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King Abdullah Petroleum Studies and Research Center

Commentary

The Changing Impact of Income and Price on Gasoline Demand in Saudi Arabia

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Introduction

The growth path of gasoline demand, a key strategic fuel, has important implications for oil security, oil-related carbon emissions, and refinery investment (Dahl 2012). As such, understanding how fluctuations in income and gasoline prices could affect the demand for oil in Saudi Arabia allows policymakers to assess what drives gasoline demand over time and the likely future development of oil demand. This knowledge can help demand-side policymakers control oil demand more effectively through the use of measures such as tariffs and taxes, among other instruments. It can also help supply-side decision-makers develop more accurate data on the oil supply needed to meet the anticipated demand and plan refinery investment accordingly. Having a clearer picture of future oil demand could also help the Kingdom to develop the necessary carbon dioxide (CO_2) mitigation measures ahead of time, enable government entities to plan transportation services with more certainty, and help car manufacturers project their anticipated sales.

The quantitative analysis that we conduct in this research could help successfully realize the initiatives and targets that form part of Saudi Vision 2030 (SV2030), such as the Fiscal Balance Program (FBP) and the National Transformation Program (NTP). For example, the successful implementation of domestic energy price reform and improved energy efficiency measures in Saudi Arabia requires a clear picture of how determinants such as price, income, and population size impact energy (including gasoline) demand.

After the fall of global oil prices, many oil-rich countries including Saudi Arabia initiated or deepened their energy price and fiscal reforms to compensate for their lost budget revenues (Gonand et al. 2019). This research provides an analytical framework to quantify how the gasoline prices set by policymakers can increase government revenues, against the backdrop of decreasing gasoline consumption and production.

Some initiatives outlined in SV2030 might increase the demand for gasoline in Saudi Arabia. For example, the number of female drivers in Saudi Arabia is projected to be around 3 million in 2020 (PwC 2018), following the lifting of the ban on women drivers in the country in 2018 as a part of the SV2030 women's empowerment policy. This might increase gasoline demand in the near future through direct and indirect channels. PricewaterhouseCoopers (PwC) (2018) also projects car sales will increase by 9% annually up to 2025, against the 3% annual increase from 2013-2017.

Some 15 papers have modeled gasoline demand in Saudi Arabia using fixed coefficient/elasticity approaches, i.e., they have assumed that the drivers of gasoline demand are constant over the periods analyzed.

However, an investigation of time-varying properties of the energy demand relationship is worth considering; or, at the least, their stability should be tested.

The domestic price of gasoline in Saudi Arabia is administered by the government, but it can be affected by international oil prices. Although the

price of gasoline in the Kingdom has been held constant in nominal terms for certain periods (i.e., 2002 to 2015), resulting in a negative growth rate in real terms, the price has fluctuated dramatically on several occasions (see Figure 1).

Algunaibet and Matar (2018) also find that Saudi Arabian consumers' responses to these price changes are not constant.

Analyzing income gives valuable insights into the time-varying properties of the gasoline demand relationship. We use disposable income as an income proxy, which is taken from Hasanov et al. (2019), and measured in million Saudi riyals (SAR) at 2010 prices. Looking at the development path of the Saudi economy, the response of gasoline demand to changes in the disposable income level is most likely not constant in the long-run. The Saudi economy witnessed periods of dramatic fluctuations between 1980-2017 (see Figure 1).

Empirical studies show that agents react more strongly to permanent than to temporary price changes.

In light of all the factors mentioned above, this study investigates possible time-varying effects of economic and demographic factors on gasoline demand in Saudi Arabia.

The study contributes the following insights to the literature:

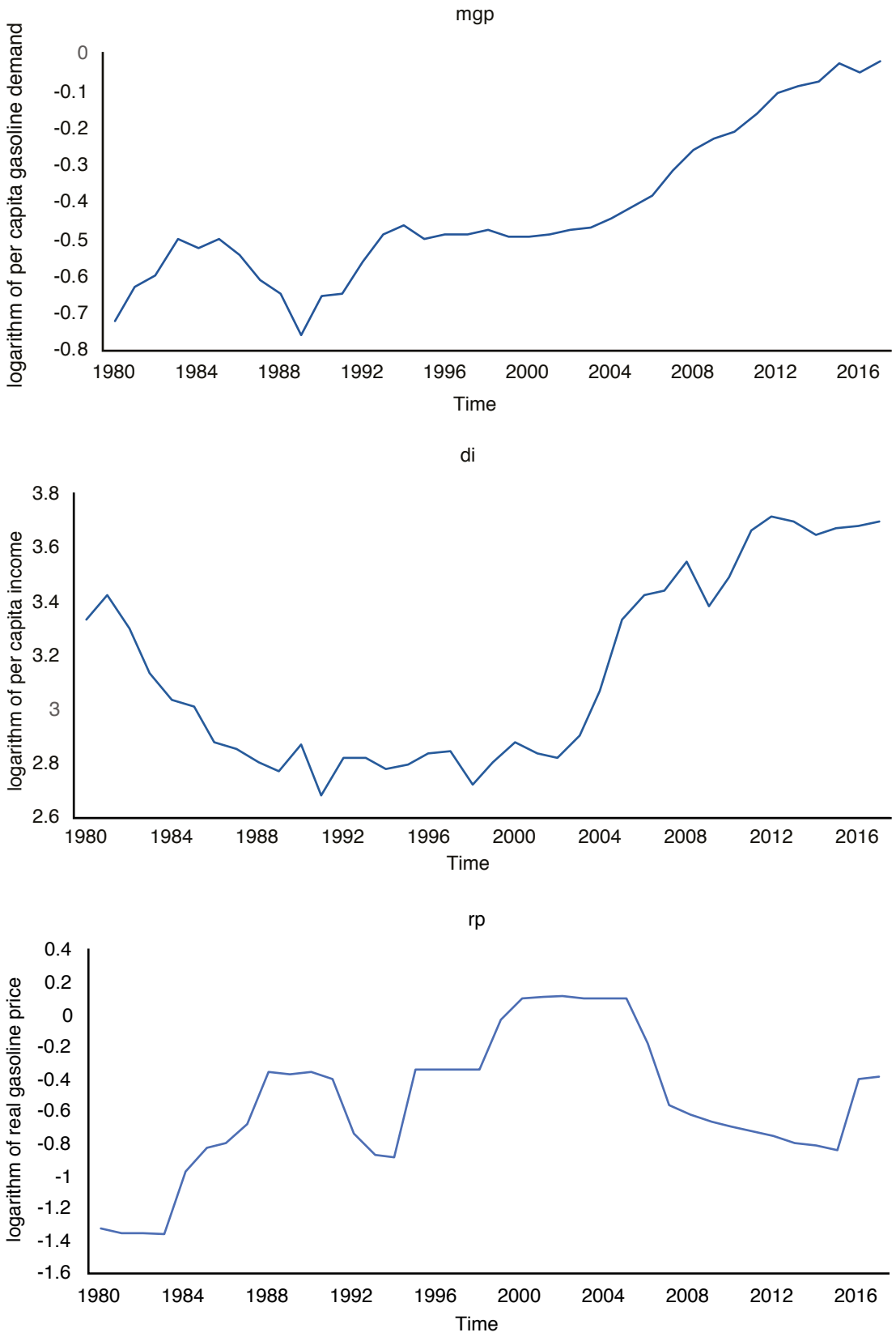
- Estimating price and income elasticities could help decision-makers implement effective policies in the interests of achieving SV2030 targets.
- To the best of our knowledge, this is the first study to have used the time-varying coefficient cointegration approach to assess the pattern of gasoline demand in Saudi Arabia.
- We consider disposable income to be a better measure of income than overall gross domestic product (GDP) or non-oil GDP when modeling gasoline demand in the Kingdom. This measure can also be used to model the demand for other sources of energy.
- Only a few papers have modeled the demand for gasoline in the Kingdom and other oil-rich countries. The pattern of gasoline demand found in this study can be used as a general pattern to understand gasoline demand in similar economies.

Data and research strategy in brief

The study uses annual time series data for Saudi Arabia from 1980 to 2017 for the final demand for motor gasoline, excluding biofuels in transport, in million liters. Data from 1980 to 2016 is from the International Energy Agency (IEA 2018). Data for 2017 was obtained using the 2017 growth rate from the Joint Organisations Data Initiative Oil (JODI-Oil 2018).

The weighted average real gasoline price is used as a price measure in SAR per liter. Price data is taken from the updated gasoline price data used in Atalla et al. (2018), prepared by KAPSARC researchers. Further details of this data can be found in Atalla et al. (2018).

Figure 1. Plots of the variables used.



Source: The data sources are as described in the data section.

Population data is used to convert gasoline demand and disposable income data into per capita terms. Population data is taken from the United Nations database (UN 2017).

Figure 1 demonstrates the historical path of the variables in logarithmic form.

Between 1983-1988, Saudi non-oil GDP decreased by 5.49% annually. From 1989 to 1995 (excluding 1990 and 1992) this decrease moderated to 1.16% per year. Non-oil GDP recovered gradually from 1996-2003, with annual growth of 0.51%, before sharply increasing to 5.4% between 2004-2011 as a result of economic diversification (Hemrit and Benlagha 2018). From 2012-2015, non-oil GDP growth in Saudi Arabia averaged 2.62% per annum, before declining to 1.84% in 2016 and 0.99% in 2017 (GaStat 2018), mainly due to the drop in international oil prices.

The energy price reform, announced at the end of December 2015, resulted in the nominal prices for 91- and 95-octane gasoline increasing from 0.45 SAR and 0.60 SAR per liter to 0.75 SAR and 0.90 SAR per liter, respectively (Apicorp-Arabia 2018). In January 2018, prices increased again to 1.37 SAR and 2.04 SAR per liter, respectively. In January 2019, the 95-octane gasoline price decreased from 2.04 SAR to 2.02 SAR per liter, while the price of 91-octane gasoline was unchanged. On April 14, 2019, the price of 95-octane gasoline increased to 2.10 SAR per liter and 91-octane to 1.44 SAR per liter, following Saudi Aramco's announcement that "local prices of gasoline are subject to change, depending on price changes in the export markets" (Asharq Al-Awsat 2019).

The study uses the time-varying coefficient cointegration approach developed by Park and Hahn (1999) to estimate the long-run relationship between gasoline demand and its drivers, after testing the variables for this relationship and 'time-dependency.' The short-run relationship between gasoline demand and its determinants is assessed using an error-correction modeling approach.

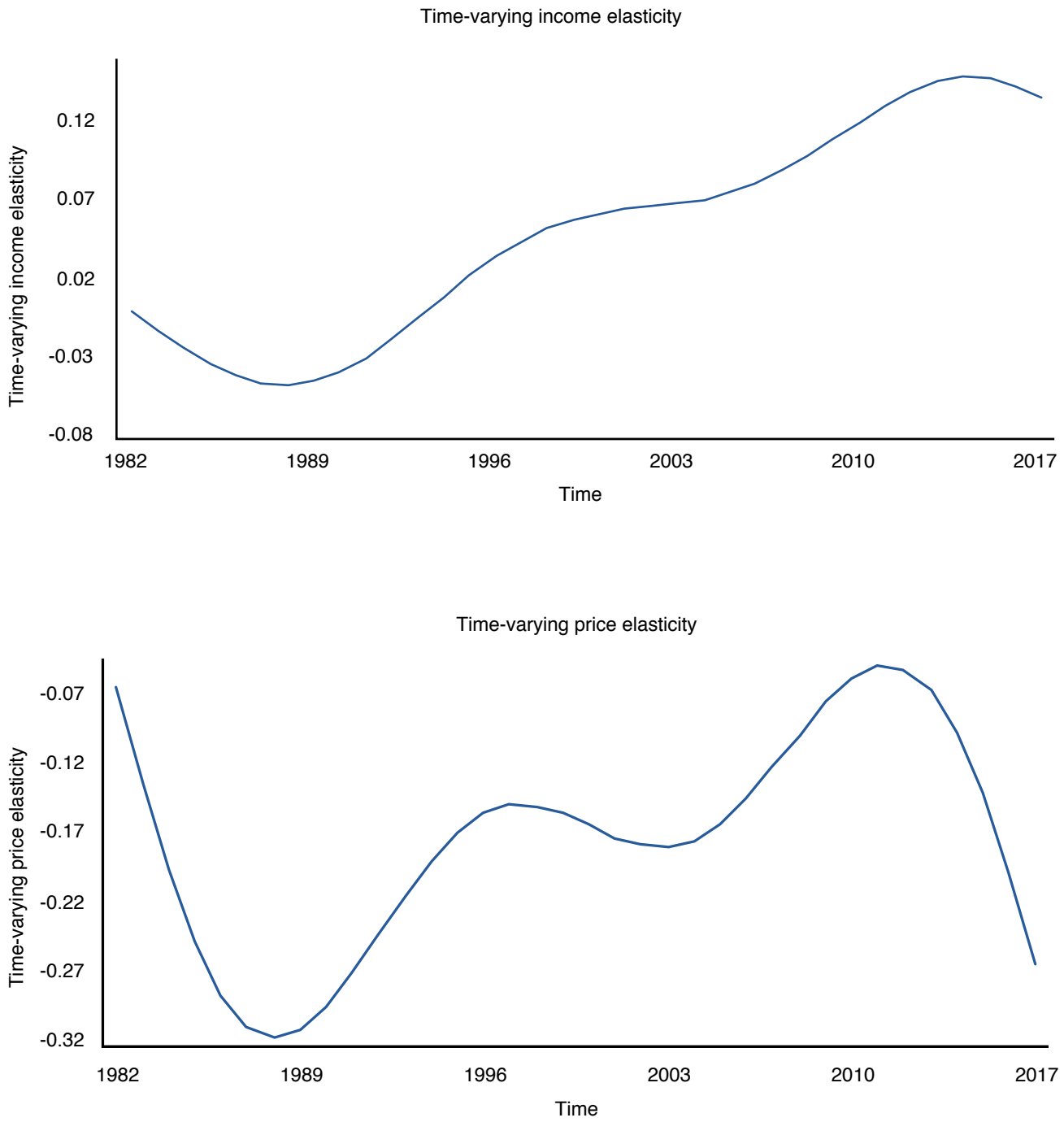
Findings of the study

The empirical estimation used a time-varying coefficient approach and found the significant long-run time-varying income elasticity was less than 0.15. Figure 2 shows the graph of the income elasticity.

The income elasticity illustrated in Figure 2 depicts the growth of Saudi Arabia's economy, from its recession in the early 1980s to its expansion from the early 1980s until 2014, before it declined again from 2014 as it absorbed the effects of the collapse of global oil prices. The change in income elasticity also gives an indication of the impact of events such as the 1986 and 2014 oil price drops, and factors influencing elasticity at different income levels (Chang et al. 2014). For example, during periods of relatively low income, the elasticity value is also relatively low.

For comparison, Figure 3 plots the time-varying income elasticity against disposable income and government transfers to the private sector, both

Figure 2. Time-varying income and price elasticity.



in per capita terms (on a normalized scale). As can be seen, the varying elasticity levels can be explained by changes to disposable income and government transfers. During the recession of 1983-1988, both disposable income per capita and government transfers declined. The relationship between income elasticity and government transfers follows the same pattern. As the recession weakened from 1989-2003, government transfers increased, with income elasticity also increasing. During the gradual economic recovery from 1996-2003, income elasticity continued to increase; oil prices also increased from 1999-2000.

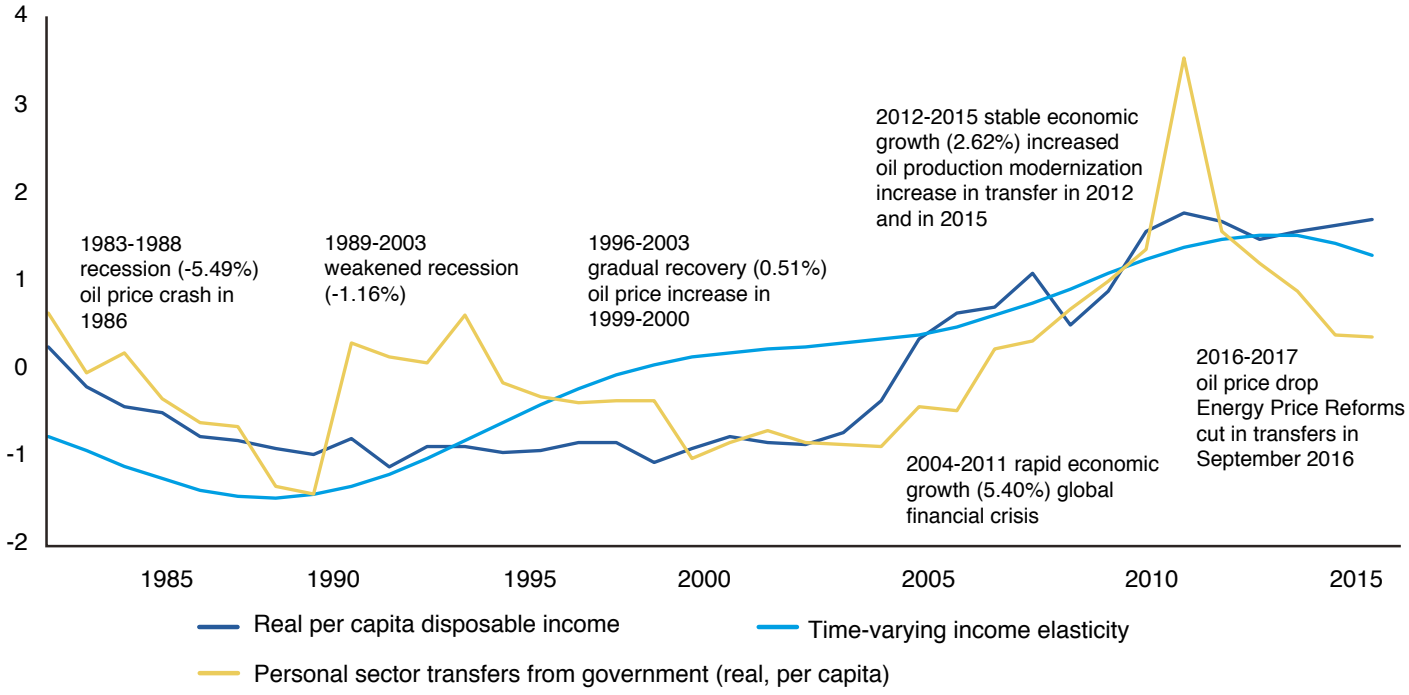
During the Kingdom's rapid economic development from 2004-2011, both the growth of disposable income per capita and government transfers increased, although the former was negatively affected by the 2009 global financial crisis. It is clear from Figure 3 that the increase in income elasticity was also higher in 2004-2011 than in 1996-2003. Disposable income growth and government transfers increased until 2012, before declining; the same was true for income elasticity.

The long-run price elasticity shown in Figure 2 was found to range between -0.31 and -0.05.

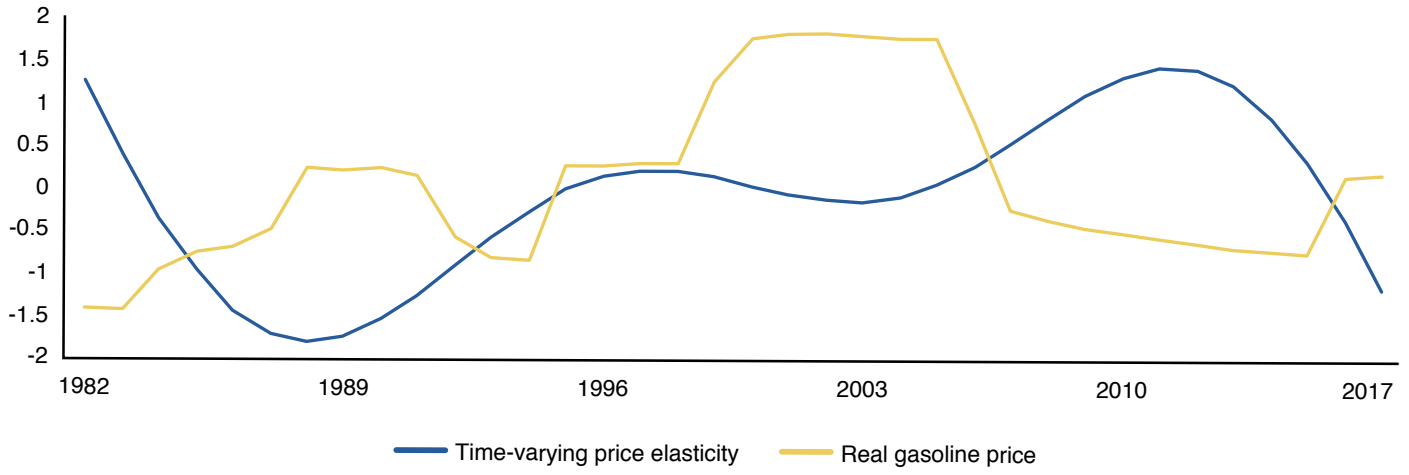
Figure 3 plots the time-varying price elasticity and real gasoline price data using a normalized scale. As can be seen from the figure, price elasticity moves in the opposite direction to the domestic price of gasoline. When the price of gasoline spiked sharply in 1988, price elasticity decreased to its lowest value (-0.31) in the period studied. Price elasticity began to increase the following year, following the decline in the gasoline price. The increase in the price of gasoline in 1995 by 72%, and its continued increase until 2002, is associated with the decline in the price elasticity until 2003. The gasoline price has declined in real terms since 2003, with the 2007 Royal decree (Al-Riyadh, 2006) further accelerating this decline. The downward trend in the domestic price of gasoline continued until 2015, while price elasticity increased until 2012. Price elasticity started to decline again as the gasoline price dropped in 2012. The Kingdom's energy price reform of 2016 increased the domestic price of gasoline, and price elasticity further declined.

Scott's (2012) finding that agents react more strongly to permanent price changes than temporary ones is evident from Figure 2: During the five-year periods of consecutive price increases (1984-1988 and 1997-2001), price elasticity fell to -0.31 in 1988 and -0.15 in 1999. However, though the gasoline price increased in 1995 by 72%, the price elasticity did not change significantly. This can be explained by the fact that the domestic price of gasoline declined in 1994 and 1996. The continued drop in gasoline prices in 2004-2011 saw price elasticity peak in 2011. The last gasoline price increase in 2016 also saw price elasticity increase. The increase in the price elasticity of gasoline could have been due to a) the gradual decrease in the growth rate of the price of gasoline, and b) the cut in government transfers. This finding allows us to conclude that a sharp increase in the domestic price of gasoline after a period of permanent price increases, or followed by income 'shrinking' policies, might result in sizeable variations in price elasticity.

Figure 3. Comparison of the income and price elasticities (normalized scale).



(a) Income elasticity



(b) Price elasticity

Lastly, the estimations show that disposable income does not have a statistically significant impact on gasoline demand in the short run, replicating the findings of Atalla et al. (2018). Three factors might explain the insignificant impact of disposable income on gasoline demand in the short run in Saudi Arabia. First, motorized transport is used ubiquitously in Saudi Arabia due to the lack of alternative modes of transportation. Second, Saudi Arabia is the fifteenth-largest car market in the world, regularly renewing its car park (Motory 2015). Furthermore, as in other Gulf countries, luxury cars are very popular (Krane and Majid 2018). These cars are modern and are mainly fuel-efficient, resulting in less gasoline consumption. Third, historically, the domestic price of gasoline has been very cheap. As such, the ability of consumers to purchase gasoline has been irresponsive to whether their disposable incomes have been increasing or decreasing in the short run. The estimated short-run price elasticity is -0.13.

Additionally, similar to Scott (2012), we found that price elasticity is more responsive to long-term price changes. Our findings also support those of Gately (1992), in that high gasoline prices result in larger price responses, and low gasoline prices result in smaller responses.

Moreover, the speed of the adjustment coefficient is found to be -0.77, meaning that any short-run deviation can be corrected to the long-run equilibrium path in under 1.5 years.

Conclusion and key policy insights

- The income elasticity of gasoline demand increased until 2014, peaking at 0.151, following growth in disposable income, before declining to 0.136 in 2017.

- Aggregate car purchases increase when disposable income rises, causing a derived increase in gasoline demand, while consumers postpone new car purchases in periods of falling income. However, consumers do not stop driving when their disposable incomes fall, resulting in a less elastic response of gasoline demand to income.

- Price elasticities sit in the range of -0.31 to -0.05, becoming less elastic when prices are low and vice versa. This pattern shows that consumers respond less to prices when prices are low but more when prices are high, perhaps reflecting their curtailment of unnecessary driving in times of high gasoline prices.

Empirical estimations show that long-run income and price elasticities are responsive to price and disposable income fluctuations.

The following policy insights are based on the findings above:

- Long-term price increases over many years might cause demand to decrease severely. This finding could be useful for policymakers, depending on their objectives. For example, if they wish to increase energy efficiency, they could gradually increase prices over the long term.

- Policymakers may also wish to consider the insights above from a budgetary revenue perspective.

Gasoline price increases when prices are already high cause larger negative impacts on gasoline demand.

- Short-run income variations do not have a significant impact on gasoline demand. This suggests that income support policies for the private sector, if required, should be designed considering their long-run impacts.

Overall, the insights mentioned above can aid the successful implementation of energy price reforms and environmental policies. The statistically significant negative and time-varying effects of the domestic gasoline price is of particular use in this regard.

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