Gasoline demand, pricing policy and social welfare in Saudi Arabia

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Please note this is preliminary work in progress and must not be referred to or quoted.

Overview

Countries in the Gulf Cooperation Council (GCC) are well known for their large fossil fuel endowments. This has led to the prevalence of energy subsidies, where fossil fuels are sold domestically at prices below international market prices. However, these energy subsidies are believed to contribute to the rapid growth of domestic energy demand in GCC countries, and more recently, have been negatively affecting government budgets in the face of persistently low oil prices. In December 2015, the Kingdom of Saudi Arabia (KSA) announced that they were reducing the gasoline subsidy, resulting 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 SAR respectively. This paper considers the potential changes to social welfare that might result from such a cut in subsidies in the KSA by estimating a gasoline demand function using the structural time series model (STSM) and using the preferred model to estimate the resulting change in social welfare.

Gasoline Demand Equation

Estimation Methodology

The STSM approach is employed to estimate an aggregate gasoline demand function for the KSA based on the following general specification:

$$g_t = \alpha_1 g_{t-1} + \alpha_2 g_{t-2} + \gamma_0 y_t + \gamma_1 y_{t-1} + \gamma_2 y_{t-2} + \delta_0 p_t + \delta_1 p_{t-1} + \delta_2 p_{t-2} + \theta_0 mpop_t + \theta_1 mpop_{t-1} + \theta_2 mpop_{t-2} + UEDT_t + \varepsilon_t \quad (1)$$ [1]

where g_t is the natural logarithm of gasoline demand in year t; y_t is the natural logarithm of real GDP in year t; p_t is the natural logarithm of the real gasoline price in year t; $mpop_t$ is the natural logarithm of the male population in year t; and ε_t is a random error term. The coefficients γ_0, δ_0, and θ_0 therefore represent the short-run impact elasticities for GDP, real gasoline price, and male population respectively and the long-run GDP, real gasoline price, and population elasticities are given by $\Gamma = \frac{\gamma_0+\gamma_1+\gamma_2}{1-\alpha_1-\alpha_2}$, $\Delta = \frac{\delta_0+\delta_1+\delta_2}{1-\alpha_1-\alpha_2}$, and $\Theta = \frac{\theta_0+\theta_1+\theta_2}{1-\alpha_1-\alpha_2}$ respectively.

$UEDT_t$ is the stochastic underlying energy demand trend estimated using the STSM as follows:

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t \;; \qquad \eta_t \sim NID\,(0, \sigma_\eta^2) \quad (2)$$

$$\beta_t = \beta_{t-1} + \xi_t \;; \qquad \xi_t \sim NID\,(0, \sigma_\xi^2) \quad (3)$$

where μ_t and β_t are the level and slope of the UEDT respectively. η_t and ξ_t are the mutually uncorrelated white noise disturbances with zero means and variances σ_η^2 and σ_ξ^2 respectively. The disturbance terms η_t and ξ_t determine the shape of the stochastic trend component. Where necessary the condition of normality of the auxiliary residuals (irregular, level and slope residuals) can be satisfied, by irregular, level, and slope interventions. These interventions give information about important breaks and structural changes at certain dates with the estimation period. In the presence of such interventions, the UEDT can be identified as:

UEDT= μ_t+ irregular interventions + level interventions + slope interventions

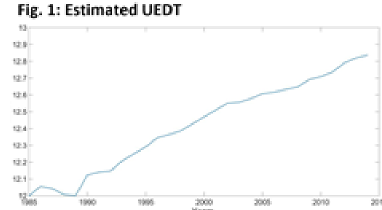
The estimation strategy involves estimating Equations (1), (2) and (3) by a combination of maximum likelihood and the Kalman filter and then eliminating insignificant variables and adding interventions but ensuring the model passes an array of diagnostic tests until the preferred parsimonious model is obtained. The software package STAMP 8.30 is used for the estimation of the preliminary preferred model below.

Preferred Estimated Equation

Following the estimation strategy outlined above the preferred equation is given by:[2]

$\widehat{g_t} = 0.399^{**} y_t - 0.098^{***} p_t - 0.060^{**} p_{t-1} + \widehat{UEDT_t}$; $\hat{\Gamma} = 0.40$ & $\hat{\Delta} = -0.16$;
$\widehat{UEDT}_t = \hat{\mu}_t + 0.052^{**}\, IRR1990$ (Illustrated in Fig.1); se= 0.02; $r_{(1)} = -0.05$;
Box-Ljung: $Q_{(5,3)} = 3.21$; Het: $F_{(8,8)} = 0.28$; Norm$_{(res)}$: $\chi_2^2 = 1.97$; Norm$_{(Irr)}$: $\chi_2^2 = 1.09$; Norm$_{(Lvl)}$: $\chi_2^2 = 0.29$; Failure: $\chi_3^2 = 1.09$; Estimation Period 1985-2014.

Fig. 1: Estimated UEDT



Welfare Calculation

Methodology for calculating welfare

The estimate of the change in KSA welfare in the short-run following a subsidy cut depends on both the supply and demand curves for gasoline. The estimated demand curve from the previous section can be expressed as:

[1] A two-year lag is chosen to capture any possible dynamic effects, since it is seen as a reasonable length given the data set being used. Therefore, given the data set is for the period 1983 to 2014, all estimated equations were for the period 1985 to 2014.

[2] Note, * represents significance at the 10% level, ** at the =5% level and *** at the 1% level.

$$\widehat{G_t} = P_t^{-0.098} \cdot P_{t-1}^{-0.060} \cdot Y_t^{0.399} \cdot e^{\widehat{UEDT}_t}$$

Therefore, consumer surplus (CS) is calculated using the following equation:

$$CS_t = \int_{p_t}^{p_{limit}} P^{-0.098} \cdot P_{t-1}^{-0.060} \cdot Y_t^{0.399} \cdot e^{\widehat{UEDT}_t} \; dP$$

where p_{limit} is an arbitrarily high price of gasoline. If the administered price of gasoline in the KSA increased from p_t to p_{t*} then the estimated change in CS would be given by the following that does not depend on the upper limit in the integral:

$$\Delta CS = \frac{P_{t-1}^{-0.060} \cdot Y_t^{0.399} \cdot e^{\widehat{UEDT}_t}}{0.902} \cdot \left(P_{t*}^{0.902} - P_t^{0.902}\right).$$

Given the structure of the KSA's refining industry, the domestic supply curve for gasoline is assumed to be effectively vertical at each year's level of production, i.e., $S_t = G_t - M_t$ where S_t is the supply of gasoline by domestic producers and M_t the imports. Producer surplus (PS) is therefore equal to the administered price of gasoline multiplied by the quantity supplied, and the change in PS is thus given by $\Delta PS = S_t \cdot (P_{t*} - P_t)$.[3]

Welfare Results

Figure 2: CS and PS in the KSA in 2014 (actual gasoline price – yellow line; hypothetical gasoline price – black line.

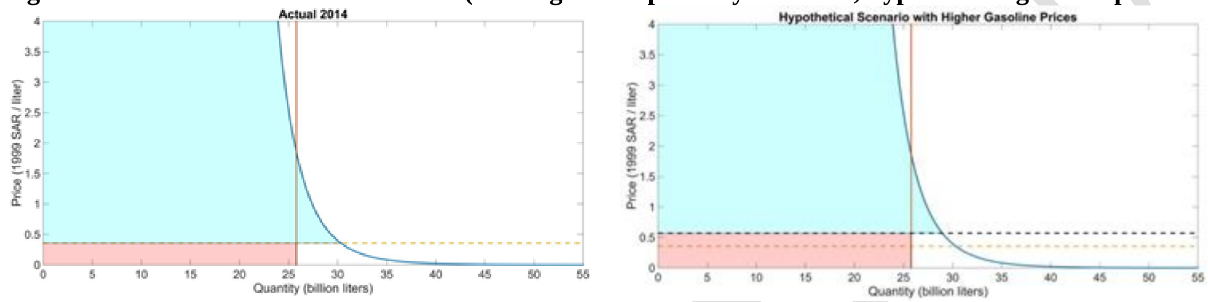


Table 2. The change in PS, CS and import bill in the short-run in the KSA (million 1999 SARs).

	Before subsidy cut	After subsidy cut	*Change*	*Change as % of 2014 GDP*
Producer surplus (PS)	9,185	14,569	*+5,383*	*+0.42%*
Consumer surplus (CS)	117,741	111,559	*-6,181*	*-0.48%*
Import bill	-8,888	-5,516	*+3,295*	*+0.26%*
Total surplus (welfare)	**118,038**	**120,535**	***+2,497***	***+0.19%***

The subsidy cut also causes imports to decrease because of diminished consumer demand for gasoline. Furthermore, the subsidy cut implies a decrease in the price gap between what Saudi pays to import gasoline and the domestic price, which leads to a decrease in the import subsidy. The combined effect of lower imports and a smaller import subsidy delivers a lower import bill.

Preliminary Conclusions

Although the effect of a gasoline subsidy cut on the sum of CS and PS is slightly negative, the accompanying lower import bill reveals that the total short-run surplus in the KSA (i.e. welfare) increases by about 0.2% of GDP in 2014.

Selected References

Ahmadian, M., Chitnis, M., Hunt, L. C., (2007). Gasoline demand, pricing policy and social welfare in the Islamic Republic of Iran. *OPEC Review*, 31, 105-124.

Dilaver, Z., Hunt, L.C., (2011). Industrial electricity demand for Turkey: A structural time series analysis. *Energy Economics*. 33, 426–436.

Harvey, A.C., (1989). *Forecasting, Structural Time Series Models and the Kalman Filter*. Cambridge University Press: Cambridge.

Harvey, A.C., Shephard, N., (1993). Structural Time Series Models. In: Maddala, G.S., Rao, C.R., Vinod, H.D. (Eds.), *Handbook of Statistics*, Vol. 11, North Holland, Amsterdam, 261-302.

Hunt, L.C., Judge, G., Ninomiya, Y. (2003). Underlying trends and seasonality in UK energy demand: a sectoral analysis. *Energy Economics*; 25, 93–118.

Koopman, S.J., Harvey, A.C., Doornik, J.A., Shephard, N., (2007). Structural time series analyser and modeller and predictor — STAMP version 8 econometric software.

[3] Given the vertical supply curve assumption we assume it is assumed that the administered price of gasoline does not affect domestic supply, which remains fixed, so that imports must fall to ensure that total supply and demand are balanced.