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INCOME AND PRICE ELASTICITIES OF GASOLINE DEMAND: AN EMPIRICAL ANALYSIS FOR RUSSIA

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ABSTRACT

The current study investigates the income and price impacts of gasoline demand for Russian case, employing different cointegration techniques to the data spanning from 2002Q1 to 2018Q1. The cointegration exercises confirmed the existence of the long-run relationship among the variables of interest. Estimation results showed that income and price has statistically significant impact on gasoline demand. The estimation results showed that 1% increase in income increases gasoline demand by 0.78%, while 1% price increase reduces the demand by 0.17%. The results of the study can be useful tool for policy-makers and investors in making relevant decisions in their service-business and investment related activities.

Key words: gasoline demand, cointegration, price and income elasticities, Russia.

JEL Codes: C22, C51, Q33, Q41, Q43, Q48

Introduction

Estimation of the demand for energy has received increasing attention globally. In this regard, the impacts of household income and gasoline price on energy demand are particularly examined. To manage demand for energy and plan refining capacity for future consumption, income and price elasticities of demand for petroleum products are crucial for policymakers. Nevertheless, the topic has received little attention in the literature for oil-dependent countries.

Growing standards of living during oil boom in oil-rich countries has resulted in increasing income and gasoline consumption. However, the income and gasoline consumption are seriously affected during negative oil price shocks. This is the case if a country's economic growth is mainly contributed by oil revenues. In its turn, gasoline prices also tend to be volatile because of demand/supply shifts, government subsidies and taxes, and fuel specifications. Treating natural resources as a national property, oil-producing countries have a history of maintaining fuel subsidies which decreases gasoline price (Arzaghi and Squalli, 2015)[1]. Therefore, due to a relatively lower price of domestically produced fuel, demand for gasoline in fuel-subsidizing economies may be more price inelastic than in other countries (Arzaghi and Squalli, 2015).

In order to scrutinize these points of view and estimate income and price elasticities of gasoline demand, we focus our research on an oil-rich country, Russia and derive policy implications for oil-rich countries with analogous economies.

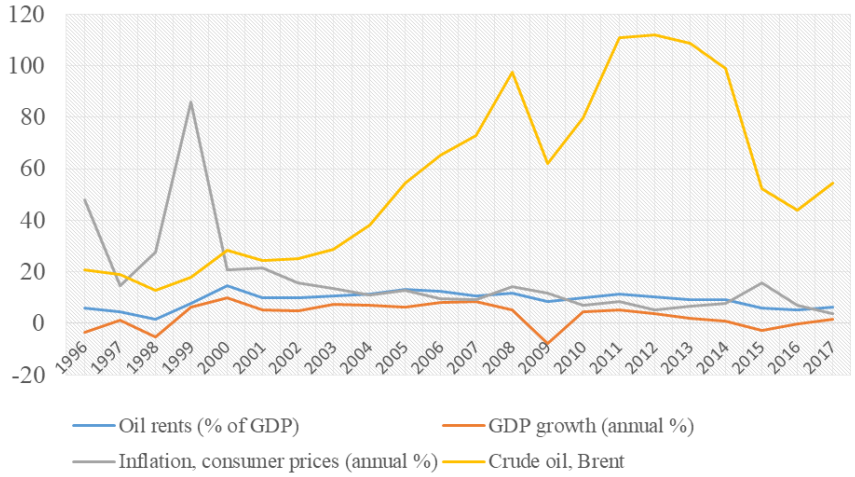
Russia is a resource-rich country, depending highly on exports that generate revenues from sales of crude oil, petroleum products and natural gas, which accounts for about a half of Russia's state budget. Fuel and energy products constituted 70 percent of total exports in 2014 and 63 percent in 2015, of which crude oil and natural gas accounted for 26 percent and 12 percent, respectively. This share decreased to 59 percent in 2016 (Russian Federation, Federal State Statistics Service, 2017).

As seen from Figure 1 below, the growth rate of GDP co-moves with oil revenue as a percent of GDP. Russia's oil revenue reached its pick level, 14 percent of GDP in 2000, accompanied by 10 percent GDP growth. GDP growth rate averaged to 7 percent during 2001-2007, a period of high oil prices, which continued until 2008-2011 with a drop in 2009 (which is attributed to the global financial crisis in 2008-2009). Therefore, due to the global financial crisis, Russia's GDP growth declined to 5 percent in 2008 accompanied by a negative growth rate of 7.8 percent in 2009. The growth rate of GDP was revived and reached 5 percent in 2011 driven by high oil revenue, constituting, on average, 11 percent of GDP until 2011. However, slowly declining oil prices after 2011 caused the share of oil rents in GDP and the growth rate of GDP decrease to 9 percent and 0.73 percent in 2014, respectively. Sharp drop in oil prices in 2014-2015 made the situation worse. The share of oil revenue in GDP declined to 6 percent in 2015, 5 % in 2016 and the growth rate of GDP declined to negative 2.8 percent and negative 0.22 percent in 2015 and 2016, respectively. Thanks to increasing oil prices in 2016, the share of oil revenue in GDP and GDP growth rate revived to 6.4 percent and 1.6 percent in 2017, respectively. This upside was also observed in 2018 when

[1] For more information on fossil-fuel consumption subsidies by country see: https://www.iea.org/weo/energysubsidies/

GDP grew by 2.3 percent, but decreased to 1.5 percent in the first quarter of 2019, possible due to contractionary fiscal and monetary policies weighing on consumer demand and investment (Oxford Economics, 2019).

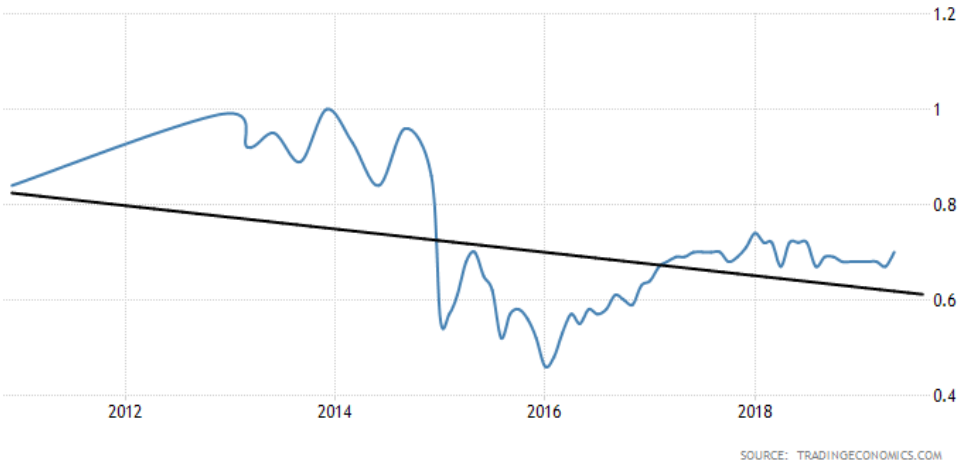
Figure 1: Main macroeconomic indicators, Russia 1996-2017



Source: *World Bank (WB), 2018.*

During the period of high oil prices, the price of gasoline in Russia reached its highest level of 1 USD/Liter in 2013 (Figure 2). Nevertheless, gasoline demand also demonstrated increasing behavior (Figure 3). During the period of low oil prices after 2012, the gasoline price declined to about 0.45 USD/Liter in 2016. Despite the low level of gasoline price, demand for gasoline also decreased. This indicates that gasoline demand is responsive more to income from oil exports rather than to gasoline prices. Being dependent on oil revenue, country's income is affected by oil price fluctuations and, therefore, gasoline consumption is stagnating due to the economic slowdown. From the other hand, lower oil prices lead to a lower subsidy and premium for refineries which benefit from the spread between crude oil and product exports which narrows at a lower crude oil price. This also led to a fall in domestic refining in 2015 and 2016 (Creon Energy Data, 2019). From this point of view, and also due to revival in oil prices, the gasoline price reached to 0.70 USD/Liter in May 2019, averaging 0.67 USD/liter from 1995 until 2019 (Trading Economics, 2019).

Figure 2: Gasoline Prices (USD/liter), Russia 2011-2019



Source: *Trading Economics, 2019*

Figure 3: Gasoline Demand (annual average), Russia 2011-2019

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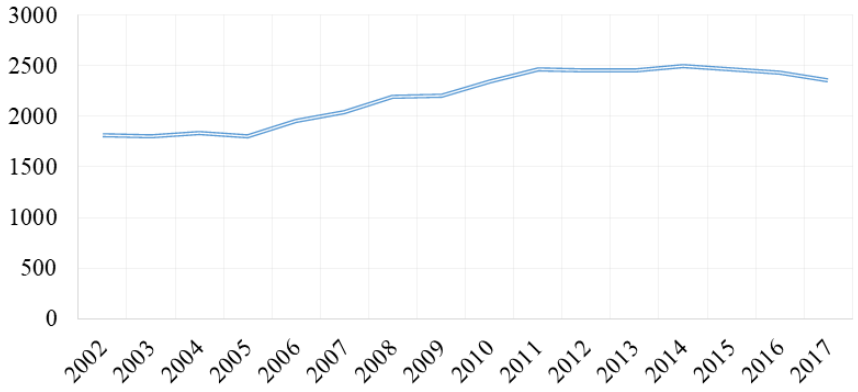


Source: *JodiOil, 2018*

These arguments indicate that demand for gasoline in Russia seems to be less price elastic. Indeed, "when facing a strong economic crisis, agents are likely to react more to an increase in the price of transport fuels given the presence of a higher opportunity cost of consumption due to less disposable income" (Bakhat et al., 2017). In turn, domestic production was slightly down in 2017 mostly due to refinery maintenance and diesel consumption increased by 2 percent in 2017 (Creon Energy Data, 2019).

The present study is the first attempt to estimate income and price responsiveness of demand for gasoline in Russia considering both high and low oil price periods using quarterly data spanning from 2002 to 2018. The paper devotes particular attention to evaluating the influence of the crisis on the income and prices elasticities in Russia due to the reduction of disposable income and changes in gasoline prices. It will also be a necessary condition for evaluating energy, environmental and fiscal policies that impact gasoline prices (Hughes et al., 2008; Bakhat et al., 2017).

The rest of the paper is organized as follows: a literature review is provided in Section 2. Sections 3 and 4 defines the methodology and describe the data. Section 5 presents and discusses the results. Section 5 concludes and offers policy implications

1. Literature Review

This section presents the brief literature review on gasoline demand studies, mainly focused on recent papers, after 2010.

Dahl (2012) for 120 countries (Russia included), Al Yousef (2013) for OPEC countries, Burke and Nishitaten (2013) for 132 countries (Russia included in the panel), Hössinger et al. (2017) for Austria, Atalla et al. (2018) for KSA investigated elasticities of gasoline demand. They concluded that the long-run price and income elasticity of gasoline demand ranges from -0.79 to -0.09 and from 0.15 to 1.10, respectively.

Several studies such as, Crotte et al. (2010), Dahl (2012), Coyle et al. (2012), Hössinger et al. (2017) and Atalla et al. (2018) found that the price elasticity varies around -0.1. Otherwise, studies like, Liddle (2012), Neto (2012), Ben Sita et al. (2012), Sene (2012), Baranzini and Weber (2013), Ackah and Adu (2014), Arzaghi and Squalli (2015) concluded that the short-run price elasticity of gasoline demand ranges from -0.62 to -0.01.

The recent studies concluded the long-run income elasticity ranging between 0.15 and 5.13. Moreover, Crotte et al. (2010), Arzaghi and Squalli (2015), Liddle (2012, Ben Sita et al. (2012), Coyle et al. (2012), Sene (2012), Baranzini and Weber (2013), Ackah and Adu (2014), Arzaghi and Squalli (2015) also have reported the short-run income elasticities. The short-run income elasticity ranges from 0.03 to 0.78.

There are a number of studies devoted to the investigation of gasoline demand modeling. To save the space, we will not review all of them. For the interested readers, Dahl (2012), Havranek et al. (2012), Havranek and Kokes (2015) are valuable review studies providing better picture of gasoline demand elasticities, for a wide range of countries.

To the best of our knowledge, there is only one study (Dahl, 2012), which reported Russia specific income and price elasticities. The reported long-run income and price elasticities are 0.23 and -0.10, respectively. The study's used data span is relatively old and does not include the recent oil price changes period. The reasonable expectation is that due to the oil-price drop the price and income responses are most likely changed. It is also a good exercises to examine whether these elasticities are constant or evolve over time.

The next section shortly discusses the econometric methodologies used, and functional specification employed for gasoline demand modeling.

2. Methodology

The study makes use of the Augmented Dickey Fuller (ADF, Dickey and Fuller, 1981) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS, Kwiatkowski et al., 1992) tests for testing the stationarity properties of the variables. The use of ADF and KPSS is for robustness check, since these two tests have opposite null hypotheses and enable better understanding of the nature of the variables under consideration. The Engle-Granger (Engle and Granger, 1987) and Variable Addition Test (VAT; Park, 1990) tests are utilized for cointegration exercise. For the estimation of the long-run relationship the Dynamic Ordinary Least Squares (DOLS, Stock and Watson, 1993; Saikkonen, 1991), Canonical Cointegrating Regression (CCR, Park, 1992), and Fully Modified Ordinary Least Squares (FMOLS, Phillips and Hansen, 1990) methods are used. Following Dahl (2012), inter alia, the below specification will be used in our empirical estimations:

$$gasd_t = \alpha_0 + \alpha_1 gdp_t + \alpha_2 price_t + \omega_t \#(1)$$

Where, $gasd_t$ is per capita gasoline demand, gdp_t is real per capita gross domestic product, $price_t$ is real gasoline price, t is time index, $\alpha_i's$ coefficients to be estimated and ω_t is error term. All variables are in logarithmic form.

3. Data

The study uses quarterly data from 2002Q1 to 2018 Q1. The description and sources of data are as follow:

GASD is motor and aviation gasoline, thousand barrels per day, (kb/d). The monthly data from the original source converted to quarterly data.

GDP is real Gross Domestic Product, billion rubles, 2016 chained prices.

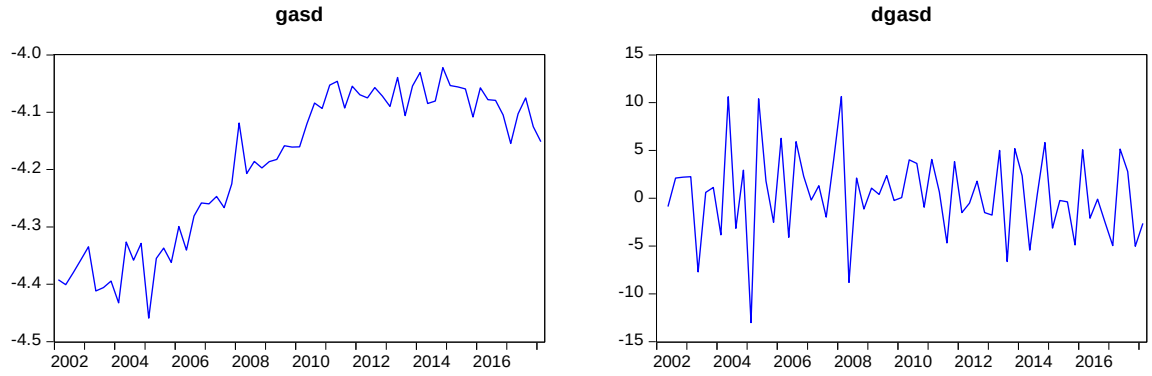
PRICE is gasoline price, rubles per tons of Oil equivalent (TOE).

The gasoline demand and **GDP** data then converted to per capita terms, dividing it by **Population** size. Price data expressed in real terms using **CPI** data.

GASD data is taken from Joint Organisations Data Initiative (JODI, 2019), while **GDP**, **PRICE**, **Population** and **CPI** data are taken from Oxford Economics, October, 2018 release.

Figure 4 demonstrates the plots of per capita gasoline demand, in logarithmic form, and growth rate of gasoline demand for the period of 2002Q1 to 2018 Q1. As can be seen from figure gasoline demand mainly demonstrated increasing behavior, tending slightly decline after 2012, which is most likely due to the oil price drop.

Figure 4. Graphs of per capita gasoline demand (in logarithmic form), and its growth rate



Source: *JodiOil*

4. Empirical Results and Discussion of the Findings

The empirical part started with the examination of the variables for unit-root properties. The results of the employed ADF and KPSS tests are given in Table 1. For the variables *gasd* and *gdp* both tests concludes non-stationarity at level and stationarity at the first difference form. The result for the *price* variable is not straightforward; both tests seem to conclude its stationarity at the level form. However, the coefficient of first lagged variable in the right-hand side of the Dickey-Fuller test specification is negative 0.51, which means in the AR form the coefficient of first lagged variable is 0.49, clearly negating the possibility of stationarity at level form. Hence, we conclude that *price* variable is also *I(1)* variable.

Table 1: Unit root tests results

Variable	The ADF test				The KPSS test	
	Level	k	First difference	k	Level	First difference
gasd	-1.58	2	-8.52***	1	0.88	0.32***
gdp	-3.07*	2	-3.59***	0	0.88	0.56***
price	-4.90***	0	-8.65***	2	0.34***	0.28***

Notes: *ADF and KPSS denote the Augmented Dickey-Fuller and Kwiatkowski-Phillips-Schmidt-Shin tests respectively. ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively; The critical values are taken from MacKinnon (1996) for the ADF and from Kwiatkowski-Phillips-Schmidt-Shin (1992) for the KPSS tests respectively.*

Since the variables are integrated at the same order, the existence of long-run co-movement can be tested, using cointegration tests. The cointegration tests results are provided in Panel A of the Table 2. For the Engle-Granger tests the null hypothesis is "no cointegration", while VAT test's null is "variables are cointegrated." As the table demonstrates, the null is rejected at 5% level in the case of Engle-Granger tests, and accepted in VAT test case. Therefore, we conclude that there is a cointegration relationship among the variables. Since, the variables move together in the long-run, we can estimate the long-run coefficients.

The estimated coefficients are given in Panel B of Table 2. All the used methods produce very similar results. The estimated coefficients have the expected signs and are statistically significant. Inder (1993) concludes that the DOLS method performs better, in small sample cases, in comparison with its alternatives used here. Hence, we interpret the DOLS results and refer to other two techniques as a robustness check. In empirical estimations, we also employed two different estimations techniques to examine if the income and price elasticities vary over time. Namely, we utilized the Park and Hahn's (1999) time-varying coefficient cointegration method and structural time series modeling approach (see Harvey, 1989; Koopman and Shephard, 1992; Durbin and Koopman, 2001; Commandeur and Koopman, 2007, among others). Either methods concluded that the coefficients are constant for the Russian case.

Based on the DOLS estimation results we can say that a 1% increase in income results 0.78% increase in gasoline demand, while a 1% increase in price level decreases gasoline demand by 0.17%. The estimations results are in line with the findings of the previous studies.

Table 2

Panel A: Cointegration tests results

Engle-Granger tau-test	Engle-Granger z-test	Park Added Variables
-4.19**	-28.27**	0.46
(0.024)	(0.016)	(0.500)

Panel B: Long-run Estimation Results

	DOLS	FMOLS	CCR
gdp	0.783***	0.779***	0.798***
	(0.000)	(0.000)	(0.000)
price	-0.169*	-0.200***	-0.218**
	(0.065)	(0.009)	(0.013)

Notes: ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively.

Our elasticities are different from that of Dahl (2012) for Russia. The reason is most likely due to the fact that Dahl (2012) does not include the last price increase period, starting from 2012. In terms of income elasticity our results are in line with the findings of the previous studies, ranging from 0.15 to 1.10 and -0.79 to -0.09 for income and price, respectively. More precisely, in terms of income elasticity our result is close to the findings of papers such as Crotte et al. (2010) for Mexico, Burke and Nishitaten (2013) for the panel of 132 countries (Russia included), Arzaghi and Squalli (2015) for 32 fuel-subsidizing Countries, Atalla et al. (2018) for Saudi Arabia. Our price elasticity is close to Burke and Nishitaten (2013), Arzaghi and Squalli (2015), Hössinger et al. (2017), Atalla et al. (2018).

The relatively higher income elasticity can be seen as a relevant value for Russian case, being a developing country still with a room satisfying the necessary driving needs. In addition, the car park mainly consists of "made in Russia" and Korean cars (PwC, 2017), which are not as energy efficient as well-known car brands. The market share of Russian and Korean cars in 2017 was 42.1% (PwC, 2017). In addition, according to the PwC (2017) and CEIC data base (CEIC, 2019) car sales started to decline substantially (the drop was 24% in 2017) after 2012 following the oil price drop. This fact indicates that the response of gasoline demand in Russia to the change in income level is expected to be relatively higher. Therefore, our income elasticity of 0.78 is in line with the expectation in Russian case.

The constancy of income and price elasticities for the period of investigation, namely after 2000 also needs clarification. In order to see the changes in drivers, income and price, we divided the whole period into 5-year intervals to see if there was a significant change in income and price levels for the period of investigation. The values of the coefficient of variation for the periods of 2002-2007, 2008-2013, 2014-2018 are 5.39%, 5.41% and 3.56% for income and 13.05%, 15.30% and 10.11% for price level, respectively. The obtained quite smaller values of coefficient of variations, being very close for the three sub-periods, indicate that for the entire period there was not substantial change in behavior of the drivers, namely income and price. Therefore, the overtime-constant income and price elasticities in the case of Russia are reasonable.

5. Conclusion

The current energy transition period, characterized by the fluctuating oil prices, increased concerns about environmental problems, necessitates the search of more efficient technologies, more efficient use of available resources, and looking for better alternatives.

In this regard, developing countries are participating in two "games" simultaneously: one is filling the gap between advanced ones, second to compete in sustainable development context. Undoubtedly, one of the most powerful "magic" wands to attend and achieve successful targets is energy accessibility, and its efficient use. Hence, policy-makers need to base their decisions on well-designed and well-investigated foundation. This in its turn requires research for analyzing and estimating the impacts of different drivers on energy types.

One of the main strategic energy types is gasoline demand, which can be called the current "soul of the transport". Having the better idea about country specific elasticities enables policy-makers and investors to design their service, business and investment activities in a more efficient way. Considering the importance of above-mentioned points, the current study investigates the income and price impacts of gasoline demand for the case of Russia, employing different cointegration techniques to the data spanning from the first quarter of 2002 to the first quarter of 2018.

Estimation results showed that income and price have statistically significant impacts on gasoline demand. The found values are in line with the previous studies' conclusions. Based on the estimation results, we can say that a 1% increase in income increases gasoline demand by 0.78%, while a 1% price increase reduces the demand by 0.17%. For the period of investigation, the income and price elasticities demonstrated constant behavior, which can be explained with the fact that for the same period the drivers of gasoline demand demonstrated relatively small variation. The found relatively higher income elasticity points out the necessity of policies easing the conditions for car purchases.

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