

An Econometric Analysis of Fuel Demand in Zambia

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Abstract

Fuel is essential to the smooth running of any industry. Without fuel, many processes would stop and be difficult to restart. Fuel can come in many forms; it can be liquid or gaseous and be a fossil fuel or renewable source. A country's reliance on fuel imports is usually because it lacks sufficient resources to produce fuel domestically. In this study, fuel refers to gasoline and diesel. There are periods in Zambia when there are shortages of fuel in the domestic markets. Indeni oil refinery was put on care and maintenance as it has become obsolete and the country now imports final finished fuel products. The implication of all this is that fuel will now get delivered by road as opposed to delivery by pipeline to Indeni which was refined into various products. Additionally, this decision removes government bureaucrats from making procurement decisions of crude oil and puts procurement decisions of final fuel products in the hands of individual oil marketing companies which sell the products to the final consumers. These developments inadvertently will have a big impact on the price of petroleum products. The result of estimating a VAR model indicates that fuel demand in Zambia is negatively related to price changes in fuel. Past values of fuel consumption are found to be important determinants of the present demand for fuel. GDP surprisingly doesn't determine fuel demand. This may be an indicator that GDP growth is not filtering through to the ordinary citizen. There is a need to design inclusive economic policies so that benefits from growth filter through to the ordinary citizens.

Keywords: Fuel Demand, VAR model, Hubbert Peak Theory, Error Correction Model (ECM), Autoregressive Distributed Lag Model (ARDL); Fuel Subsidy Reforms.

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1.0 Introduction

Fuel is essential to the smooth running of any industry. Without fuel, many processes would stop and be difficult to restart. Fuel can come in many forms; it can be liquid, gaseous, fossil, or renewable. A country's reliance on fuel imports is usually because it lacks sufficient resources to produce fuel domestically. Fuel is used in all aspects of production and transport: powering vehicles, heating homes, and generating electricity. It can also be used in producing fertilizers, manufacturing goods, and transporting goods. In this way, fuel demand is primarily driven by the need for energy and raw materials to produce goods and services.

Fuel sold at filling stations to retail customers constitutes the largest consumer of fuel in Zambia (Energy Regulation Board 2020). Transporting goods, workers, and ordinary users of transport services consumes most of the country's fuel; this includes public buses, trains, and lorries used by businesses and governments alike. In addition, there are private vehicles such as cars and trucks used by individuals to transport goods and people. There are also electric generation facilities that use fuel as a source of power generation for their factories or farms.

The mining industry is the second largest consumer of fuel in Zambia (Energy Regulation Board 2020). Mining companies use large amounts of fuel during exploration processes such as when they excavate sites or bring equipment to a mine site. They also have to transport goods using their own vehicles after mining operations finish. The country's demand for petroleum products is expected to continue to rise as the economy continues to expand. The demand for fuel is directly linked to the economy and the living standard in the country. In other words, if the economy grows, so will the demand for fuel. Similarly, an increase in the demand for fuel may be an indicator of a higher standard of living i.e. increased use of motor vehicles as a mode of transporting goods and services.

Fuel price in Zambia is mainly determined by international oil prices and exchange rate. An increase in fuel prices is inevitable when the exchange rate depreciates or when there is an international oil price hike. Additionally, the government regulates the price of fuel at the pump— influencing how much consumers pay for their petrol or diesel. In an effort to ensure cost-reflective prices, the government through the energy regulator sets a monthly pricing cycle that determines the retail price of fuel.

2.0 Motivation for the study

There are periods in Zambia when there are shortages of fuel in the domestic markets. Indeni Oil Refinery was put on care and maintenance as it has become obsolete, and the country now imports final finished fuel products. The implication of all this is that fuel will now get delivered by road. The crude oil used to be pumped through a pipeline to the Indeni refinery, where it was refined into various products. Additionally, this decision removes government bureaucrats from making procurement decisions of crude oil and puts procurement decisions of final fuel products in the hands of individual oil marketing companies which sell the products to the final consumers. These developments inadvertently will have a big impact on the price of petroleum products.

The government has adopted a monthly cycle in which they review and adjust prices of fuel to ensure that they are cost reflective. The public is prepared to welcome price cuts but dislikes increases in fuel prices. Little is known about the responsiveness of fuel demand to a change in the price of fuel affects the demand for the commodity. We have no empirical basis for understanding how a change in national income will affect the quantities of fuel the country will consume.

3.0 Theoretical Literature Review

Hubbert Peak Theory postulates on the notion that since oil/fuel is a finite resource, it is expected that its production will peak at a certain period before eventually going into a terminal decline owing to its non-renewable nature (Hubbert, 1949). As oil is finite resource, Pebbles (2017) goes on to state that based on this theory, it is generally expected that demand for oil (crude) will be price inelastic though emphasis is also placed on the quality and level of processing that the oil is subjected to as that affects its demand.

The Scarcity theory is the basis of almost all economic thought. It is based on the premise of individuals in society having unlimited needs against limited resources hence opportunity costs arise as not all needs can be met (Jhingan, 1997). The scarcity of oil stems from the fact that it is a non-renewable resource produced in a few countries i.e. Organization of the Petroleum Exporting countries (OPEC) hence production of it is limited to those countries who consequently set prices for it on the international market with this oil attracting a global demand. Therefore, price is an important element that is used to ration scarce resources such as crude oil; hence it is expected to influence its demand.

The utility theory is equally important in the field of economics. The utility is often associated with the term satisfaction, as it is believed that individuals derive some level of satisfaction from the consumption or use of a good or service (Kapteyn, 1985). Society does not necessarily derive utility by consuming fuel, but rather they derive satisfaction when they make use of fuel for other ventures such as fueling their vehicle for transportation purposes or using it as a source of energy for diesel or petrol-powered generators. This hence makes the demand for fuel a derived demand.

3.1 Empirical Literature Review

Shaw (2020) used yearly time series data from 1966 to 2019 to estimate the demand for petrol in India using single-equation dynamic models. The explanatory variables used in the model are the real income, the real price level of petrol, and the volume of cars. Shaw (2020) observed that the demand for petrol is inelastic to its price in both the short and long run, with price adversely affecting the demand for petrol in India. There was also evidence of a long-term unidirectional relationship running from real income to the consumption of petrol.

Elizalde (2011) examined the gasoline demand in Mexico using monthly data collected from 1997 to 2007. The study used an Error Correction Model (ECM) with demand for gasoline captured using the consumption of unleaded and premium gasoline. The real prices of unleaded and premium gasoline were used as independent variables alongside income. Estimation results showed that, in both the short and long run, price only adversely affected the demand for unleaded gasoline. In contrast, income positively affected both types of gasoline. Further, demand for both unleaded and premium gasoline was found to be inelastic both in the short and long run.

Boshoff (2010) used an Autoregressive Distributed Lag Model (ARDL) to ascertain the demand for petrol, diesel, and jet fuel in South Africa using quarterly data collected between 1998 and 2009. Estimation results showed that the price of petrol, diesel, and jet fuel all exhibited a negative effect on their respective consumption. At the same time, income elasticity was significantly high for all three products and had the expected sign (positive).

Wadud et al. (2009) used a Cointegration approach to model the demand for gasoline in the USA using annual time series data from 1949 to 2004. Demand for gasoline was captured using gasoline consumption per capita, with the real income per capita and real price of gasoline used as the explanatory variables. The study further incorporated the presence of a structural break owing to the 1978 oil crisis. The results showed that there has been a positive relationship between gasoline consumption and real income post the oil crisis.

Akinboade et al. (2008) used a Cointegration technique to examine fuel consumption in South Africa. Estimation results indicated that in the long run, demand for fuel is both price and income inelastic, with the observed coefficients beings negative and positive, respectively. These results indicate that, on average, South Africans do not change their consumption patterns of gasoline that much when fluctuations are observed in the price of fuel and their income.

Koshal et al. (2007) analyzed the demand for gasoline in Japan using time series data collected from 1957 to 1999 with an analysis done using the Ordinary Least Squares technique (OLS). The results suggested that demand for gasoline was determined by inflation, income, price of available substitutes as well as the previous consumption behavior of consumers. Further, it was observed that in the short run, price and income had inelastic coefficients, with price negatively affecting demand and income positively affecting demand for gasoline. In the long run, these coefficients were elastic.

De Vita et al. (2005) used the Autoregressive Distributed Lag Model (ARDL) to ascertain the determinants of energy demand in Namibia. The study made use of annual secondary data collected between 1980 and 2002. For this model, De Vita et al. (2005) used air temperature, energy prices and GDP as the explanatory variables. The ARDL estimation results showed that GDP had direct effect on energy consumption in Namibia. In contrast, energy prices and air temperature negatively affected energy demand.

Ramanathan (1999) used the ECM technique to ascertain the demand for gasoline in India. For this study, the price of gasoline and income were used as explanatory variables, with demand captured through consumption of gasoline. The results showed that in the long run, income had a positive and elastic effect on gasoline demand in India, while price had a negative and inelastic effect on gasoline demand in India. The error correction term was found to be negative and significant indication that demand for gasoline would correctly adjust towards its long-run equilibrium should it deviate from it.

Eltony and Mutairi (1995), between 1970 and 1989, examined the factors influencing the demand for gasoline in Kuwait by making use of an ECM. It was observed that in both the short and long term, demand for gasoline in Kuwait was price inelastic, whereas demand for gasoline was found to be income inelastic in the short run and elastic in the long run.

In this study, we build on the work of the reviewed literature by adding a Zambian perspective to the demand for fuel. The study used the latest available dataset, allowing for helpful insight in a bid to understand traits unique to Zambia.

3.3 Conceptual Framework

Based on some empirical review, we develop a basic conceptual framework with price and income being the most prominent explanatory variables used in analyzing fuel demand.

4.0 Methodology

4.1 Data

In this study, two models are developed, i.e., one for the demand for petrol and the other for diesel, with price and income identified as the key explanatory variables of interest as developed by Elizalde (2011). The data used in the analysis was monthly time series data collected from the Energy Regulation Board of Zambia (ERB) and Zambia Statistical Agency (ZSA) databases between 2017 and 2021. Data from ERB included the price and quantities of diesel and petrol recorded in kwacha and cubic meters respectively, whilst data on Gross Domestic Product (GDP) was collected from the ZSA website and captured in kwacha. The study used the Vector Autoregressive Technique (VAR) to analyze how demand for petrol and diesel respond to changes in their respective prices and GDP (income).

Variable	Definition	Units of Measurement
Fuel Consumption	Volumes of fuel sold every month by oil marketing companies	cubic meters
Price of Fuel	value of fuel per liter	monetary units
Monthly GDP	Value of goods and services produced in Zambia on a monthly basis	billions of kwacha

4.2 Model Specification

The demand for petrol is specified as follows;

Demand for Petrol (QDP) = f (Price of petrol, GDP) ………………………… (1)

Represented in log-linear form as;

$$\mathbf{QDP_t = \beta_0 + \beta_1 LogPRPt + \beta_2 GDP_t + E_t} \ldots\ldots\ldots\ldots \quad (2)$$

With (2) further specified in VAR form as;

$$\mathbf{\Delta LogQDP_t = \beta_0 + \Sigma\beta_1\Delta LogQDP_{t-n} + \Sigma\beta_2\Delta LogPRP_{t-n} + \Sigma\beta_3\Delta LogGDP_{t-n} + E_t\,(-1)} \ldots\ldots \quad (3)$$

Similarly, the demand for diesel is influenced by price and income such that specified in VAR form it takes up a similar format to that of petrol and is shown below:

$$\mathbf{\Delta LogQDD_t = \beta_0 + \Sigma\beta_1\Delta LogQDD_{t-n} + \Sigma\beta_2\Delta LogPRD_{t-n} + \Sigma\beta_3\Delta LogGDP_{t-n} + E_t\,(-1)} \ldots\ldots \quad (4)$$

Where LogQDP is the log of quantity demanded for petrol, logPRP is the retail price of petrol, logGDP is the log of GDP and Et is the error term as shown in equation (3). From equation (4), logQDD is the log of quantity demanded for diesel and logPRD is the log of the price of diesel. **Δ** is the first difference operator and n is the optimal number of lags used in estimating the VAR.

The suitability of the VAR model is suitable in the estimation of models that have variables that are integrated in the order I(1) and show no evidence of cointegration; hence it is crucial to establish the order of integration before estimating the model.

4.3 Estimation Procedure

4.3.1 Testing for Stationarity

The results for stationarity results are shown in Table 1 below. The Augmented Dickey Fuller test (ADF) was used to test for stationarity under the null of a variable having a unit root as stated by Brooks (2014). For a variable to be stationary, the null has to be rejected in the ADF test, and the rule of thumb is that for stationary variables, the ADF test will have a p-value less than 0.05, and for those that are not stationary, the test statistic will have a p-value greater than 0.05

Based on Table 1, it was ascertained that all variables were non-stationary in their levels and only attained stationarity in their first difference; hence are integrated in the order I(1).

Table 1: Stationarity Test Results

Variable	***LogQDD***	***LogQDP***	***LogPRD***	***LogPRP***	***LogGDP***
			Level		
ADF statistic	-1.9966	-1.4746	-0.3714	-0.3759	-0.6484
P-value	0.2875	0.5392	0.9068	0.9061	0.0000
			First Difference		
ADF statistic	-9.6557	-8.6153	-5.9589	-6.3587	-7.8936
P-value	0.0000	0.0000	0.0000	0.0000	0.0000

Source: Authors Computation

4.3.2 Testing for Cointegration

The Johansen Cointegration Trace test was used in both models and the results depicted in Figures 1 and 2 [1]in the appendix show that no evidence of cointegration existed amongst the variables in both equation (3) and (4) hence a VAR was the appropriate model. Further Figures 3 and 4 [2]showed that the appropriate number of lags to be used in both equations was 1 as was chosen by the selection criterion.

4.4 Model Estimation Results

The VAR estimation results for the equations (3) and (4) are presented below in tables 2 and 3 respectively.

[1] See figures 1 and 2 in the appendix
[2] See figures 3 and 4 in the appendix

Table 2: VAR Results for Demand for Petrol

Dependent Variable: Quantity Demanded of Petrol			
Variable	**Coefficient**	**Standard Error**	**Probability**
DLogQTP (-1)	0.6511	0.0936	0.0000*
DLogPRP (-1)	-1.4648	0.5431	0.0093*
DLogGDP (-1)	0.4811	0.3061	0.1218
Constant	-3.9771	6.2132	0.5248
R^2 = 0.6953		***Prob (F) = 0.0000****	

/ denote significance at 1% and 5% level respectively*

Source: Authors Computation

From Table 2 above, it is observed that the previous value of petrol demanded and its price have a significant effect of the demand for petrol with the coefficients exhibiting a positive and negative effect respectively. Further, GDP was found be insignificant in explaining petrol demand.

Table 3: VAR Results for Demand for Diesel

Dependent Variable: Quantity Demanded of Diesel			
Variable	**Coefficient**	**Standard Error**	**Probability**
DLogQTD (-1)	0.3387	0.1234	0.0082*
DLogPRD (-1)	-1.9171	0.9126	0.0403**
DLogGDP (-1)	0.5427	0.6279	0.3912
Constant	-0.9234	13.3749	0.9452
R^2 = 0.2732		***Prob (F) = 0.0005****	

Source: Authors Computation

The demand for diesel is adversely affected by its price, with this effect being statistically significant while its lagged value had a positive effect. GDP was observed to have an insignificant effect on diesel demand in Zambia.

5.0 Discussion of Results

The results of equations (3) and (4) are very similar. The demand for fuel in Zambia is well behaved and follows the law of demand. When prices increase, the demand for fuel (petrol and diesel) decreases. If we assume that consumers are optimizing, the price increase will lower the quantities of fuel consumed and ultimately decrease welfare. These results are consistent with the findings of Boshoff (2010) and Elizade (2011) that found similar results in South Africa and Mexico respectively.

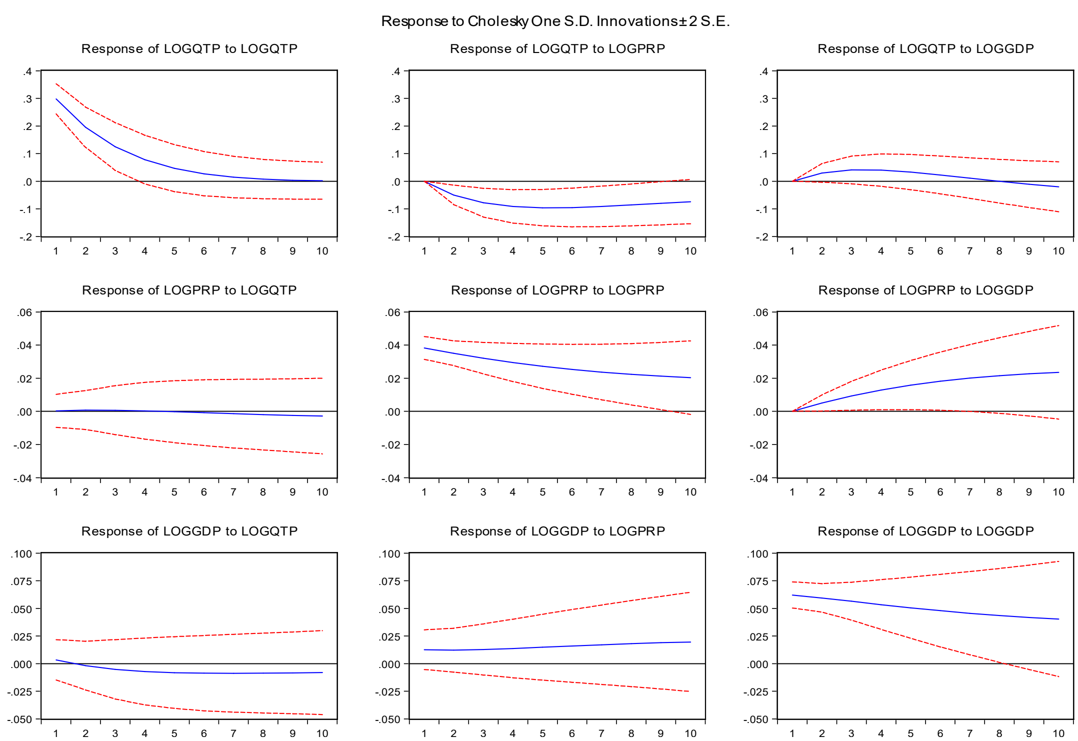
GDP is not significant in determining the level of fuel that is demanded. This result is surprising as it is contrary to the expectations of economic theory and reviewed studies that suggest that an increase in GDP will raise fuel demand. What then could be explaining these results? Inequalities-This could imply that the growth of GDP is not felt by the majority of citizens such that when GDP increases, almost all the increases are absorbed by capital owners and entrepreneurs and are repatriated as profits to countries where the capital originated from. This may then render GDP ineffective in influencing fuel consumption in Zambia despite it having the expected positive sign. Past values of the consumption of fuel are important determinants of the present consumption of fuel as can be observed by the significant coefficients in both models. This means that when the public is making fuel purchases, they make references to the quantities they purchased in the previous period. The past values of consumption positively affect present demand, and this explains the rising fuel consumption demand in Zambia.

To further analyze the effect of price and GDP in both models, the models were subjected to impulse response function analysis.

5.1 Impulse Response Function Results

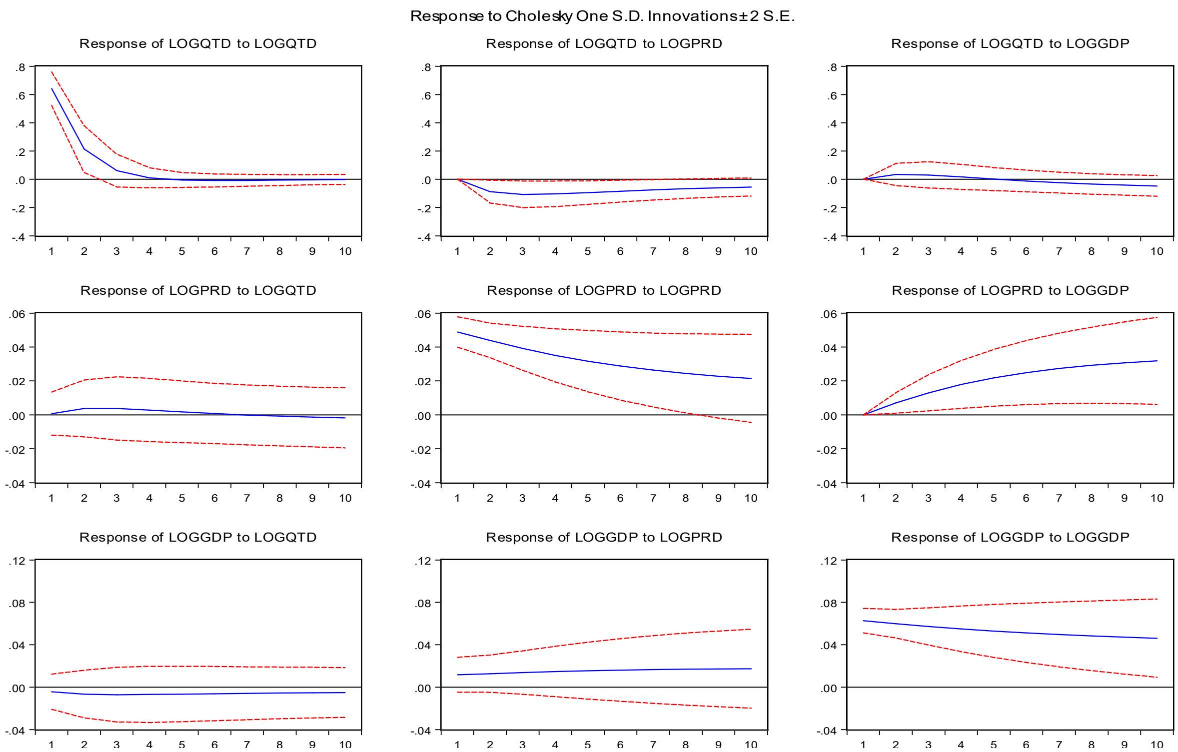
The results for the impulse response analysis for the petrol and diesel models are represented in figures 5 and 6 below respectively. In both the figures, the focus is on the coefficients that exhibited a statistically significant effect on the quantity demanded of petrol and diesel.

Figure 5: Impulse Response Function for Petrol



The impulse response function for petrol demand shows that a one standard deviation shock to petrol prices permanently decreases demand for fuel. This further validates the inverse relationship found between the two variables as consumers want to maximize their utility at the least possible cost. Additionally, results from the impulse response function indicate that a one standard deviation shock to demand for petrol lowers petrol demand, but its effect clears out after eight months.

Figure 6: Impulse Response Function for Diesel



Similarly, the impulse response function for diesel shows that a one standard deviation shock to the price of diesel has a permanent adverse effect on the quantity demanded of diesel, whereas a one standard deviation shock in demand for diesel reduces its demand with the effect of clearing out after four months.

5.2 Model Stability Test Results

Both the estimated models were subjected to stability tests. Based on figures 7 and 8 in the appendix, the models are deemed stable.

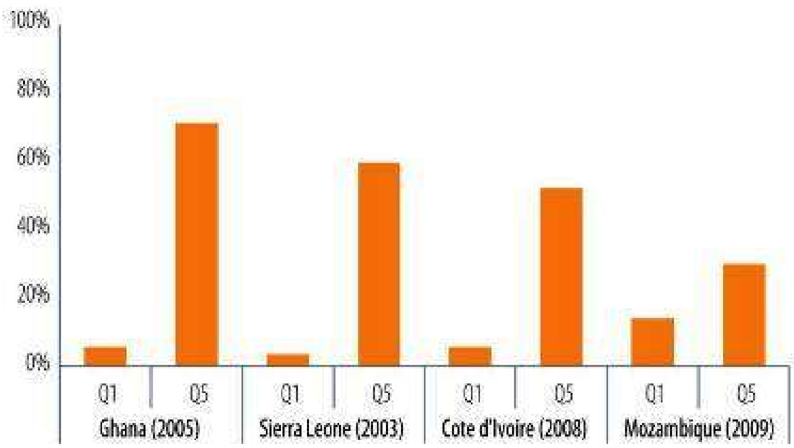
5.3 Rationale for Efficient and Sustainable Fuel Price Subsidy Reforms

It is undoubtedly clear from evidence across the developing world that the main beneficiaries of fuel price subsidies are high-come households leaving out the major targeted beneficiaries – the have-nots. According to the (Chuhan-Pole 2012):

> *"Expenditure data for seven African countries show that the distribution of these subsidies is disproportionately concentrated in the hands of the rich. Richer households spend a larger amount*

on fuel products, and, consequently, benefit more than poorer households from any universal subsidy on these products. On average the richest 20% receive over six times more in subsidy benefits than the poorest 20%."

Potential distribution of gasoline subsidy to households by income group, % of gasoline subsidy



Source: Africa's Pulse, Vol.5, World Bank

The results above should not be considered as the basis of removing fuel subsidies without due consideration of the poorest of the poor. It is clear that fuel subsidies promote income inequality. Consequently, promoting all forms of inequality as income inequality has a transmission mechanism into all the other forms of inequality. This results into making the poorest of the poor even more.

It clear that countries such as Zambia, cannot sustain fuel price subsidies in its current state of debt-distress. According to the IMF Staff Country Report (2022) on Zambia:

"Zambia is dealing with large fiscal and external imbalances resulting from years of economic mismanagement, especially an overly ambitious public investment drive that did not yield any significant boost to growth or revenues. A drought in 2019 and the COVID-19 pandemic exacerbated the acute economic and social challenges facing the country, with poverty, inequality, and malnutrition rates amongst the highest in the world. As a result, Zambia is in debt distress, defaulting on its Eurobonds in November 2020 while also accumulating arrears to other creditors. The war in Ukraine has increased prices of fuel and fertilizer, amplifying pressures further."

Zambia is at a time, in respect of monetary and fiscal policy, where fuel subsidies cannot be sustained. However, there is a need to pay attention to the impact of subsidy removal on the poorest of the poor who negatively get affected by both scenarios: First, the provision or/and maintenance of fuel subsidies in their current form; and second, the removal of fuel subsidies as is the case now in Zambia (Mwange 2022).

6.0 Conclusion and Recommendations on Fuel Subsidy Reforms

The study has demonstrated that demand for fuel in Zambia depends on fuel price and past values of fuel consumption. GDP surprisingly does not affect the demand for fuel in Zambia. This may be an indicator that GDP growth is not filtering through to the ordinary citizen. There is a need to design inclusive economic policies so that benefits from growth filter through to the ordinary citizens. It is against this background that the study further recommends that policies such as fuel price subsidies should be reformed with the goal of ensuring that all the four Strategic Development Areas identified in the Plan are achieved, namely: economic transformation and job creation; human and social development; environmental sustainability; and good governance environment. It is worth noting that the ongoing fuel price subsidies reforms should be undertaken with the Zambia's current in-distress classification by the IMF/WB's Debt-Sustainability (DSA) and Debt-Sustainability Framework (DSA). Therefore, any fuel price subsidies should be undertaken with serious caution on not only considering the effects of fuel subsidies on the high-income earners households, and on the low-income earners households, but also consideration needs to be made on the impact of fuel price subsidies on Zambia's macroeconomic fundamentals. Therefore, this paper adopts the recommendations of the IMF ((Clements, et al. 2015) in its Working Paper, ***The Unequal Benefits of Fuel Subsidies Revisited: Evidence for Developing Countries,*** incorporating recent research and increasing the number of countries, this paper provides developing countries with then-current evidence on the extent of the welfare impact of subsidy reform and its distribution across income groups. The rationale for this paper is that understanding who benefits from fuel price subsidies and the impact of rising fuel prices on welfare is key to planning subsidy reform and gaining public support. It was meant to be. The paper confirms that a very large portion of the benefits from price subsidies go to high-income households, further widening existing income inequalities.

It is worth noting that for Zambia to attain successful price fuel subsidies that will that can put Zambia's macroeconomic fundamentals in balance, and also the benefits trickle down to the intended beneficiaries, it should religiously adhere to the recommendations outlined by IMF (Clements, et al. 2015):

> "International experiences with energy subsidy reform suggest a number of barriers to successful reform, including (1) lack of information regarding the magnitude and shortcomings of subsidies; (2) lack of government credibility and administrative capacity; (3) concerns regarding the adverse impact on the poor; (4) concerns regarding the adverse impact on inflation, international competitiveness, and volatility of domestic energy prices; (5) opposition from specific interest groups benefiting from the status quo; and (6) weak macroeconomic conditions (Clements and others 2013). Many countries that have successfully reformed energy subsidies have incorporated specific measures into their subsidy reform strategies to overcome these barriers. While there is no single recipe for success, analysis of international reform experiences suggests the following six reform ingredients can help address reform barriers and increase the likelihood that reforms will achieve their objectives, thus helping to avoid policy reversals (IMF 2015):

1. **Develop a comprehensive reform plan** - The reform plan should have clear objectives. It should identify specific measures that will achieve these objectives, and include a timeline for implementing and assessing these measures. A comprehensive plan will incorporate many of the measures discussed below. Designing and executing such a reform plan therefore needs careful advance planning.

2. **Develop an effective communication strategy** - An extensive public communication campaign can help generate broad political and public support, help prevent misinformation, and should be undertaken throughout the reform process. Transparency is a key component of a successful communication strategy.
3. **Appropriately phase and sequence price increases** - Phasing in price increases and sequencing them differently across energy products may be desirable. The appropriate phasing and sequencing of price increases will depend on a range of factors, including the magnitude of the price increases required to eliminate subsidies, the economy's fiscal position, the political and social context in which reforms are being undertaken, and the time needed to develop an effective social safety net and communication strategy. However, gradual reform can create additional reform challenges, including lower budgetary savings in the short term, distortion in consumption patterns due to sequencing of reform by energy product, and the risk that opposition may build up over time.
4. **Improve the efficiency of energy state-owned enterprises (SOEs)** - Improving the efficiency of SOEs (refineries, distribution companies, and so on) can reduce the fiscal burden of the energy sector. Energy producers often receive substantial budgetary resources—consisting of both current and capital transfers—to compensate for inefficiencies in production, distribution, and revenue collection. Improvements in efficiency can strengthen the financial position of these enterprises and reduce the need for such transfers. It will also help assure consumers that price increases are not simply being used to protect inefficient and poorly governed producers.
5. **Implement targeted mitigating measures** - Well-targeted measures to mitigate the impact of energy price increases on the poor are critical for building public support for subsidy reforms. The degree to which compensation should be targeted is a strategic decision that involves trade-offs between fiscal savings, capacity to target, and the need to achieve broad acceptance of the reform. Subsidy reform involving SOE restructuring may require temporary, sector-specific social measures to support employees and enterprises.
6. **Depoliticize energy pricing** - Successful and durable reforms require a depoliticized mechanism for setting energy prices. Establishing an automatic pricing formula for fuel products that links domestic energy prices to international energy prices can help distance the government from the pricing of energy and make it clearer that domestic price changes reflect changes in international prices that are outside the government's control. Price-smoothing rules can help prevent large price increases. How much smoothing the government chooses to implement will depend on its preference between lower price volatility and higher fiscal volatility"

In conclusion, there is a need to also consider how to insulate the Zambian Kwacha against international currencies so that it can still remain stable during periods of international oil price shocks. Whatever the policy on how to sustain fuel prices in Zambia, it is important to consider commodity price shocks, especially for copper which is the major earner of the country's foreign exchange. The loss of foreign exchange reserves due to declined inflow of such caused by the low prices of copper and high prices of oil has a high price of fuel transmission mechanism. It is against this background that Mwange and Meyiwa (2022) recommend that proactively implementing contractionary monetary policy alongside expansionary fiscal policy, using conventional and unconventional policies is the most effective. If this is done, there is a high likelihood that fuel prices shall be insulated against external and global shocks that affect Zambia's foreign exchange stability. Consequently, the cost of subsidizing fuel, if the recommendations provided above by the IMF are implemented, will be within sustainable and efficient levels (Mwange, et. al., 2022). Therefore, the attainment of all developmental outcomes under each of the four strategic areas of Zambia's 8t National Development Plan shall be realized, and Zambia shall once again get on the journey towards the vision of turning Zambia into a Middle-Income Country by the year 2030.

References

Akinboade, O. A., Ziramba, E., & Kumo, W. L. (2008). The Demand for Gasoline in South Africa: An empirical analysis using co-integration techniques. Energy Economics 30, 3222-3229.

Brooks, C.A. (2014). Introductory Econometrics for Finance. Cambridge: Cambridge University Press.

Boshoff, H, W. (2010). Petrol, Diesel Fuel and Jet Fuel Demand in South Africa: 1998-2009. Department of Economics, Stellenbosch University, South Africa.

Chuhan-Pole, Punam. 2012. *Who benefits from fuel price subsidies?* Blog: Africa Can End Poverty, Washington, D.C.: World Bank.

Clements, Benedict, de Mooij Ruud, Gupta Sanjeev, and Keen and Michael. 2015. *The Unequal Benefits of Fuel Subsidies Revisited: Evidence for Developing Countries.* IMF Working Paper, Washington, D.C.: International Monetary Fund.

Energy Regulation Board. 2020. *Energy Sector Report.* Lusaka: Energy Regulation Board .

De Vita, G., Endresen, K., Hunt, LC. (2005). An Analysis of Energy Demand in Namibia. Energy Policy 34 (2006) 3447-3463.

Elizalde, M. (2011). An Empirical Analysis of Gasoline Demand in Mexico using Cointegration Techniques. University of Texas at El Paso.

Energy Regulation Board (2022). Statistical Bulletin: January to December 2021. Lusaka, Zambia

Energy Regulation Board (2019). Statistical Bulletin: January to December 2018. Lusaka, Zambia.

IMF. 2015. *The Unequal Benefits of Fuel Subsidies Revisited:.* Working Paper, Washington, D.C.: IMF.

Hubbert, M. King. (1949). Energy from Fossil Fuels. American Association for the Advancement of Science 109.2823 (1949): 103-09. Web.

Jhingan, ML. (1997). Microeconomic Theory; Fifth Revised & Enlarged Edition. Vrinda Publications (P) LTD.

Koshal, R., Miyamiza, S., Koshal, M. (2007). Demand for Gasoline in Japan. International Journal of Transport Economics. Vol. XXXIV, No.3. October 2007.

Mwange, A. (2022). An empirical investigation of the impact of monetary policy on economic growth in Zambia. Journal of Accounting, Finance and Auditing Studies, 8(4), 306-321

Mwange, A. and Meyiwa, A. (2022). Monetary Policy Responses to Crude Oil-Price Shocks: The Case of Selected Central Banks. Economics and Business Quarterly Reviews, 5(3), 102-112.

Mwange, A. (2022). An empirical investigation of the impact of monetary policy on economic growth in Zambia. Journal of Accounting, Finance and Auditing Studies, 8(4), 306-321.

Mwange, A., & Meyiwa, A. (2022). Monetary Policy Responses to Crude Oil-Price Shocks: The Case of Selected Central Banks.

Mwange, A., Kasongola, P., & Meyiwa, A. (2022). An Assessment of the Effect of Mobile Money Services on the Profitability of the Banking Sector in Zambia.

Pebbles, T (2017). Development of Hubbert's Peak Oil Theory and of its Continued Validity in US Oil Production. Yale University

Shaw, C. (2020). Econometric Analysis of Demand for Petrol in India, 1966-2019. MPRA Paper No. 104797.

Wadud, Z., Noland, B.R., Graham, D. (2009). A Cointegration Analysis of Gasoline Demand in the United States. Department of Economics, Warwick University, Coventry CV4 7AL, UK.

Zambia Statistical Agency. (2022). Monthly Bulletin; December 2021. Lusaka, Zambia.

Zambia Statistical Agency. (2018). Monthly Bulletin; December 2017. Lusaka, Zambia.

APPENDIX

Figure 1: Cointegration Test for Demand of Petrol

Hypothesized No. of CE(S)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None	0.219767	24.24597	29.79707	0.1902
At most 1	0.156123	9.982521	15.49471	0.2922
At most 2	0.000122	0.007094	3.841466	0.9323

Trace indicate no cointegrating equations at 0.05 level.

Source: Authors Computation

Figure 2: Cointegration Test for Demand of Diesel

Hypothesized No. of CE(S)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None	0.231188	24.7531	29.79707	0.1704
At most 1	0.150421	9.505634	15.49471	0.3207
At most 2	0.000875	0.050794	3.841466	0.8217

Trace indicate no cointegrating equations at 0.05 level.

Figure 3: Lag Selection Test for Petrol Demand

Lag	LogL	LR	AIC	SC
0	34.21428	NA	-1.135065	-1.025574
1	165.8865	244.1921*	-5.597909*	-5.157909*
2	170.6272	8.274651	-5.440989	-4.674552
3	179.1911	14.01372	-5.425132	-4.330223
4	189.1642	15.23159	-5.460516	-4.037134
5	196.3651	10.21221	-5.395095	-3.643241

*Indicates lag order selected by criterion

Source: Authors Computation

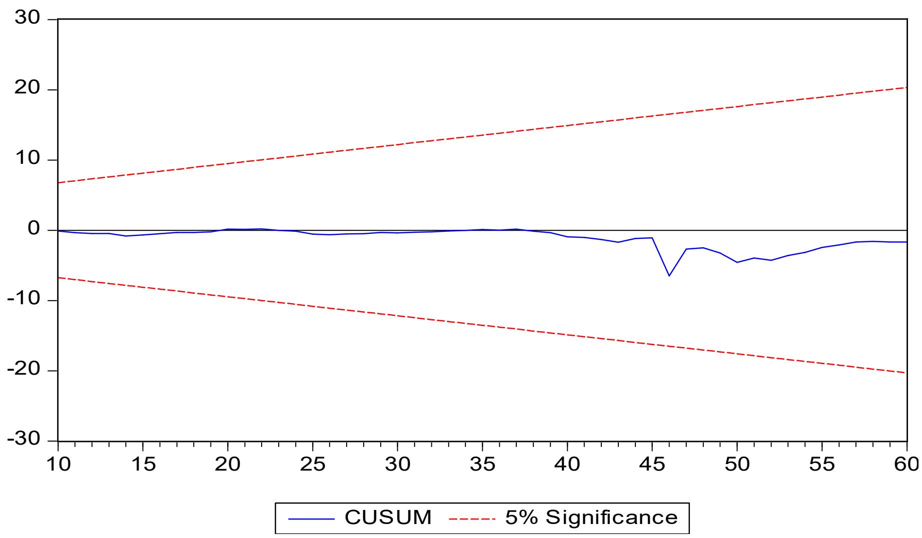
Figure 4: Lag Selection Test for Diesel Demand

Lag	LogL	LR	AIC	SC
0	0.643557	NA	0.085689	0.128030
1	109.5141	201.9054*	-3.545968*	-3.376604*
2	113.3151	6.634517	-3.356914	-3.060527
3	117.1818	6.327277	-3.170248	-2.746837
4	127.2046	15.30747	-3.207438	-2.657005
5	130.7524	5.01346	-3.009178	-2.331722

*Indicates lag order selected by the criterion

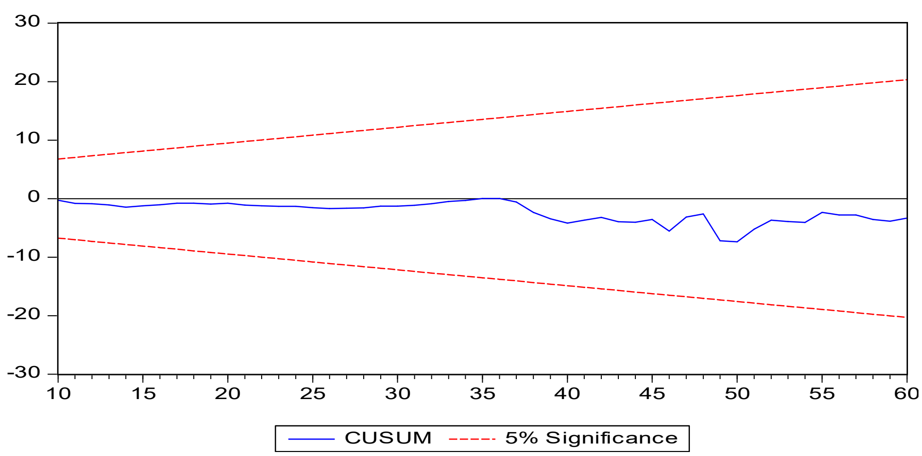
Source: Authors Computation

Figure 5. Stability Test for Demand for Diesel Model



Source: Authors Computation

Figure 6: Stability Test for Demand for Petrol Model



Source: Authors Computation