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Shift in demand elasticities, road energy forecast and the persistence profile of shocks

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ABSTRACT

We forecast demand and investigate the shift in price and income elasticities and the persistent profile of shocks for diesel and gasoline fuels in the road transport sector in Ghana using annual data from 1971 to 2011. First, we find that gasoline and diesel demand are both price inelastic in the short- run, but the income elasticity for the former is inelastic and elastic for the latter. There is evidence of a shift in the long-run price and income elasticities after the eighties. We find that these elasticities differ between diesel and gasoline. We show that government decision to withdraw fuel subsidies will increase the energy efficiency gap in the diesel sector more than the gasoline sector. Using the Structural Cointegration VAR, we also show that government intervention in pricing of petroleum products in the road sector seems to be politically and not economically driven. Further, shocks are more persistent for diesel than gasoline. Last, road diesel and gasoline consumption are expected to increase but slow down between 2020 and 2030 with a possible dieselization of the economy. These results have important implications for government fuel tax policy and investment commitment in the road sector.

1. Introduction

Global transport energy consumption constitutes 26% of total world energy use, and it is responsible for 23% of world energy related emissions (World Energy Council, 2012). It is projected that, from 2010 to 2040, global transport energy demand will increase by 40%. Much of this increase is expected to come from developing countries. While transport energy demand is expected to fall by 10% in OECD countries, it is expected to double in developing countries (ExxoMobil, 2015). Re-emphasizing and promoting energy efficiency in developing countries should therefore be an issue of a global concern. This is because the consequences of climate change do not pertain to a single region or country. In poor developing countries, energy efficiency improvement can also serve as a catalyst to poverty alleviation. This is because money that is not spent on energy could be saved or directed towards other productive sectors in the economy.

The transport sector in Ghana contributes significantly to gross domestic product in the country. In 2009, the sector's contribution to total GDP was 12.8%, but this increased to 13.9% in 2014 (see Okudzeto et al., 2015). However, inefficiencies abound in the sector, and this has caused a rise in transport energy consumption. Estimates show that Ghana's road transport energy intensity is twice that of Thailand (Ghana Energy Commission, 2006). The consequence is that related carbon dioxide emissions have increased. According to a survey by the Environmental Protection Agency (EPA, Ghana), carbon dioxide emissions from the road sector are about three times the EPA target. Recent developments, such as higher than average fuel consumption per kilometre travelled, sharp rise in road bulk haulage vehicles; rising vehicular traffic, and changing urban structure imply that there is no hope for a downward trend in energy use by the road sector. These worrying trends require re-emphasizing energy efficiency measures in the road transport sector in Ghana. With the recent renewed interest in pricing policies in the road transport sector, it is important to analyse consumers' response to price and income changes and how that has changed in the long-run overtime.

Government tax policies for diesel and gasoline in the road sector have been uniform in Ghana. This has been based on the premise that consumers treat both fuels the same and therefore respond the same way to price changes. However, given the differences in consumption productivity per mile for diesel and gasoline driven cars, there could be differences in consumers' response in which case discriminatory tax policy might be preferred. Recently, in 2014, the government reduced subsidies on gasoline and diesel fuel, and this caused a symmetric increase in the price of both fuels by about 25%. Are the energy efficiency

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gains for both energy types induced by the policy likely to be symmetric or asymmetric?

There are two contrasting arguments when it comes to government fuel subsidies — economic and social grounds. The political dimension is often not discussed. But this could also be another important motive for government intervention in the pricing of energy products. In Ghana, energy affordability and availability has become an important issue that affects the voting pattern. Though the market has been allowed to operate on its own recently, historically, there have been occasional interventions by the government. The political factor may be important, in the case of Ghana, yet we do not know with certainty what the real motive for intervention in the petroleum sector has been.

In the long-term, changing consumer preference and income patterns, government policies and innovation could affect how consumers behave in a particular market. Structurally, a lot has happened in Ghana after the reforms in 1983. Income patterns have changed, innovations have improved and development structures have improved relatively. Yet we do not know empirically to what extent income and price elasticities have changed after this period. Finally, with the growing urbanization and increasing ownership of cars in Ghana, road transport energy will keep up with the increase. This requires making long-term strategic decisions about the optimal investment required to meet future demand. This further requires information on what future energy needs are likely to be.

These questions are essential policy questions in the road energy sector in Ghana which requires an empirical investigation. The current study has four broad objectives:

1. Determine the symmetric or asymmetric consumer response to price and income changes for gasoline and diesel fuels.
2. Investigate how price and income elasticities have shifted after the eighties for gasoline and diesel consumers.
3. Examine the persistent time profile of system-wide, price, income and consumption shocks for gasoline and diesel fuels.
4. Predict gasoline and diesel consumption up to 2030.

Previous studies on energy demand in Ghana have focused on transport energy demand (see Ackah and Adu, 2014; Annan et al., 2015), electricity demand (see Adom, 2013; Adom and Bekoe, 2013; Adom et al., 2012; Adom and Bekoe, 2012), natural gas demand (see Ackah, 2014) and liquefied petroleum gas (see Mensah, 2014). In the case of road sector diesel and gasoline demand, we are not aware of any study on Ghana. This makes the current study different from Ackah and Adu (2014) and Annan et al. (2015). The current study also makes the following contributions to the general transport energy demand literature. The present study is much broader in scope in terms of the policy issues it addresses compared to earlier attempts in the literature (see Polemis, 2006; Akinboade et al., 2008; Broadstock and Hunt, 2010; Brons et al., 2008; Sene, 2012; Limanond et al., 2011; Xu et al., 2015; Keshavarzian et al., 2012; Ajavonic and Haas, 2012; Ben sita et al., 2012; Karagiannis et al., 2015 inter alia). Second, contrary to previous attempts that employ half-way adjustment cointegration models (see Dahl and Kurtubi, 2001; Alves and Bueno, 2003; Polemis, 2006; Iwayemi et al., 2010; Ajavonic and Haas, 2012), we employ the Structural Cointegration Vector Autoregressive (SCVAR) method. The SCVAR allows for complete adjustment to equilibrium. Third, we contribute to the scarce literature on shifts in income and price elasticities (see Dahl, 2011; Goodwin et al., 2004; Small and Van Dender, 2007; Hughes et al., 2008; Al Dossary, 2008; Fouquet (2012), which has been, at present, biased towards developed economies.

The rest of the study is organized as follows. Section 2 discusses the literature. Section 3 presents a brief overview of the Ghanaian transport sector and energy use. Section 4 describes the method, model and data used. Section 5 discusses the main findings, and Section 6 concludes the paper with policy recommendations.

2. Literature review

Theoretically, demand for any commodity is determined by price of the commodity, income of consumers and other social-economic and demographic factors. However, which factors are crucial to consider largely depends on the type of good and the context of study. In the transport sector, demand for energy is determined by the price of energy, income, traffic situation, number of miles travelled, fuel efficiency and state of road infrastructure. Nevertheless, empirical studies have concentrated on the price of energy and income mainly due to data availability. These empirical specifications have been justified on the grounds that income changes may reflect in the number of miles travelled, stock of vehicles, and fuel efficiency. As a result, the effects of income may reflect these behaviours albeit in a more compact form. Basically, the literature on transport energy demand has focused on four key policy issues: consumers' responses to price and income changes; forecast of transport energy demand; asymmetric price response and stability of income and price elasticities. Therefore, we organize the literature along these four policy issues.

Sharma et al. (2002) estimate gasoline and diesel fuel demand using data from India covering the period 1970 to 1998. The result shows that gasoline demand is price inelastic and negatively related to the price of petrol. Also, the result shows that a change in population has a positive impact on gasoline demand. Belhaj (2002) analyses the same problem but studies both vehicle and fuel demand for Morocco. The result shows that both diesel fuel and gasoline fuel are strongly related to fluctuations in income, real prices and vehicle stock. Akinboade et al. (2008) employ the ARDL approach to analyse the determinants of gasoline demand in South Africa. The result shows that price and income are inelastic in the short-run and long-run. Sene (2012) also finds that gasoline demand is price and income inelastic in the short-run and long-run in Senegal. Ackah and Adu (2014) use the structural time series technique to analyse transport gasoline demand in Ghana. The result shows that price is inelastic in the short-run and long-run, and income is inelastic in the short-run but highly elastic in the long-run. Alves and Bueno (2003) use an error correction model to analyse gasoline demand in Brazil. They find that gasoline demand is price and income inelastic in the short- and long-run. Romero-Jordan et al. (2010) also estimate the price and income elasticities for the transport sector in Spain. The result shows that transport demand is price inelastic and income elastic. Broadstock and Hunt (2010) use the structural time series model to quantify the impact of non-economic factors on transport oil demand in the United Kingdom (U.K.). The result shows that income has a significant positive impact on oil demand, but the effects of fuel efficiency and price are significantly negative. Further, the result reveals that the contribution of fuel efficiency and price is small, but the contribution of income and non-economic factors is relatively large. Nicol (2003) examines a similar problem. But contrary to previous attempts, Nicol (2003) uses regional data for Canada and the United States, which makes the study more micro-based. The result shows that, on the whole, the price and income elasticities are inelastic, but these elasticities vary significantly across regions in Canada and the United States. Polemis (2006) studies a sub-section of transport energy demand — road sector energy demand for Greece. The study analyses the problem within a Vector autoregressive model. The result shows that, in the long-run, gasoline demand is income and price inelastic, but diesel fuel is price inelastic and income elastic in the long-run. Also, Iwayemi et al. (2010) estimate demand for petroleum products in Nigeria based on Johansen multivariate cointegration technique. Data covered 1977 to 2006. The result shows that demand for petroleum products are price and income inelastic in the short-run and long-run, but the elasticities differ according to the product type. Brons et al. (2008), contrary to the above studies, conduct a meta-analysis of the price elasticity of gasoline demand based on the Seemingly Unrelated Regression (SUR). The result shows that gasoline demand is price inelastic in the short-run and long-run. According to the authors, price responses are