Gasoline demand, pricing policy, and social welfare in Saudi Arabia: A quantitative analysis

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ARTICLE INFO

ABSTRACT

Domestic energy prices in Saudi Arabia are set below international market prices. This, coupled with rapid economic and population growth, is believed to have contributed to the rapid growth in domestic energy demand and, recently, affected the government budget in the face of low international oil prices. In December 2015, Saudi Arabia announced increases in domestic energy prices. This paper therefore considers the impacts, focusing on gasoline, by estimating a demand function and using it to estimate the change in social welfare.

Gasoline demand is found to be price inelastic suggesting that it may be difficult for the Saudi government to limit future growth in gasoline consumption using only increases in the administered price of gasoline. Thus, limiting future gasoline consumption in the KSA might require improved energy efficiency of passenger cars, increased energy awareness by drivers through education and marketing campaigns, and the provision of alternative transport modes within cities.

Although the announced gasoline price increase is not expected to reduce demand considerably, it can deliver estimated welfare increases of up to 1.66 billion 2010 US\$ (~6.23 billion 2010 Saudi Arabian Riyals), which is around 0.26% of Saudi gross domestic product.

1. Introduction

The past several decades have seen the Kingdom of Saudi Arabia (KSA) experience a large economic and demographic leap, fuelled by its sizeable oil revenues. Between 1979 and 2015, the KSA's real GDP increased from around 1.26 trillion 2010 Saudi Arabian Riyals (SAR) to 2.52 trillion (SAMA, 2016), population grew from 9.3 million to 31.5 million (World Bank, 2016), and total primary energy consumption increased from about 22.5 million tonnes of oil equivalent (Mtoe) to roughly 200 Mtoe (IEA, 2016). During this period, oil revenues have allowed the Saudi government to provide electricity, fuel, and water to its citizens below international market prices. The IEA (2017) estimates that in 2014, the implicit subsidies for electricity and fossil fuels in the KSA amounted to over \$70 billion. Not surprisingly, rapid economic and population growth, alongside such low administered energy prices, contributed to the KSA's tenfold increase in energy consumption over this period.

According to MEP (2015a), the road transport sector is one of the largest consumers of energy in the KSA. Rising incomes have allowed most households to own private vehicles, while economic development has delivered large cities with extensive road infrastructure and a vast network of highways that connect the numerous cities scattered across the KSA. The need for private vehicles to travel is reinforced by the current lack of public transportation systems within cities. As highlighted above, the low administered price of gasoline seems to have also played a role as the demand for motor gasoline grew from 25 million barrels in 1979 to 204 million barrels in 2015, an average growth of about 6% per annum (MEP, 2015a; MEIM, 2016).

In December 2015, the Saudi government announced an increase in the prices of electricity, fuel, and water, which resulted in the nominal prices for 91- and 95-octane gasoline increasing from 0.45 and 0.60 SAR per liter to 0.75 and 0.90, respectively (although they still remain below international market prices). The price increases have been designed to promote greater efficiency in the KSA's energy economy and reduce the rapid growth in domestic oil consumption, which some believe may possibly have put Saudi Arabia on a trajectory to become a net oil importer sometime in the 2030s (Lahn and Stevens, 2011).

Nevertheless, according to Krane (2015a) low fuel costs are part of

the social contract in the Gulf Cooperation Council (GCC) countries. It is therefore important to understand and quantify the impact of the increased gasoline price on both demand and social welfare in the KSA. Our analysis follows the approach in Ahmadian et al. (2007) by estimating a gasoline demand function using the structural time series model (STSM), thus providing estimates of price and income elasticities and an underlying energy demand trend (UEDT) for gasoline in the KSA. The preferred econometric estimates for the gasoline demand function are then used to estimate the change in social welfare that might arise from increasing the gasoline price (in other words, reducing the implicit subsidy) in the KSA.

The remainder of this paper is organised as follows. Section 2 reviews the literature related to econometric estimates of gasoline demand and welfare. Section 3 introduces the estimation strategy for the gasoline demand function, describes the data, and presents the results of the estimation. Section 4 uses the preferred econometric estimates of gasoline demand to conduct the welfare analysis. Finally, Section 5 offers a brief summary and concludes.

2. Literature review

2.1. Econometric studies of gasoline demand

A plethora of articles has attempted to model econometrically gasoline demand for a wide range of countries and groups of countries. Therefore, following a brief discussion of some previous surveys and meta-studies on modelling gasoline demand, econometric studies of gasoline demand that focused on the KSA are reviewed, followed by a discussion on the development of the STSM/UEDT approach to modelling energy demand, given this is the approach used in this paper.

A number of surveys of gasoline demand modelling and elasticity estimates have been conducted by Dahl and her associates. The average short- and long-run price elasticities were found to be −0.29 and −1.02, respectively, by Dahl (1986), and −0.24 and −0.80, respectively, by Dahl and Sterner (1991). On the other hand, the average short- and long-run income elasticities were found to be 0.47 and 1.38, respectively, by Dahl (1986), and 0.45 and 1.16, respectively, by Dahl and Sterner (1991). Furthermore, Dahl (2012) found that for static models only, gasoline price elasticities ranged between −0.11 (for middle-income economies with low gasoline prices) to −0.33 (for high-income economies with high gasoline prices). She also found that the income elasticity had a median size of 0.57 across the surveyed studies. These surveys therefore suggest that gasoline demand is generally price inelastic in both the short and long run but more inelastic in the short run. Within the ranges there exists considerable variation across different countries but Dahl (1986) suggests that the results also vary because of the different models, data series, time horizons, functional forms, and/or econometric techniques used by researchers, even when studying the same country.

Meta-analysis (an approach that uses statistical techniques to compare different studies in order to understand how the methods used by the authors of each study affect its estimates) has been used to consider gasoline demand elasticity estimates by a number of researchers. This includes Espey (1998), who examined both gasoline price and income elasticity estimates and found that they were sensitive to the inclusion or exclusion of some measure of vehicle ownership and that gasoline demand was getting more price elastic and less income elastic over time. Furthermore, Brons et al. (2008) found that the geographic area, study year, time horizon, and functional form significantly affected the gasoline demand price elasticity estimates, concluding overall that the average short- and long-run price elasticities were −0.34 and −0.84, respectively.

Havranek et al. (2012) built on these two earlier meta-analyses by considering the same studies used in Brons et al. (2008) and using the same definitions of the short and long run used by Espey (1998). In doing so, Havranek et al. (2012) demonstrated that when controlling for publication bias (the tendency to suppress negative and insignificant elasticity

estimates) the estimated short- and long-run gasoline price elasticities of demand were "approximately *half* compared to the results of the previously published meta-analyses" (p. 206). Consequently, after correcting for publication bias, Havranek et al. (2012) found that the short- and long-run gasoline price elasticities averaged −0.09 and −0.31, respectively. Finally, Havranek and Kokes (2015) undertook a meta-analysis of estimated income elasticities using the studies surveyed by Dahl (2012) and, like Havranek et al. (2012), found that there was publication bias. After correcting for the bias, they found that the short- and long-run gasoline income elasticities averaged 0.1 and 0.23, respectively.

The studies above covered a wide range of countries, techniques, and data periods but the core message is that gasoline demand is price (and income, to an extent) inelastic in both the short and the long run. Given the scope of the research being undertaken here, Table 1 focusses explicitly on previous studies that have econometrically modelled gasoline demand in the KSA either specifically or within a group or panel. Table 1 shows that in general the estimated elasticities are in line with the above, suggesting that the short- and long-run price and income elasticities of gasoline demand in the KSA are inelastic – the estimated long-run income elasticity by Al-Sahlawi (1997) being the only exception. In summary, most models of gasoline demand suggest that it is price and income inelastic, which is equally true for the KSA, whether individually or as part of a panel. Given this, it is interesting to consider whether similar results are obtained using the STSM/UEDT approach used in this paper. The previous literature on this approach is therefore considered next.

2.2. Discussion of methodological issues

The studies considered above generally used time series or panel data models in order to estimate the price and income elasticities of gasoline demand. Furthermore, some of the models incorporated a measure or proxy to try to capture the impact of improvements in the energy efficiency of the stock of passenger cars over time. An alternative approach, particularly useful where there are data constraints, is to incorporate a UEDT, as suggested by Hunt et al. (2003a, 2003b). The UEDT captures the influence of exogenous factors that influence demand over time such as energy efficiency and behaviour changes, and can be modelled stochastically using Harvey's (1990) STSM (aka the unobserved components model), which Hunt et al. (2003a, 2003b) argue provides more realistic estimates of energy demand models.

Subsequently, the STSM/UEDT approach to modelling energy demand relationships has been applied to a number of areas of energy demand modelling,[1] including transportation oil and gasoline demand.[2] The only study that we are aware of that has used the STSM/UEDT approach for Saudi Arabia that is connected to gasoline consumption is Alkhathlan and Javid (2015), who attempted to analyse the effect of transport and total oil consumption on the environmental quality of the KSA.[3] Although connected to the research undertaken here, Alkhathlan

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[1] Such as for: UK aggregate energy demand in different sectors with different data frequencies (Hunt et al., 2003a, 2003b; Dimitropoulos et al., 2005); natural gas demand in Ghana (Ackah, 2014); aggregate energy demand for the whole economy and the residential sector in South Korea (Sa'ad, 2011); electricity consumption in Pakistan (Javid and Qayyum, 2014; European natural gas demand Dilaver et al., 2014); and industrial aggregate energy demand in the OECD countries (Adeyemi and Hunt, 2014).

[2] These include studies of: British and Japanese transport oil demand (Hunt and Ninomiya, 2003c); Iranian gasoline demand (Ahmadian et al., 2007); Indonesian petroleum products demand (Sa'ad, 2009); British transport oil demand (Broadstock and Hunt, 2010); South Korean transport energy demand (Sa'ad, 2010); UK gasoline and diesel demand (Broadstock et al., 2011); Ghanaian gasoline demand (Ackah and Adu, 2014); Swedish and British gasoline demand (Karimu, 2014); Nigerian petroleum products demand (Abdullahi, 2014; Adagunodo, 2014); and Greek gasoline demand (Broadstock and Papathanasopoulou, 2015).

[3] Using data for the period 1971–2013, Alkhathlan and Javid (2015) use the STSM to estimate what they refer to as the UEDT for total carbon emissions and carbon emissions from the domestic transport sector, which is found to be non-linear for both the total and the transport sector.