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The demand for transport fuels in Turkey

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ABSTRACT

In this paper, we estimate the demand for transport fuels in Turkey. Specifically, using four different models, namely a partial adjustment model, a distributed lag model, an autoregressive distributed lag model, and an error correction model, we estimate gasoline and diesel demand functions with quarterly data covering the period 2003:Q1–2014:Q3. We find a stable long-run relationship only for diesel demand, income and price. Our results imply that gasoline demand does not respond to income and price in the long run, reflecting a shift from gasoline towards diesel induced by differential tax policies. Furthermore, we find that transport fuel demand is price inelastic, making tax on fuel a perfect tool for raising budget revenues. In addition, our results suggest that fuel demand responds to negative and positive price changes symmetrically.

1. Introduction

The knowledge of price and income elasticities of transport fuels is crucial both for policy authorities and firms. Forecasting and managing energy demand has been one of the central policy issues, especially in the case of energy importing countries, mainly due to increasing concerns about energy security and emissions of greenhouse gases (see, for example, Wadud et al., 2009; Havranek et al., 2012; Dahl, 2012). Policy authorities need to know price elasticity of fuels for setting tax on fuels. If the demand for fuel is price inelastic, then increasing taxes on fuel will have a little effect on consumption and hence, on the associated greenhouse gas emissions. However, in this case, governments may be willing to impose excessive taxes on fuel to increase budget revenues. In addition, the knowledge of price elasticity of fuels is essential for setting optimal tax rates on various types of fuels. In fact, in his seminal contribution to the theory of taxation, Ramsey (1927) has shown that, in order to reduce distortionary effects of taxes on social welfare, governments must impose higher tax rates on goods with lesser elastic demand. Ramsey (1927) found that "the tax ad valorem on each commodity should be proportional to the sum of the reciprocals of its supply and demand elasticities". Later, Baumol and Bradford (1970) have shown that optimal taxation rules derived by Ramsey (1927) are directly applicable for determining the second-best prices for multiproduct monopolies. Price elasticity is also of central importance for price setting decisions of firms. Producers can increase sales revenues by charging higher prices if demand is price inelastic. Income elasticity is needed to forecast fuel demand in the future, which is vital for taking appropriate policy measures to ensure energy security. Fuel producers also need to obtain reliable forecasts of fuel consumption for production planning and investment decisions. Therefore, it is not surprising that estimating short- and long-run elasticities of fuel demand has attracted a huge interest of economists during the last four decades.

Income and price elasticities of gasoline and diesel fuels have been widely examined in the case of both developed and developing countries (e.g., Alves and Bueno, 2003; Baltagi and Griffin, 1997; Havranek and Kokes, 2015; Hughes et al., 2008; Ramanathan, 1999; Sterner et al., 1992; Wadud et al., 2009). Goodwin et al. (2004), Graham and Glaister (2002), Basso and Oum (2007), and Dahl (2012) provide excellent literature surveys.[1] Although some researchers have also considered fuel consumption in Turkey (see, for example, Baltagi and Griffin, 1983, 1997; Sterner et al., 1992; Birol and Guerer, 1993; Franzen, 1994; Erdogdu, 2014), existing literature is still inadequate from several perspectives. First, previous researchers except for

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[1] For earlier surveys, see Dahl (1986), Dahl and Sterner (1991) and Goodwin (1992), among others.

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Franzen (1994) have used some type of dynamic models without pretesting cointegration properties of the variables. It is now a well established fact that if the variables under investigation are unit root processes but not cointegrated, conventional models may produce spurious results. Regression with non-stationary series may form a non-stationary error term, which violates the assumption of residuals being independent and normally distributed. Non-stationary error terms, in turn, entail a rejection of the null hypothesis that the model describes a long-run equilibrium relationship (Franzen, 1994). Furthermore, in their assessment of empirical methodologies used to estimate fuel demand, Basso and Oum (2007) concluded that cointegration techniques produce relevant results which seem to challenge some of the accepted core results in the literature. In particular, they argued that failure to take account of non-stationary nature of the data may lead overestimation of long-run price elasticities.

Second, most of these studies used data prior to 1990s. However, the Turkish economy grew considerably during 2000s. While diesel consumption also grew well during 2000s, gasoline consumption fell drastically during the same period. In fact, while total gasoline consumption in 2000 was around 3.6 million m^3, it fell to 2.6 million m^3 in 2014. On the other hand, diesel consumption rose from 9.7 million m^3 in 2000 to 21.2 million m^3 in 2014. This fact suggests that fuel consumption dynamics in Turkey might have been changed drastically with economic growth. Dahl (2012) argued that income elasticity of fuels might have fallen with increasing income per capita. Therefore, it would be interesting to estimate fuel demand functions using recent data. Only Erdogdu (2014) estimated fuel demand functions using the post-2000 period data in his analysis of transport fuel prices in Turkey. However, his sample period was too small (19 quarterly observations from the second quarter of 2006 to the last quarter of 2010), and as a result, estimated elasticities were found to be statistically insignificant.

Third, existing studies mainly concentrated on gasoline consumption. However, as we have already noted, gasoline consumption in Turkey was too low when compared with diesel consumption during 2000s. Only Birol and Guerer (1993) and Erdogdu (2014) estimated diesel demand function in Turkey. Results of both studies imply that diesel consumption does not react to price. As diesel has the greatest share in total fuel consumption in Turkey, there is need to estimate price and income elasticities of diesel demand.

Finally, none of the previous researchers have examined possible asymmetries in response of fuel consumption to price changes. Hamilton has shown that oil price changes affect economic growth asymmetrically (Hamilton, 1996, 2003). Dahl (2012) also concluded that price responsiveness of fuel consumption might be greater for price increases. Therefore, it would be interesting to see whether fuel consumption reacts to price changes symmetrically or not.

In this paper, we estimate Turkish gasoline and diesel demand functions using quarterly data for the 2003–2014 period. Our main purpose in this study is to contribute to the literature by addressing the above-mentioned shortcomings of the existing literature on fuel consumption in Turkey. In particular, in addition to previously used conventional models such as partial adjustment model (PAM), distributed lag (DL) and autoregressive distributed lag (ARDL) models we also test for cointegration among fuel consumption, income and price. For this purpose, we first test stationarity of variables using a battery of stationarity tests. Various tests provide mixed evidence on order of integration of variables under investigation. Therefore, we use bounds testing procedure proposed by Pesaran et al. (2001) to test cointegration among variables. Another contribution of this study is that we also test whether fuel consumption reacts to price falls and increases symmetrically.

Our results suggest that only diesel consumption is cointegrated with underlying economic variables, suggesting existence of a long-run relationship between diesel consumption, income and price. However, we do not find any long-run relationship for gasoline. Yet, our results suggest that gasoline consumption responds to price changes in the short run whereas it is not sensitive to income. On the other hand, we find that diesel consumption responds only to income but not price in the short run. Our results further imply that differential taxes on fuels have caused a shift away from gasoline to diesel. Lastly, we find that that distinction between price falls and increases is irrelevant for both fuels.

The remainder of the paper is organised as follows. In the next section we provide a review of the empirical literature on fuel consumption in Turkey. Then we present the econometric model in Section 3. In Section 4 we present the data and estimation results. Section 5 presents discussion of the results, and then Section 6 concludes.

2. Literature review

In this section we discuss previous studies on fuel consumption in Turkey. Estimated price and income elasticities of fuel demand in Turkey vary from those computed for countries with comparable levels of development but close to estimates for developed countries (Dahl, 2012). In particular, estimated price elasticities of fuel demand in Turkey are lower than those estimated for developing countries and comparable to price elasticities estimated for developed countries. On the other hand, income elasticity is greater than estimates for developing countries. However, in their meta-analysis of price and income elasticities of fuels using data provided in Dahl (2012), Havranek et al. (2012) and Havranek and Kokes (2015) found that reported elasticities suffer from publication bias, removal of which suggests much lower price and income elasticities than those reported in the literature. Yet, price and income elasticity estimates reported in Baltagi and Griffin (1983), Baltagi and Griffin (1997), Sterner et al. (1992) and Franzen (1994), who have estimated fuel demand functions for a panel of OECD countries as well as estimates of Birol and Guerer (1993), who considered developing countries suggest that elasticities of fuel demand are more comparable with developed countries rather than developing countries.

Table 1 provides a summary of the existing literature on fuel demand in Turkey. In their analysis of gasoline demand in a sample of eighteen OECD countries Baltagi and Griffin (1983) estimated various specifications using various estimators for the period 1960–1978. While Baltagi and Griffin (1983) estimated three specifications, namely, static, partial adjustment and polynomial distributed lag specifications for gasoline demand, they reported only estimates of the static model for individual countries. For other specifications, they presented only results of the pooled estimators. Their results suggest that both income and price elasticities are statistically insignificant, although both had the correct sign. Pooled estimates of income and price elasticities produced statistically significant estimates of elasticities. They found that the long-run price elasticity in the sample countries falls in the range of −0.5 to −0.9, and income elasticity is in the range of 0.6 to 0.9 depending on the choice of pooling technique.

Sterner et al. (1992) examined price and income elasticities of gasoline demand for 21 OECD countries, including Turkey, using three different specifications, namely, the distributed lag model (DL), the so-called inverted-v (INV) lag model, and the partial adjustment model (PAM), or as the authors refer to it, the lagged endogenous model. They found that the long-run price elasticity in Turkey was in the range of −0.5 to −1.1, whereas income elasticity was in the range of 1.1 to 1.3. They, however, did not report standard errors, and hence statistical significance of the long-run elasticities. Sterner et al. (1992) reported short-run elasticities using only the PAM, according to which short-run price and income elasticities of gasoline demand in Turkey were −0.31 and 0.65, respectively. Both elasticities were found to be statistically significant.

Birol and Guerer (1993) considered gasoline and diesel demands for six developing countries. Unlike other studies, Birol and Guerer (1993) estimated total fuel demand using not total but per capita income and real fuel prices. They considered only a partial adjustment model. Birol and Guerer (1993) found that short-run price and income elasticities