does not change external prices. To avoid possible endogeneity channels related to international shocks to domestic demand, we control for some U.S. macroeconomic variables.

For diesel, the estimates indicate that the elasticity is statistically equal to zero in the short run. However, in the long run significant elasticities are obtained between -0.13 and -0.005. Thus, in the short run, a tax would have no effect on the quantity demanded, although in the long run it is possible that some reduction, in statistically significant terms, in diesel consumption would be noted.

The short run elasticity for gasoline low-octane level gasoline is in the range of -0.19 and -0.08, while in the long run, the elasticity is in the range of -0.15 and -0.10. Gasoline low-octane level gasoline has been considered an economical substitute for high-octane level gasoline by many consumers. This situation could be behind the low sensitivity of demand for this fuel to price changes. The high inelasticity of low-octane level gasoline would indicate that, for example, tax increases would decrease the amount consumed by a small amount.

The results indicate that High-octane level gasoline presents the highest elasticities among the three fuel categories studied, i.e. the price elasticity of demand in the short run is in the interval -0.58 and -0.30, and in the long run it is between -0.58 and -0.51. The relatively high sensitivity of high-octane level gasoline could be explained by the substitution effect between high-octane level gasoline and low-octane level gasoline, as users tend to prioritize the price factor, especially when the price gap between the two fuels widens. Furthermore, the magnitude of the high-octane level gasoline elasticity suggest that price changes caused by increases in the gasoline tax, reduce the quantity demanded in a statistically significant way.

The rest of this paper is organized as follows, section 2 presents a brief summary of the results previously found in the literature, section 3 describes the data used, section 4 explains the methodology, section 5 shows the results, and finally the conclusions are in section 6.

2. Price Elasticity in the Literature

The literature on the price elasticity of gasoline demand is extensive. The studies provide a spectrum of results for gasoline and diesel elasticity depending on the period of analysis, the econometric model used, the functional form and specification of the model, and the frequency of the data. For example, Levin at al. (2017), state that elasticities of greater magnitude are attributed to the use of higher frequency data. Additionally, according to the analysis by Lin & Prince (2013), price volatility also influences the size of the elasticity. Lin & Prince find that the higher the price volatility, the lower the price elasticity of gasoline consumption in the United States, so consumers respond very slightly to higher prices.

In the following, we describe gasoline price elasticities in different countries and using different periods and estimation methods. Thus, Lin & Prince (2013) outline the results previously found for developed countries; from their work it can be summarized that in the short run the elasticities are in the range of -0.57 to -0.01, and in the long run they range from -1.81 to 0. For the United States, several authors have found a negative and quite small price elasticity, from -0.35 to -0.04 (Havránek et al., 2012; Levin et at., 2017; Wood et al., 2022). These authors have applied meta-analysis, traditional time series models such as SVAR or VECM, and instrumental variables.

In this regard, Levin et at. (2017) states that endogeneity causes a bias in the elasticities, making them more inelastic than they really are. In addition, using highly aggregated data increases bias, while using high-frequency data allows sufficient variation to identify demand, and reduces potential endogeneity biases. Concerns about endogeneity have led other researchers to address the instrumental variable method, for example, Lin & Zeng (2013), estimated an elasticity in the range of -0.50 and -0.20 for China, using various data frequencies from 1997 to 2008. They, also, compile the results obtained for different Asian countries, describing that in the short run price elasticities are in the range of -0.50 to 0.055.

For México, the results found by Crôtte et al. (2010) are much more inelastic than those for China, even though some of the estimates are based on the generalized method of moments, which also makes use of the idea of an instrument. Specifically, they estimate price, income and cross-elasticities of gasoline demand per car, both at the national and local level. The long run elasticities found for Mexico City range from -0.2 to -0.26, while in the short run the elasticity showed to be between -0.10 and -0.38. The price elasticity in the short run at the national level varies in the range of -0.06 to -0.15, while in the long run it ranges from -0.06 to -0.38.

In the meta-analysis performed by Galindo et al. (2015), it is noted that the elasticity in the long run in Latin America is lower in absolute value than those presented in OECD countries. The explanation for this result, and in general for the low gasoline price elasticities in the region, is due to the low substitutability of private transport versus public transport options in most Latin American countries.

Gasoline itself may have substitutes that affect price elasticities. Following this line, Gervásio Santos (2013) argues that the fuel market in Brazil is very diverse in terms of the options or substitutes that may be available for gasoline. Thus, he includes the prices of substitute goods and finds an elasticity in the short run equal to -0.40 and in the long run equal to -1.19. In the same line, Galindo et al. (2015) conclude that the inclusion of the prices of gasoline substitutes allows for obtaining elasticities of greater magnitude.

3. Data

To estimate the price elasticity of fuel demand, monthly nationwide data on consumption in liters were used from January 2000 to February 2017. The three fuel categories of interest for this study are high-octane level gasoline, low-octane level gasoline and diesel, which are the main fuel for transportation in the country. The reference price and the price of each fuel category were calculated as the average price weighted by the number of days in the month that a price was in effect.

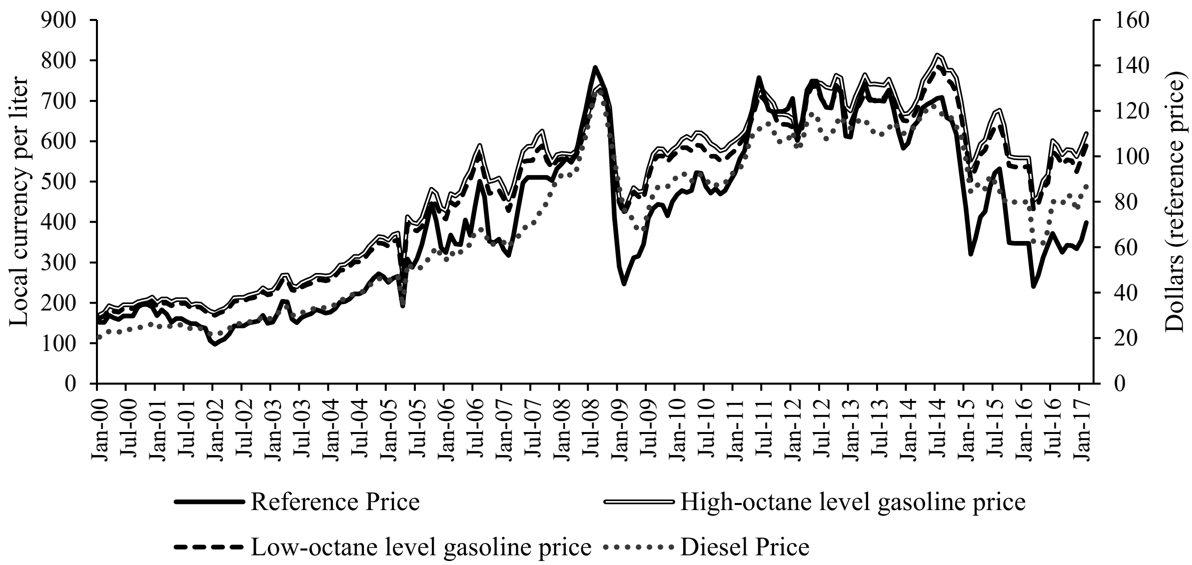
Consumption and price data for each of the gasoline categories were collected from the Costa Rican Petroleum Refinery (RECOPE), while the international reference price was taken from the Public Services Regulatory Authority (ARESEP). The two national variables used were the consumer price index and the monthly economic activity index. The former was extracted from the National Institute of Statistics and Census, and the latter was obtained from the Central Bank of Costa Rica. Additionally, for the instrumental variable models, macroeconomic variables from the United States were used, these are the Economic Activity Index and the unemployment rate, both taken from FRED.

Figure 1 shows the monthly evolution of the gasoline prices, as well as the international reference price used to calculate the final price of each of the three fuels from January 2000 to

February 2017. Note that the local price of fuels follows the behavior of the international reference price. Fuel prices in Costa Rica are regulated by law and adjustments are based on the reference price as the main component of local prices. In particular, in Costa Rica, to determine the price of fuels, a price proposal must first be submitted by RECOPE and then analyzed by ARESEP, which finally decides on the approval or rejection of the proposal.

Figure 1.

Gasoline Price and Reference Price in Costa Rica

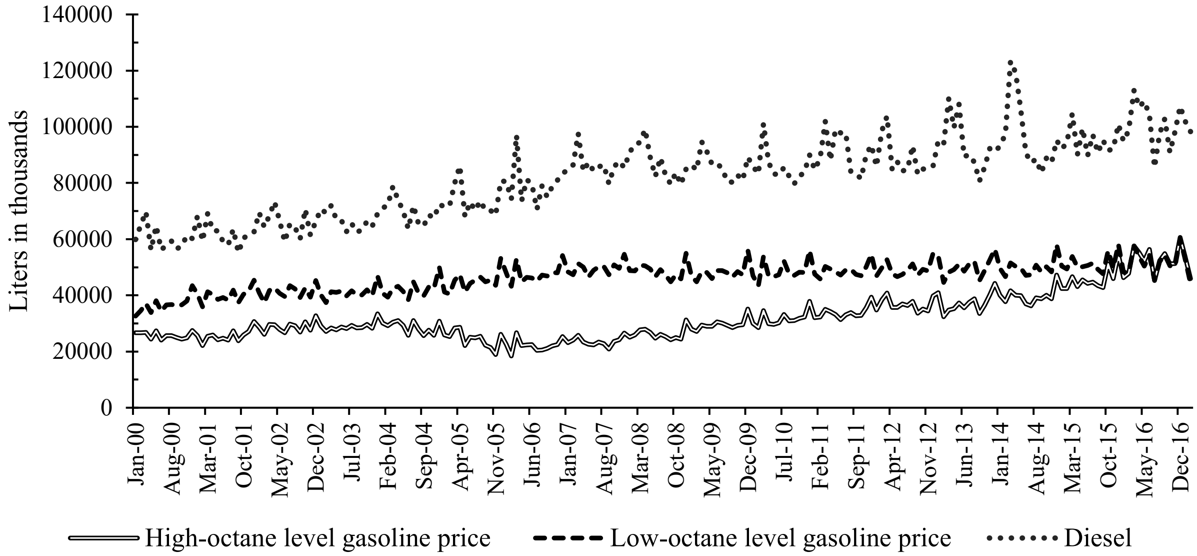


Source: Own elaboration based on RECOPE data.

In Figure 2 is presented the evolution of monthly fuel consumption between 2000 and 2017. The fuel with the highest consumption in the country is diesel, since is mainly used by industrial and transportation sectors, which depends on this input to develop the activities. Furthermore, its consumption has increased through the period studied. High-octane level gasoline and low-octane level gasoline fuels are related to household consumption and transportation in private vehicles, which could explain the slight behavior of prices over time. Also, given the features of each of these gasolines, the consumption of high-octane level gasoline has been lower than the consumption of low-octane level gasoline.

Figure 2.

Monthly consumption of Gasoline Liters in Costa Rica

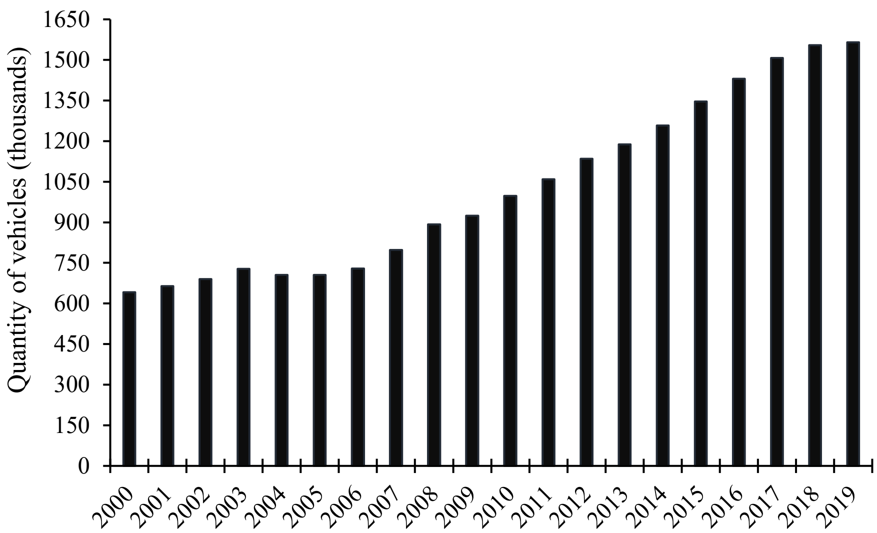


Source: Own elaboration based on RECOPE data.

Closely related to the long run growth in the demand for fuels is a growing demand for vehicles that require such fuel for their operation. As shown in Figure 3, at the beginning of the period, Costa Rica had a total vehicle fleet of 607102 vehicles. By 2017 that number increased 2.4 times, reaching a total of 1,506,932 vehicles, with an average annual growth rate of the vehicle fleet of 5.6%. The above is especially striking in the context of the average annual growth of the Gross Domestic Product in the same period was 4.2%.

Figure 3.

Vehicle fleet in Costa Rica, 2000 to 2019



Source: Own elaboration based on the Statistical Yearbooks of the Transportation Ministry.

The increase in the number of vehicles has consequences that go beyond the increase in the demand for fuels, such as an increase in carbon dioxide emissions, air pollution, and fuel dependence. This is a generalized phenomenon, and in certain countries, it is a particularly acute problem, as shown, for example, by the analysis made by Lin and Zheng (2013) for the case of China, where rapid economic growth and urbanization over the last three decades has led to average growth of the vehicle fleet of approximately 15% in the period between 1985 and 2010. This has raised air pollution levels to a situation that creates real threats to human health. This problem has been alleviated through measures such as a tax on fuel consumption.

4. Methodological Strategy

4.1. Basic Model

The first model proposed to analyze the price elasticity of demand for fuels has the following functional form:

$$lnD_t = \beta_0 + \beta_1 lnP_t + \beta_2 lnIMAE_{t-1} + \sum_{j=2}^{12} \gamma_j Mes_j + \sum_{k=2}^{17} \varphi_k Año_k + \varepsilon_t \quad (1)$$

Where D_t represents the consumption in liters per month t, P_t the final price of fuel in month t. As a covariate, the logarithm of the Monthly Index of Economic Activity $IMAE_t)$ is included, and to control for the economic cycle and seasonality, dichotomous variables are included for each month and year, taking January as the base month and 2000 as the base year.

The interpretation of the coefficients in this log-log model assumes that the price elasticity of demand for each fuel category should be as follows:

$$\frac{\partial lnD_t}{\partial lnP_t} = \beta_1 \quad (2)$$

In order to evaluate the sensitivity of the basic model and its results, alternative models will be analyzed in an attempt to address the endogeneity of fuel prices with respect to their demand.

4.2. Instrumental variable models

A recurrent and well-known problem in the estimation of demand equations is that both price and quantity are determined simultaneously by the intersection of the supply and demand curves in the market equilibrium. The endogeneity implies that the estimators obtained by Ordinary Least Squares (OLS) of the basic model presented above are biased.

To address this problem, it is necessary to find an instrumental variable that meets the following two requirements: 1. It must be highly correlated with the price of fuels and 2. It should not be related to unobserved shocks on demand. For this research, the instrument selected is the logarithm of the international reference price, which is closely related to the local price because it is a variable directly included by RECOPE in the determination of the final price. The international reference price also has the characteristic of not being related to possible unobserved effects on the local demand for fuels, since it is an exogenous price that is determined internationally.

The relationship between the international oil price and local retail prices has focused on the periodicity and duration of the pass-through effect of changes in the international price on gasoline prices, although some studies warn that the pass-through effect and its persistence may be asymmetric (Wood et al., 2022). It is of interest for this research only the causal relationship between these prices in order to be able to solve the endogeneity of our variable of interest. Although it is possible to deduce from Table 1, which contains the first stage of the instrumental variable method, that the pass-through effect of the international price on domestic prices is also observed for Costa Rica.

Taking into account that the international price could also be endogenous due to channels such as tourism, we decide to include the Coincident Economic Activity Index and the unemployment rate in the United States. In Costa Rica, tourism, and especially that of Americans, is one of the sectors that contributes most to the gross domestic product and economic growth. Therefore, the

U.S. economy, through the arrival of tourists, could be affecting the consumption of gasoline by airlines and tourists within the country. Likewise, the income from tourism could generate increases in household and national income that could allow for more frequent use of vehicles and longer trips.

The results of the first stage are presented below to show the relevance of the instrument. In particular, two first stage models were used to evaluate the relationship between local prices and the international reference price.

$$lnD_t = \beta_0 + \beta_1 lnP_t + \beta_2 IMAE_{t-1} + \beta_2 lnCEAI_t + \beta_3 lnU_t + \sum_{j=2}^{12} \gamma_j Mes_j + \sum_{k=2}^{17} \varphi_k Año_k + \varepsilon_t \quad (3)$$

$$lnD_t = \beta_0 + \beta_1 lnP_t + \beta_2 IMAE_{t-1} + \beta_2 lnCEAI_t + \beta_3 lnU_t + \sum_{j=2}^{12} \gamma_j Mes_j + Año_t + Año_t^2 + \varepsilon_t \quad (4)$$

The first model indicated by equation (3) includes the logarithm of the international reference price and, as control variables, the logarithms of the Coincident Economic Activity Index ($CEAI_t$) and of the monthly unemployment rate (U_t) of the United States, in addition to the dichotomous variables of month and year that were included for the basic model described in equation (1). In the second model (equation (4)), the difference lies in replacing the year dichotomous variables with a trend variable, which takes the value of the year in which each observation was made, and the square of that trend variable.

Table 1 shows a clear positive and statistically significant relationship between the international reference price and the price of each fuel category.

Table 1.

First Stage Instrumental Variable

		log(price)	
		(1)	(2)
High-octane level gasoline	log(reference price)	0.504*** (0.019)	0.429*** (0.012)
	Observations	205	205
	R^2	0.996	0.994
Low-octane level gasoline	log(reference price)	0.504*** (0.019)	0.438*** (0.012)
	Observations	205	205
	R^2	0.997	0.994
Diesel	log(reference price)	0.513*** (0.030)	0.582*** (0.017)
	Observations	205	205
	R^2	0.994	0.991
Year effects		Yes	No
Month effects		Yes	Yes
Trend		No	Yes
Controls		Yes	Yes

Note 1: standard errors in parenthesis. *** significance at 1%, ** significance at 5%, * significance at 10%.

Note 2: high-octane level gasoline refers to an octane level of 95, and low-octane level gasoline means an octane level of 91.

4.3. Partial Adjustment Model

Considering the data available and the literature on price elasticities, a partial adjustment model is presented, which is considered one of the least complicated dynamic models to estimate. Following Gervásio Santos (2013), this model takes into account that frictions in the fuel market may cause price changes to be non-instantaneous. For this model the variables are used in real terms. Thus, the prices of the three fuels are expressed in constant January 2000 prices, using the Costa Rican Consumer Price Index. On the other hand, we decided to leave the real reference price, in nominal dollars, since it reflects the real cost of fuel in Costa Rica.

Thus, the model consists of modifying equation (1) of the basic model by using real prices and adding the logarithm of the demand of the previous period (D_{t-1}) as follows:

$$lnD_t = \alpha_0 + \alpha_1 lnP_t + \alpha_2 lnD_{t-1} + \alpha_3 lnIMAE_{t-1} + \sum_{j=2}^{12} \gamma_j Mes_j + \sum_{k=2}^{17} \varphi_k Año_k + \varepsilon_t \quad (5)$$

By estimating equation (5) using OLS, it is obtained that the coefficient α_1 represents the elasticity in the short run, while $\alpha_1/(1-\alpha_2)$ can be interpreted as the elasticity in the long run. It should be noted that, as Lin & Zeng (2013) explain, if the adjustment in prices occurs briefly then the fully adjusted elasticity can be called short run elasticity. The estimation of the partial adjustment model using instrumental variable follows the same logic outlined above in which two models that differ slightly in the control variables used are estimated, and the long run coefficient is obtained as with OLS.

5. Results

Table 2 shows the results of the models estimated using OLS and Instrumental Variable. The three log-log models used to measure the price elasticity of demand for each fuel category between the years 2000 and 2017 yielded consistent estimates. For diesel, the coefficients are significant only for the basic OLS model with a magnitude of -0.12; in general, the results are in the interval between -0.12 and -0.004. However, it is interesting to note the elasticities close to zero obtained for diesel in columns (1) and (2) of the instrumental variable, indicating no effect of price over the quantity consumed.

The short run elasticities obtained for low-octane level gasoline are significant and are in the interval -0.17 and -0.8. The case of high-octane level gasoline shows significant elasticities in the range between -0.53 to -0.40. In general, the size of the elasticity for high-octane level gasoline is larger than that of the elasticity for gasoline with low-octane levels. In addition, in the instrumental variable models, the coefficients obtained tend to be smaller than those estimated by OLS, which warns of a negative bias in the estimates of the basic model.

Table 2.

Basic Model and Instrumental Variable results

		Dependent variable: Liters of gasoline (diesel)		
		OLS	Instrumental Variable	
			(1)	(2)
High-octane level gasoline	log(Price)	-0.504*** (0.050)	-0.531*** (0.054)	-0.399*** (0.044)
	Observations	205	205	205
	R^2	0.971	0.975	0.946
Low-octane level gasoline	log(Price)	-0.169*** (0.038)	-0.128*** (0.044)	-0.084*** (0.026)
	Observations	205	205	205
	R^2	0.922	0.921	0.905
Diesel	log(Price)	-0.122** (0.049)	-0.035 (0.063)	-0.004 (0.028)
	Observations	205	205	205
	R^2	0.928	0.928	0.918
Year effects		Yes	Yes	No
Month effects		Yes	Yes	Yes
Trend		No	No	Yes
Controls		Yes	Yes	Yes

Note 1: standard errors in parenthesis. *** significance at 1%, ** significance at 5%, * significance at 10%.

Note 2: high-octane level gasoline refers to an octane level of 95, and low-octane level gasoline means an octane level of 91.

The above results, and specifically those presented for high-octane level gasoline, are consistent with previous research conducted for different countries. It should be noted, as mentioned, that for different countries and periods there is considerable variability. The elasticity found, for example, by Ramanathan (1999) for fuel in India in the period 1973-1987 was -0.21, while a study conducted for 11 Asian countries by McRae (1994) found an elasticity for fuels in the range between 0.01 and -0.5, a range within which the results of the present research also fit.

Table 3 summarizes the results for the partial adjustment model estimated both by OLS and using instrumental variable, following the specifications used in the previous models. In general, the magnitude and significance of the short run elasticities found using real prices for the three fuel categories are relatively similar to those found using nominal prices (see Table 2). Low-octane level gasoline and diesel tend to show lower elasticities using real prices, contrary to what the coefficients for high-octane level gasoline show.

Table 3.

Partial adjustment models

		Dependent variable: Liters of gasoline (diesel)		
		OLS	Instrumental Variable	
			(1)	(2)
High-octane level gasoline	log(Price)	-0.483*** (0.057)	-0.582*** (0.065)	-0.301*** (0.054)
	log(Liters)_t-1	0.059 (0.064)	-0.010 (0.063)	0.446*** (0.059)
	Observations	205	205	205
	R^2	0.969	0.972	0.952
Low-octane level gasoline	log(Price)	-0.189*** (0.040)	-0.141*** (0.046)	-0.100*** (0.031)
	log(Liters)_t-1	-0.224*** (0.071)	-0.223*** (0.071)	-0.042 (0.070)
	Observations	205	205	205
	R^2	0.926	0.926	0.906
Diesel	log(Price)	-0.135** (0.054)	-0.030 (0.069)	-0.005 (0.032)
	log(Liters)_t-1	-0.042 (0.074)	-0.061 (0.076)	0.026 (0.073)
	Observations	205	205	205
	R^2	0.929	0.928	0.918
Year effects		Yes	Yes	No
Month effects		Yes	Yes	Yes
Trend		No	No	Yes
Controls		Yes	Yes	Yes

Note 1: standard errors in parenthesis. *** significance at 1%, ** significance at 5%, * significance at 10%.

Note 2: high-octane level gasoline refers to an octane level of 95, and low-octane level gasoline means an octane level of 91.

Finally, as shown in Table 4, the short and long run elasticities are slightly different. For diesel, the short and long run magnitudes differ minimally, although the long run elasticities do show significance, albeit only at 10%. For low-octane level gasoline and diesel, the long run elasticity is lower than the short run elasticity using absolute values. The long run elasticity for low-octane level gasoline is significant at least at 5%. The long run elasticity for high-octane level gasoline, is significant and higher than the short run elasticity, in absolute terms.

High-octane level gasoline has historically had higher prices than the other fuels analyzed. This characteristic could be behind the explanation for the higher elasticity in the long run, since people would have more time to modify their consumption patterns in the face of price changes. low-octane level gasoline, on the other hand, has been seen as a cheaper alternative to high-octane level gasoline, explaining the lower price elasticity in the long run. Something similar happens with diesel because, as mentioned before, it is mainly used by buses, trucks and trailers associated with public transportation or industrial and commercial sectors that usually use vehicles whose engines run only on diesel or biodiesel. Nevertheless, given the low production of the second option, users have no alternative but to consume diesel at the price at which it is sold, thus explaining the low and almost null response of consumers in both the short and long run.

Table 4.

Price elasticity of demand for the three categories of fuels

		OLS	Instrumental Variable	
			(1)	(2)
High-octane level gasoline	Short run elasticity	-0.483***	-0.582***	-0.301***
	Long run elasticity	-0.513***	-0.576***	-0.543***
Low-octane level gasoline	Short run elasticity	-0.189***	-0.141***	-0.100***
	Long run elasticity	-0.154***	-0.115***	-0.096**
Diesel	Short run elasticity	-0.135**	-0.030	-0.005
	Long run elasticity	-0.130*	-0.028*	-0.005**

Note 1: standard errors in parenthesis. *** significance at 1%, ** significance at 5%, * significance at 10%.

Note 2: high-octane level gasoline refers to an octane level of 95, and low-octane level gasoline means an octane level of 91.

6. Conclusion and Policy Implications

In the previous section we found that the two types of gasoline and diesel are quite inelastic. Among the three fuel categories investigated, high-octane level gasoline showed, in absolute terms, the highest elasticities in both the short and long run. The results for diesel showed an elasticity statistically equal to zero in the short run, which suggests that changes in the price of diesel will not have a significant impact on the consumption of this fuel by public transport vehicles and industrial sectors. The null response in the short run is due to the limited capacity of the diesel consumers to change their consumption needs. The reduced response capacity of the sectors that consume diesel might indicate that price increases are transferred to the final consumer of the goods that use it as an input, which would cause increases in the general price level of the economy.

The low sensitivity of gasoline with low-octane levels is possibly explained by two reasons. The first is its quality as a substitute for high-octane level gasoline, and the second is its historically lower price, which makes it a cheaper option for high-octane level gasoline. The easiness of substitution between these two types of gasoline indicates that, although the consumption of both is affected by their own price, consumers will prefer to buy low-octane level gasoline when the price of high-octane level gasoline increases, even when the price of low-octane level gasoline has also increased, since, throughout the period analyzed, the price of high-octane level gasoline has tended to be higher than the price of low-octane level gasoline.

The results suggest that the quantity of high-octane level gasoline purchased will vary significantly, albeit little, in response to price changes resulting from tax changes. Low-octane level gasoline will respond similarly to tax changes, but the response in quantity will be lesser, as this type of fuel is much more inelastic than high-octane level gasoline.

In fiscal terms, the inelasticity shown by the three types of fuels studied can be translated into increases in tax revenue through policies aimed at modifying the price. Our results indicate that consumers do not vary substantially the quantity of fuels purchased when the price changes. Thus, although the quantity demanded would decrease with price increases, the decrease would be quite slight, and thus total tax revenue would increase. At the opposite, reductions in taxes would increase the amount of fuel purchased very little, and the final effect would tend to decrease revenue.

On the other hand, public policy that seeks to reduce negative externalities such as CO2 emissions should pursue price increases, either through taxes or fees, high enough to begin to make demand more elastic so that it responds more strongly to prices. However, a tax, even a Pigouvian tax, does not solve the tangible negative effects caused to the environment. Thus, other alternatives must be sought and implemented to mitigate such effects.

Finally, future research could estimate the income elasticity of gasoline including the size of the automobile fleet to understand the link between national income and automobile demand, and also to understand and devise public policies that resolve or create resilience to the negative externalities associated with road congestion in the country's urban centers and areas.

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