Exchange Rate, Petroleum Price and Price Determination in Sierra Leone

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Abstract

The Sierra Leone economy is a net importer with a chronic negative balance of trade. Imports as a percentage of GDP averaged 40.8% between 2001 and 2010. Imports of food, mineral fuels and lubricants accounted for 50.8% of the total value of imports within the same period. Also, the value of the leone depreciated from Le 920.75 in 1996 to Le 4,000 in 2010 while inflation averaged 12.6% for the same period. As a result of the interplay of these forces, fuel prices are most times adjusted upwards to compensate for the depreciation of the leone against the dollar or to match up with increases in the world price of crude oil. This study determines the effects of monetary environment as well as exchange rate movement and petroleum prices on domestic prices in Sierra Leone by estimating a hybrid model of inflation in which inflation responds to its own lags, lags of other variables, and a set of error-correction terms that represent short run disequilibria from the money market, external sector and output that feed into the inflation process.The empirical results from the parsimonious model show that petroleum product prices and exchange rate, as well as monetary factors determine inflation in Sierra Leone. What is also significant from the findings is that the contribution of petroleum prices to domestic price formation is unfounded in the long run, meaning that it is only a short-run phenomenon. The results also support the view that a fair portion of fluctuations in domestic prices is driven by its own shocks.

JEL Classification: *C13, E31, E51, O55.*
Keywords: *Sierra Leone, Inflation, Pump Price, Exchange Rate.*

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1. Introduction

The problem

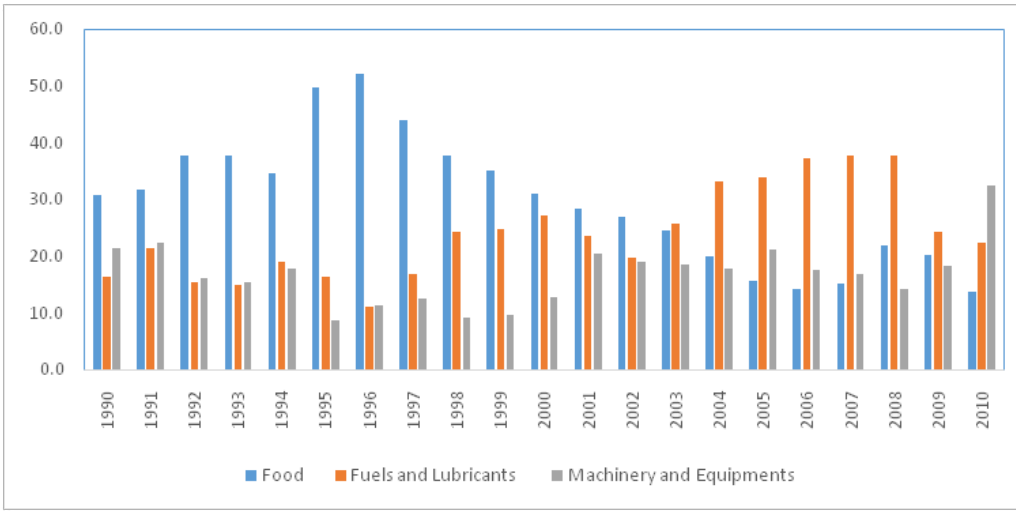
In many oil importing countries in Sub-Saharan Africa (SSA), the prices of petroleum products as well as exchange rate dynamics are key elements driving domestic prices. In other words, rising oil prices and currency depreciation are prominent external factors affecting inflation (Salvatore, 1984). Monetary policy, fiscal policy and wage policy also have an impact on domestic price levels.[1] Several possible explanations account for the impact of these external factors on domestic prices: a higher proportion of imports on the CPI basket; a higher share of imported inputs in the production process; and the degree of competitiveness of the different sectors of the economy. Petroleum prices have a significant impact on domestic prices because fuel products are essential in the production process. Menu-cost models of price adjustment suggest that inflation is higher in markets where price changes are more frequent (Taylor, 1999; Amano and van Norden, 1998). This is partially due to the cost of changing prices.

A continuous hike in petroleum prices can throw a country into balance of payment difficulties, especially for an oil importing country such as Sierra Leone. This would invoke larger and more frequent currency devaluations or depreciations and higher cost for all other inputs, thus significantly contributing to domestic inflation (Salvatore, 1984). Deficit financing of major capital expenditures can also be inflationary in developing countries (Vogel, 1974). The reason is that the share of monetary GDP to total GDP is very low, thus a given deficit financed by sale of government securities to the banking system would lead to a disproportionate increase in money supply.

Petrol and diesel are the major petroleum products in Sierra Leone, used mainly for power generation and transportation. Therefore, a rise in prices of petroleum products will increase almost the entire cost of production. The relative shares of selected major imports over the period 1990-2010 are shown in Figure 1. The average share of fuels and lubricants to total imports in Sierra Leone is 23.9% during the review period while the average shares of food and machinery relating to the same period are 29.6% and 16.8%, respectively.

It is clear from Figure 1 that during the initial period, food imports outweigh imports of fuel and lubricants, but the tide is reversed from 2003 upwards. It can also be seen that during 2010, imports of machinery and equipment outweigh those of fuel and food. The reason is due to the large importation of heavy machinery for the setting up of African Minerals and London Mining, a company involved in the extraction of iron ore.

Figure 1:Relative shares (percentage) of selected items to total imports



The total volume of trade between 1990 and 2010 is shown in Figure 2. It is clear from Figure 2 that the value of imports outpaces exports during the entire study period, and that the volume of trade increased during the initial period, nose dived in 1995 and 1996 when the war heightened, and gradually trended upwards for the rest of the research period.

Figure 2: Total value of imports and exports in US dollars, 1990-2010

The critical concern is how to gauge the impact of petroleum prices on domestic prices, since inflation is a perennial problem of the Sierra Leone economy, implying that the former would have contributed only to a prevailing difficulty. In tandem with this, domestic petroleum prices are determined according to world crude oil prices and exchange rate movements. Thus, exchange rate dynamics have double impact on

domestic prices; pass-through in general, and its specific impact on petroleum imports.[2] As a result of this, it is not unusual for domestic petroleum prices in Sierra Leone to likely respond to changes in exchange rate and fluctuation in world oil prices. This study attempts to fill this gap in terms of exploring the link between domestic price level and prices of imported petroleum products, on one hand, and the impact of exchange rate movements on domestic prices, on the other. The reason is that understanding the causes and consequences of price rigidities in an economy is essential for assessing the impact of macroeconomic policies on that economy. This analysis is very significant if policy makers are to mitigate the impact of exchange rate dynamics on petroleum prices, and come up with policies that will enhance stability of pump price.

Objectives of the study

The broad objective of this study is to investigate the role of prices of petroleum products, and exchange rate, in price determination in Sierra Leone. The specific objectives are to:

(i) Empirically examine the relative significance of pump price of petrol on inflation; and

(ii) Investigate the effect of exchange rate on domestic inflation.

The rest of the paper is structured into four sections. Section II presents stylized facts on prices in Sierra Leone. Section III discusses the relevant literature and model specification. Section IV estimates the model and contained in Section V are some conclusions and policy implications.

2. Stylized facts on prices in Sierra Leone

The structure of the Sierra Leone economy is rudimentary. Retailing, dominated by small-scale businesses, shapes the business landscape. The decade-long civil conflict in the 1990s devastated both social and economic infrastructure condemning many people to the abyss of poverty as the country is persistently ranked as among the poorest in the world, according to the UN Human Development Index (IMF Ex-Post Assessment of Longer-term Programme Engagement, No. 5-192). Sierra Leone has a rich resource base as well as a diversified largely untapped agricultural sector. The key exports of the West African nation are dwindling and include diamonds and agricultural crops, coffee and cocoa. The mining industry accounted for almost 5% of the country's GDP between 2007 and 2010, while minerals made up 79% of total export revenue, with diamonds accounting for 46% of export revenue in 2008. The main minerals mined in Sierra Leone are diamonds, rutile, bauxite, gold, iron and limonite. The Government of Sierra Leone has signed lease agreements with some mining companies that started the mining and exportation of iron ore and bauxite in 2012, with the growth rate projected to be a double digit.

Exchange rate policy in Sierra Leone

A series of exchange rate adjustments were adopted in the 1980s due to persistent deficit in the balance of payments.[3] The deterioration in economic performance in the 1980s, including poor external sector performance, led to the introduction of a dual exchange rate system in 1982 under the Modified Exchange Rate Arrangement (MERA). This involved an official exchange rate and a commercial market rate but the policy was not effective as external sector performance continued to deteriorate. The poor performance emanated from the fact that such a system often encourages the diversion of export remittances from the official market to the parallel market.

As a result of these inherent difficulties, a unified exchange rate system was adopted in July 1986. However, fiscal deficit continued to widen and was mainly financed by borrowing from the domestic banking system, especially through domestic credit. Therefore, money supply was difficult to control, leading to inconsistent monetary expansion with high inflation and real exchange rate appreciation as consequences.[4] Thus, external sector performance could not be improved despite the unification.

A managed type floating exchange rate regime was adopted in April 1990, and most current account transactions were liberalized. The main reason for such a move was that, the premium between the official and parallel market rate was getting larger during the

fixed exchange rate regime. Smuggling of diamond, gold and other produce was on the increase, thereby undermining the balance of payments. The nominal exchange rate has been depreciating since the adoption of the (managed) floating exchange rate.

The Central Bank of Sierra Leone introduced a system of foreign exchange auction in February 2000. This weekly foreign exchange auction has continued to provide a regular source of foreign exchange, complementing the other sources, with the intention of financing private sector imports. The sectors opened to the auction are banks, oil companies, manufacturing industries and general imports. Notwithstanding this action, in most cases, the supply tends to lag behind the demand for foreign exchange.

CPI and petroleum prices

The Consumer Price Index (CPI) in Sierra Leone is made up of 251 items categorized under 12 functions according to the Classification of Individual Consumption according toPurpose (COICOP). The weight of food and non-alcoholic beverages in the CPI basket is 51.02%, while housing, water, electricity, gas and other fuels is 9.81% and transport is 5.95%.[5] Furthermore, the proportion of imported goods in the CPI basket is almost 60%. This high proportion implies that exchange rate dynamics have an impact on the prices of goods in the CPI basket. Also, the weight of food and non-alcoholic beverages in the basket possibly explains why increase in transportation fares normally impacts on the overall CPI, since these items need to be transported locally. Also, food items are typically unprocessed goods and, therefore, have little value-added beyond their primary input costs to absorb cost shocks (Kovanen, 2006). The average of imported goods as a percentage of GDP between 2000 and 2010 was 40.75. The value of imports within this same period averaged US$ 340 million, with mineral fuels and lubricants and food accounting for 50.8%. Exchange rate depreciated from Le 920.75 in 1996 to Le 3,450.68 in 2010, while inflation rate averaged 12.57% for the same period.

The impact of petroleum product prices on domestic prices is very crucial in Sierra Leone, since transportation fares are sometimes raised to reflect increases in the pump price of fuel.[6] The difference between the domestic and world prices of fuel is sometimes absorbed by the government through direct and indirect subsidies. This action sometimes prevents a direct impact on inflation but has an indirect one through the management of monetary and fiscal policies.

In few instances, for example in June 2009, Sierra Leoneans have experienced reduction in petroleum product prices in response to decline in world price of crude but the magnitude of the reduction at the domestic level is sometimes not commensurate to the reduction at the world level. Similarly, the magnitude of the increase in world price of crude is most times not fully transmitted to the domestic consumer. The pump price of fuel is normally determined by the Petroleum Monitoring Unit located in the Ministry of Trade and Industry.[7] Petroleum products in Sierra Leone attract a series of levies: an import duty of 5% on an *ad valorem* basis, storage cost, port charges, and transfer and agency fees. These levies contribute to the landing cost of the products. In addition to these levies, the products also lure an excise duty, a road user charge and a petroleum fund levy. The management of oil-related taxes is under the Petroleum Fund Unit located at the Ministry of Trade.

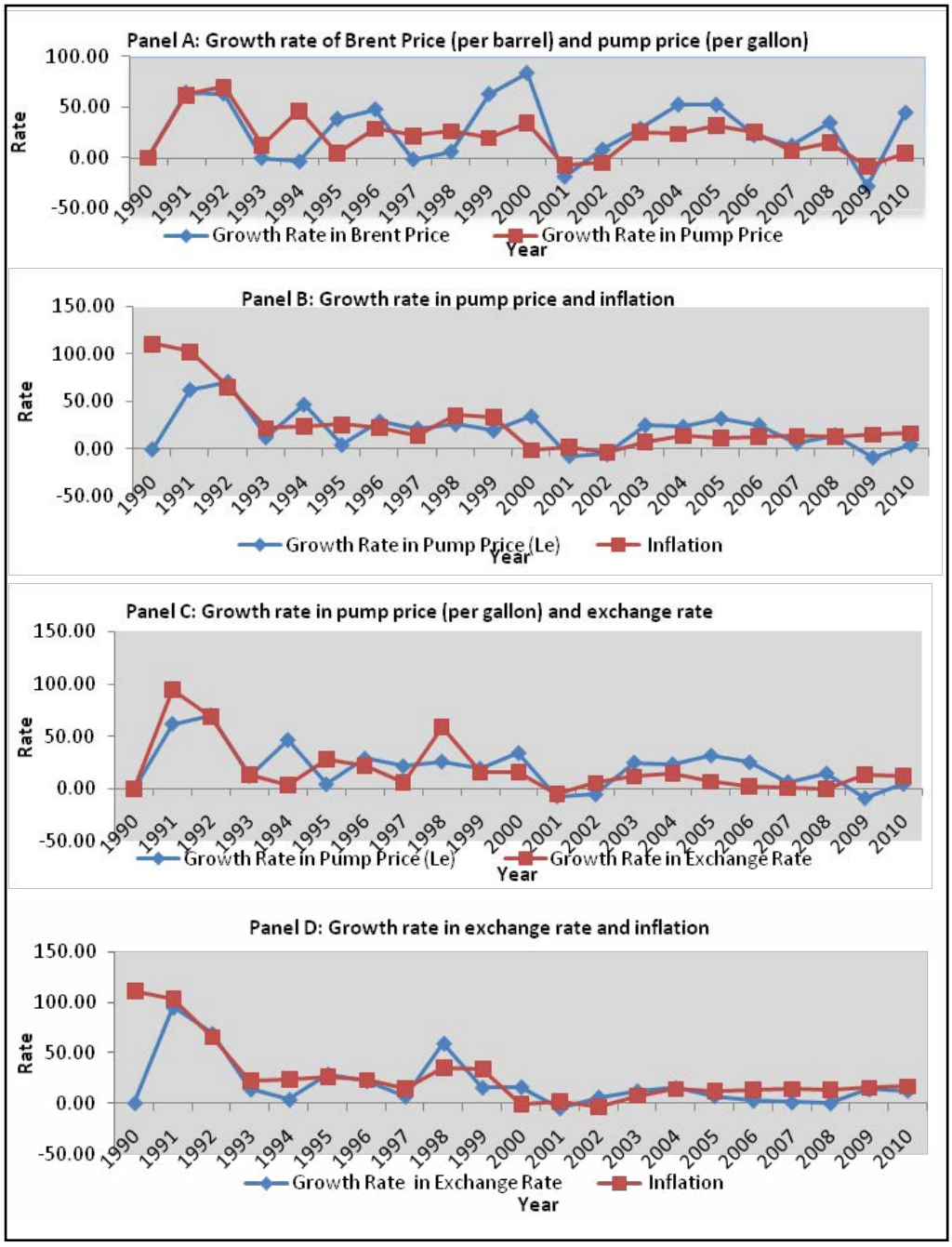
The Government of Sierra Leone reintroduced a fuel subsidy in August 2009 to match the soaring of the world price of crude oil around that time, but maintaining this provision was not sustainable as the subsidy was eliminated in May 2011, coinciding with the change in fuel measurement from imperial to metric. The excise duty on petrol was Le 2,808 per gallon for 2009 and 2010 and currently stands at Le 137.07 per litre (Le 625.04 per gallon), a reduction by 77.7%[8] (Leone, 2011).

The dynamics in the pump price of petrol, inflation and movements in the exchange rate is illustrated in Figure 3. The trend analyses explored all the links as specified earlier; i.e. barrel price and pump price, pump price and inflation, exchange rate and inflation, and exchange rate and pump price.

Panel A shows a cross plot of the growth rate of the pump price of petrol and the Brent price per barrel. It is clear from Panel A of Figure 3 that the pump price of petrol generally mimics the growth in the international price. This implies that there is some pass-through from the international market to the domestic market for petroleum products. Moreover, domestic prices do not fully reflect international prices in Sierra Leone due to the fact that the good is politically sensitive, and that the authorities adjust taxes and/ subsidies to buffer the ensuing volatility.

A plot of the growth rate in pump price and inflation is contained in Panel B. It is clear from Panel B that the pump price of fuel and inflation do not flow in the same direction. The picture can best be described as being mixed; for example in 2000, there is a drastic fall in inflation while the pump price soars. It can largely be generalized that during the period under investigation, inflation rate does not perfectly echo movements in petroleum pump price. The growth rate in the pump price of petrol, and exchange rate, largely staggered throughout the period under review as displayed in Panel C. The picture in the last two years (2009 and 2010) is that exchange rate soars while pump price remains stable. A plausible reason that might explain such a clumsy link between the two variables is the price stabilization policy intervention on the side of the government, such as making foreign exchange available to oil importers at the official auction rate. What is still clear is that the exchange rate depreciated throughout the period of analysis. The link between exchange rate and inflation is displayed in Panel D. It can be inferred that both variables largely move in the same direction, also suggesting some amount of pass-through to domestic prices.

Figure 3: Trends in petrol pump price, inflation and exchange rate dynamics



3. The literature and model specification

The oil crisis of the 1970s provoked investigations on the impact of imported petroleum on domestic inflation in not only oil-importing developing countries but also industrialized countries. The key implications arising from the studies are that the oil price hike of the 1970s led to an average price spiral and adverse macroeconomic consequences (Rafiq et al, 2009; Cologni and Manera, 2008; Cunado and Gracia, 2005; Chen and Chen, 2007). Another factor worth noting is that inflation was widespread in most LDCs even before the sharp increase in petroleum products in 1973 (Salvatore, 1984; Lowinger, 1978). In addition to the world price increase, exchange rate dynamics also impacted on domestic prices (Perera, 2005; Leigh and Rossi, 2002; Choudhri and Hakura, 2006).

Lowinger (1978) investigated the link between domestic inflation and exchange rate changes in less-developed countries by modelling a close-economy price equation as well as an open-economy reduced form equation. The study revealed that for relatively open economies, a variable exchange rate imposes additional costs in terms of a higher rate of inflation. In almost all the regression equations, the coefficients of the expected rate of inflation are positive and significance. A shortfall of this investigation is the lack of determination of inflationary expectations.

In assessing the impact of petroleum prices and exchange rates on domestic inflation in developing nations, Salvatore (1984) extended the closed-economy monetary model to examine the channels and relative significance of the increase in price and in the overall cost of imported petroleum on domestic inflation in oil-importing developing nations. The empirical results seem to pinpoint that higher petroleum prices did contribute to domestic inflation in oil-importing developing nations. In a similar study for industrialized countries, and adopting the same extended model, Salvatore (1986) concluded that the main channel by which inflation was imported is primarily through currency depreciation resulting from sharply increased petroleum import bills, rather than directly through increase in the price of imported petroleum itself.

A seminal study by Canetti and Greene (1992) did not find a common pattern in African countries as far as the causes of inflation are concerned; in some cases, the exchange rate channel seems to be more effective, while in others the money supply growth has the longer term impact. The research used a vector auto-regression analysis to separate the influence of money supply growth from exchange rate changes on prevailing and predicted rates of inflation in Africa. The results of the investigation find that both exchange rate movements and monetary expansion affect consumer price changes in a number of SSA countries. In particular, the study disclosed that exchange rates have a

significant causal impact on prices in Tanzania, Sierra Leone and the Democratic Republic of Congo (DRC). This is linked to the high inflation incidents in these countries.

The inflationary process in Sierra Leone was investigated by Kallon (1994) using quarterly data for the period 1967-1987. The research estimated a reduced-form inflation equation using an open economy IS-LM model. The findings could not reject the hypothesis that money-supply growth would lead to an equi-proportionate increase in inflation in the long run, while it is rejected in the short run. Moreover, the evidence suggests that part of Sierra Leone's inflation is imported from the rest of the world.

On inflation and exchange rate dynamics literature, Agenor and Montiel (1999) observe that under purchasing power parity (PPP), the domestic price level appears to be determined by the exchange rate. Thus, stabilization of inflation would seemingly require that the rate of depreciation be slowed to that of the exchange rate, thereby assigning it the task of ensuring price stability, and external balance be achieved through restrictive aggregate demand policies.

A detailed analysis of the exchange rate pass-through to domestic prices in Colombia using two different econometric frameworks, unrestricted VAR and the Johansen framework of multivariate cointegration, was undertaken by Rowland (2002). Impulse-response functions were used in both frameworks. Based on the results of the research, the pass-through in Columbia was incomplete. Import prices respond more swiftly compared with producer prices with pass-through coefficients of 0.48 and 0.28, respectively. The unrestricted VAR framework yielded a pass-through coefficient of 0.08 after a one year lag, while the Johansen framework yielded a coefficient of 0.15. The fact that the two frameworks produced different results called for further research to provide justification for the application of both approaches.

Perera (2005) measured the impact of changes in petroleum prices (diesel price was used as a proxy) on inflation in Sri Lanka for the period 2002 to 2004 using an autoregressive distributed lag (ADL) model, and the research analysed both direct and indirect impacts. The direct impact was measured through items relating to petroleum prices, such as electricity charges and transport fares as included in the CPI basket. The study revealed that an increase in diesel price by 10% would directly increase the Sri Lankan CPI by 0.19%.The ADL model was used to assess the indirect impact. Increase in diesel price by 10% would increase the monthly CPI by 1.01% with a lag of 2-3 months. Thus, even though the indirect impact is larger compared with the direct impact, its effect comes with a lag. A shortcoming of this study is that it does not take into consideration the other factors that are important in domestic price determination in Sri Lanka.

An examination of the effect of changes in exchange rate on consumer prices in Tanzania using a structural VAR model was undertaken by Mwase (2006). The study finds that the exchange rate pass-through to inflation declined in the late 1990s despite the depreciation of the currency, and it was partly attributed to the macroeconomic and structural reforms that were implemented during the study period.

Khan and Schimmelpfennig (2006) examined the relative significance of monetary factors as well as structuralist supply-side factors for inflation in Pakistan using a hybrid monetarist model based on monthly data. The estimates from the Vector-Error Correction Model indicate that monetary factors affect inflation, and that wheat prices influence inflation only in the short run.

Kovanen (2006) analysed the causes of frequent price changes in Sierra Leone using micro-level price data from two perspectives: cross-section and overtime. The research decomposed the variance of the monthly price change into extensive and intensive margins. The study suggested that variance in inflation may be explained largely by the extensive margin (fluctuations in the fraction of items subject to price changes). However, the fraction of prices subject to change each month is influenced by lagged inflation and broad money. While the coefficient of broad money was found to be statistically significant with a positive impact on the fraction of prices changing each month, that of the exchange rate variable was not statistically significant. The study concluded that by containing money growth and inflation, monetary policy would reduce the fraction of price changes in Sierra Leone.

The influence of commodity prices and money on inflation is studied by Browne and Cronin (2007) using a cointegrated VAR framework and data from the US. The empirical findings showed long-run proportional relationships between money, and in turn consumer prices and commodity prices.

The impact of crude oil price volatility on economic activities in the Thai economy was examined by Bloch et al (2008) using a VAR system. The different set of results (Granger causality, impulse response and VAR decomposition) showed that oil price volatility has significant impact on macroeconomic variables such as unemployment and investment.

Cologni and Manera (2008) investigated the impact of oil prices on inflation and interest rates in a co-integrated vector auto-regressive (VAR) framework for G-7 countries. Using quarterly data for the period 1980-2003, they find that, except for Japan and the UK, oil prices significantly affect inflation, which is transmitted to the real economy by increasing interest rates. Impulse response function analysis suggests the existence of an instantaneous, temporary effect of oil price change on inflation.

Inflation dynamics and food prices in Ethiopia were examined by Durevall et al (2010) using monthly data. The research developed a single-equation ECM and considered money growth, exchange rate changes, imported inflation, energy-inflation, and world fertilizer-price inflation. The key conclusion is that movement in international prices of food and goods measured in domestic currency determined domestic prices in the long run, and that agricultural supply shocks and money supply growth affect food inflation and non-food price inflation, respectively, in the short run.

Adam et al (2012) developed an empirical to analyse the relationship between food prices and inflation in Tanzania using high frequency data. The study estimated single equation models for headline inflation and its core constituents, including energy, food and core inflation as stationary processes that depend on their own past values, on short term inflation determinants, and lagged deviations from a set of pre-estimated long run inflation anchors. The results of the analyses pointed to the fact that monetary or demand-side effects feed fuel and price inflation, even though the transmission to headline inflation is principally through core inflation. Furthermore, food price inflation is driven by domestic agricultural supply shocks as well as pass-through from world prices for food and fuel.

This study goes beyond assessing the relative significance of exchange rate dynamics on domestic prices but also examines the contribution of domestic pump price of fuel

as well as the monetary factors to inflation.[9] The differences between this study and the few studies on Sierra Leone lie in the coverage period, type of data, methodology and variables of interest (domestic petroleum pump price).

The model

The determinants of inflation tend to vary across studies depending on the weights allocated to the sources of inflation. The structuralist models of inflation stress on supply-related factors such as wage costs, interest rates, output, foreign prices and exchange rates (bottlenecks on the real side of the economy) as determinants of inflation. The structuralists assume that these factors have to be accommodated by monetary policy makers because they are exogenous to the monetary domain. Monetarist models emphasize monetary growth with two well-known prepositions: i.e. exogenous changes in money stock lead to equivalent percentage changes in the overall price level under conditions of stable money demand; and exogenous changes in the money stock are neutral in the long-run steady state.

The Phillips curve and the quantity theory are the two approaches used to model inflation. The general theoretical framework of this analysis is derived from the quantity theory perspective, and focuses on money supply and demand, assuming that inflation is fuelled by excess money supply. Following the works of Woo (1984), Menon (1995), Juselius (1992), Hyder and Shah (2005), Durevall et al (2010) and Adam et al (2012), this study adopts the view that inflation mainly originates either from price adjustments in markets with excess demand or supply, or from price adjustments due to import costs. The approach is to embed a parsimonious model of inflation within a generalized framework in which inflationary pressures emerge from the deviation from equilibrium in different markets. The focus is on markets in three sectors: the monetary sector, the external sector (limited to the petroleum sector in this study), and business cycle fluctuations (deviation of output from its trend).

Specifically, the study hypothesizes that changes in the domestic price level are affected by deviations from the long-run equilibrium in the money market, the petroleum sector, and fluctuations in natural output. The parsimonious approach modelled inflation as a set of error correction terms that measure deviations from equilibrium in the three sectors, and in which inflation responds to its own lags, and lags of other variables. Therefore, the research evaluates the impact on inflation of excess money supply, changes in petroleum prices and output. This is a hybrid of inflation as it encompasses the other variables considered in modelling inflation. The money demand function is therefore specified as:

$$\ln M_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln R_t + \ln P + \varepsilon_t \quad (1)$$

Where: M = Money Supply,
Y = Real Gross Domestic Product, and
R = Treasury bill rate, and
P = Consumer price inflation.[10]

Petroleum is internationally traded; the study, therefore, measures the deviation of pump price from the world petroleum price and the specification is shown in Equation 2.

$$\ln PP_t = \lambda_0 + \lambda_1 \ln E_t + \lambda_2 \ln BP_t + \upsilon_t \quad (2)$$

Where: PP = Pump price of petrol per gallon,
E = Exchange rate, and
BP = international price of Brent per barrel.

In order to examine the relative significance of the disequilibrium emerging from the monetary sector and petroleum sector, the above specifications are estimated separately and disequilibrium terms are then included in a single ECM. The specified ECM is:

$$d \ln P_t = \sum_{i-1}^{k-1} \Omega_0 d \ln P_{t-i} + \sum_{i=0}^{k-1} \Omega_1 d \ln M_{t-i} + \sum_{i=0}^{k-1} \Omega_2 d \ln E_{t-i} + \quad (3)$$

$$\sum_{i=0}^{k-1} \Omega_3 d \ln R_{t-i} + \sum_{i=0}^{k-1} \Omega_4 d \ln Y_{t-i} + \sum_{i=0}^{k-1} \Omega_5 d \ln PP_{t-i} + \Omega_6 ECM_{pp(t-1)} +$$

$$\Omega_7 ECM_{md(t-1)} + \Omega_8 Y_{gap(t-1)} + D_{war} + \mu_t$$

Where: d = First difference operator,
μ = White noise process,
D_w = War dummy,
ECM_{pp} = Error correction representing disequilibrium from the pump price;
ECM_{md} = Monetary disequilibrium from the cointegrated money demand equation, and
Y_{gap} = the difference between GDP and 'natural' GDP, and all other variables are as defined earlier.

The GDP gap itself is an error-correction term. Conventionally, output variation impact on inflation is gauged through direct measurement of what is referred to in the literature as deviation of actual from potential output (Loening et al, 2009; Adam et al, 2012). The output gap is measured using Hodrick-Prescott (HP) filter.[11]

The war dummy is included in the specification to clean the influence of the monetization of government expenditure driven by the cost of the conflict and subsequent reconstruction programmes.[12] The coefficients of the error correction terms, i.e. Ω_6, Ω_7 and Ω_8 show the amount of disequilibrium transmitted in each period into the current rate of inflation.

4. Results

Analytical tools and data requirements

The empirical model used quarterly data for the period 1990-2010 as it provides a reasonable time frame to study exchange rate, petroleum prices and price determination in Sierra Leone. The selected period covers both war and non-war years. Estimates were arrived at using general-to-specific modelling in order to obtain the short-run dynamics. The time series properties of the data were examined using the Phillips-Perron unit root test.

Inflation is change in overall year on year CPI. The pump price of petrol is considered as a proxy for petroleum products because petrol is in higher demand compared with diesel and, in the past seven years, there is unanimity in the pump price of petrol and diesel. The exchange rate variable (E) used in this study is the nominal exchange rate. Broad money (M) and the Treasury bill rate (TBR) are used in the model to capture the effect of private agents' decisions on inflationary trends.[13]

Estimates of the models

The summary statistics of all the variables used in this empirical section is provided in Appendix Table 2, while the correlation matrix is in Appendix Table 3. The correlation coefficient between petroleum price and inflation is very high and also strong, but the correlation between petroleum price and exchange rate is inverse. The correlation between broad money and inflation is 0.96. The Phillips-Perron test statistic was used to test the variables for unit root. All the variables in log levels are non-stationary and are integrated of order one as contained in Table 1.[14]

Table 1: Phillips-Perron unit root tests

Variable		Phillips-Perron Test Statistic		Conclusion
		With Drift	Drift and Trend	
P	Log Level	1.6145	-1.5957	I(1)
	ΔLevel	-4.5948**	-4.0465*	
Y	Log Level	0.2293	-1.5307	I(1)
	ΔLevel	-4.3734**	-4.7206**	
M	Log Level	0.1056	-1.9412	I(1)
	ΔLevel	-3.0435*	-3.7832*	
R	Log Level	-2.4570	-2.5820	I(1)
	ΔLevel	-4.8089**	-4.8022**	
BP	Log Level	-2.1628	-2.3529	I(1)
	ΔLevel	-4.4529**	-4.2511**	
PP	Log Level	0.7517	-1.7163	I(1)
	ΔLevel	-4.8111**	-5.3630**	
E	Log Level	-0.4732	-3.2215	I(1)
	ΔLevel	-5.0173**	-7.0695**	
Ygap	Log Level	-23.7837**	-31.4392**	I(0)
ECMmd	Log Level	-5.3602**	-5.3137**	I(0)
ECMpp	Log Level	-8.8625**	-8.8157**	I(0)

Notes:
(i) Critical values for the Test Statistic with Drift at 1% and 5% are -3.5112 and -2.8972.
(ii) Critical values for the Test Statistic with Drift and Trend at 1% and 5% are -4.0738 and -3.4655.
(iii) Δ represents first difference operator.
(iv) ** (*) implies significant at 1% (5%) level.

Cointegrated money demand

The Johansen's maximum likelihood procedure provides a unified framework for the estimation and testing of cointegration relations in the context of vector autoregression (VAR). The first stage in carrying out the Johansen's maximum likelihood procedure is the determination of the optimal lag length of the related VAR.[15] The Akaike Information Criterion (AIC), Schwartz Information Criterion (SIC), Hannan Quin (HQ) test, Likelihood Ratio (LR) test and Final Prediction Error (FPE) test were used in the selection of the appropriate lag lengths. A chosen lag length is appropriate if more of the five criteria provide support for it. The diagnostics pointed to an optimal lag length of 1. Thus, the VECM is estimated with a lag length of 1 and the associated system has a cointegrating rank of 1. The cointegrated money demand equation is shown in Table 2 and the full cointegration analysis is shown in Appendix Table 3.

Table 2: Cointegrated money demand

Variable	Coefficient	t-statistic
Constant	-13.138	
LnY	1.311	11.826
LnR	0.386	3.876
LnP	1.347	5.846

In a bid to gauge the impact of the disequilibrium from the cointegrated money demand on inflation, the lagged error-correction term, ECMmd, is carried over the parsimonious model of inflation. The deviation obtained from the cointegrated money demand involving M, Y, TBR and P is stationary.

Model of petroleum price

The estimates of the petroleum product specification are shown in Table 3. The disequilibrium in the domestic pump price of petrol is obtained by taking the deviation in the relative Brent price per barrel to the domestic pump, taking the exchange rate into consideration. The deviation obtained in Table 3 is stationary after HP-filtering. In addition to the deviation obtained from the cointegrated money demand function, the lagged deviation from the petroleum product market is also carried over to the parsimonious model of inflation (Appendix Figure 1 for the graphs of the disequilibria from the different sectors). The pump price and barrel price series follow each other over time as shown in Appendix Figure 1 and the associated disequilibrium graph appears to be stationary.

Table 3: Petroleum pump price inflation

Variable	Coefficient	t-statistic
Constant	0.6519	3.81
LnE	0.5756	7.06
LnBP	0.4511	9.89
N=79, R^2=0.968, Adj. R^2=0.967 Normality(JB) = 0.04		

Parsimonious inflation model for Sierra Leone

The research carried out a general-to-specific modelling and all the variables included in the modelling process are in first difference and the model is estimated with OLS. The estimation included the lagged error correction terms and the reported results are based on models with 6 lags in the general ECM. The estimation results are shown in Table 4. The coefficient of the war dummy is not statistically significant in the estimation and not reported, but the ECM of the pump price is included in the reported results in Table 4 for illustrative purposes, even though it is statistically insignificant.

The coefficient of lagged price variable is statistically significant, indicating some degree of inflation inertia in the short run; i.e. there is a tendency for inflation to reproduce itself from one period to the next. This finding is in consonance with the study carried by Kovanen (2006) on the causes of frequent price changes in Sierra Leone. The coefficient of GDP variable is also significant at the one per cent level, with the highest t-value and biggest coefficient in the reported results. It explains most of the price waves in the short run. This finding is consistent with an economy that is largely agrarian, as agriculture contributes, on average, 40% of GDP.[16] Thus, a fall in agricultural production will lead to an upward movement in domestic prices.

The coefficient of the money supply variable is also significant. This outcome is in harmony with the studies undertaken by Kallon (1994) and Kovanen (2006). Broad money's coefficient was found to be significant and impacting on inflation on a monthly basis, according to Kovanen. The coefficient of money supply is statistically significant with a value of 0.27. This implies that in the short run, a unit increase in money supply will increase inflation by 0.3 units. Another variable of monetary policy used by the research is interest rate, proxied by the Treasury bill rate. The coefficient of this variable is positive and significant. The Government of Sierra Leone heavily relies on the sale of treasury bills to finance the revenue dwarfs in the budget, mostly for current consumption. The Treasury bill rate is fundamental in raising the much needed revenue from the public.

Table 4: General-to-specific modeling

Variable	Coefficient	t-Statistic
Constant	0.0548	7.34
ΔP(t-1)	0.2462**	3.06
ΔY(t-3)	-0.3498**	-7.44
ΔM(t-4)	0.2672**	4.74
ΔE(t-4)	0.2266**	5.41
ΔR(t-4)	0.1902**	3.73
ΔPP(t-3)	0.1525**	5.99
ECMpp(t-1)	0.0169**	1.62
ECMmd(t-1)	0.0172**	3.10
Ygap(t-1)	-0.0008**	-5.86
Sigma	= 0.0121341; RSS	=0.00853966362; R2 = 0.84;
F(14,58)	= 21.06 [0.000]**; log-likelihood	= 226.87;
DW	= 1.86;No. of observations	= 73; No. of parameters = 15;
Mean(DLCPI)	= 0.0346954; var(DLCPI)	= 0.000711637
Diagnostic Tests		
AR 1-5 test: F(5,27)	= 0.74529 [0.5965]	
ARCH 1-4 test: F(4,24)	= 0.28264 [0.8863]	
Normality test: Chi^2(2)	= 0.264 [0.0022]	
Hetero test: F(38,17)	= 0.97996 [0.5404]	
Chow test: F(22,34)	= 0.70923 [0.7994] for break after 2005(1)	

** Indicates significance at the 5% level

The coefficient of the exchange rate variable reported in Table 4 is significant at the one per cent level. The exchange rate in Sierra Leone is on a free-fall throughout the period of analysis and, as aforementioned, the average of imported goods as a percentage of GDP between 2000 and 2010 was 40.75. This implies that depreciation in exchange rate seeps to domestic prices. The coefficient of the exchange rate variable from the estimation is 0.23, indicating that it has a stronger influence on inflation. This result is in harmony with Canetti and Greene (1992), as the results of their investigation found that both exchange rate movements and monetary expansion affect consumer price changes in a number of SSA countries. In particular, the study revealed that exchange rates have a significant causal impact on prices in Tanzania, Sierra Leone and DRC.

A prime variable of interest in this study is the pump price of petroleum products. The reported coefficient in Table 4 shows that the pump price variable is highly significant and carries the correct sign. The implication is that changes in the pump price of fuel affects

domestic prices in the short run. The t-value from the disequilibrium emanating from the pump price of fuel (ECMpp) suggests that pump price is statistically insignificant in the long run. The results of the estimation insinuate that the development in the pump price of petroleum (PP) does not matter in price formation in Sierra Leone in the long run. This finding is in tandem with Khan and Schimmelpfennig (2006) as it was concluded for the case of Pakistan that wheat support price influence inflation in the short run but not in the long run.

The output gap defining business cycle fluctuations is also important. The variable explains the oscillations in domestic prices away from long-run equilibrium, even though the coefficient is very minute. The tiny coefficient also translates into a minimal impact on inflation in the long run. Apart from the output gap, the disequilibrium from the monetary sector is also included in the estimation process, and the variable (ECM_{md}) is significant at the one per cent level. This coefficient suggests that monetary environment matters in price formation in the long run.

The reported results are based on models with six lags in the general parsimonious ECM. An array of diagnostic tests is reported in Table 4 and seems to intimate that the model is largely stable and does not exhibit neither serious generalized autocorrelation nor evidence of heteroskedasticity. The overall goodness of fit of the model is comfortable; i.e. a high percentage of the variation in domestic prices in Sierra Leone is explained by the factors embedded in the parsimonious model.

5. Conclusion and policy implications

This research explores the dominance of structural factors such as real GDP, exchange rate and pump price of petrol and monetary factors (broad money and treasury-bill rate) on domestic price determination in Sierra Leone by using a parsimonious model of inflation. The approach specified error-correction equations in which inflation responds to its own lags, lags of other variables, and a set of error-correction terms that represent short run disequilibria that feed into the inflation process. The essence is to examine whether the deviations from the long-run values explain future inflation. The first specific objective was to examine the relative significance of the pump price of petrol in determining inflation, and the second was exchange rate on inflation while the research also analysed the effect of monetary factors.

The empirical results from the estimation show that lagged inflation has explanatory power for subsequent inflation. The key result is that pump price of fuel as well as exchange rate do play a part in the inflationary process at least in the short run. This implies that changes in oil prices can only affect relative prices and not the inflationary process, unless it attracts monetary expansion. The policy implication arising out of this is that fiscal authorities can allow percolation of a sizeable pass-through in the short run.

Monetary factors (broad money and Treasury bill rate) and output are significant in determining inflation in Sierra Leone, both in the short and long runs as the disequilibria from the two markets also proved important. Since the study provides evidence that the monetary environment as well as fluctuations in inflation play a role in the determination of consumer prices in Sierra Leone, the policy implication is that by repressing money growth and inflation, monetary policy could reduce the rate of inflation. Real GDP negatively affects inflation. This implies that structural policies that will boost local production of goods, especially food products, will help to stabilize prices. This is due to the fact that the weight of food and non-alcoholic beverages in the CPI basket is 51% and, coupled with a proportion of 60% of imported goods in the CPI basket, a sustained increase in domestic production especially of the staple food (rice) might lead to a downward spiral in CPI.

Notes

1. Gagnon and Ihrig (2004) suggested that it is the credibility of a country's monetary policy that ultimately determines how inflation reacts to the dynamics of exchange rate.

2. Exchange rate pass-through is defined as "the percentage change in local currency import prices resulting from a 1% change in the exchange rate between the exporting and importing countries."

3. A fixed exchange rate regime was in place in the early 1980s but before that the leone was pegged to the British pound between 1967 and 1978.

4. For example, the rate of inflation was 179% (the highest in the inflationary history of Sierra Leone) in 1987.

5. For comprehensive details, see Statistics Sierra Leone CPI Report, various issues. The CPI composition further reflects the nature of consumption and low levels of income, as more than half of the goods in the basket are food items. The prices of food items, by their very nature, are typically more volatile than the prices of non-food items.

6. The increase in transportation fares sometimes provokes an increase in the prices of local foodstuffs and other essential goods brought to the major towns from rural areas.

7. The pump price of petroleum products is normally adjusted upwards or downwards periodically as and when the combined effect of the changes in world market price and the exchange rate leads to a minimum of 5% change in the landed cost of the product(s) in the domestic currency.

8. The reason for this huge sacrifice on the part of the government is to enhance the welfare of the consumers following the removal of the subsidy.

9. Pump price development is seen most times by many as a source of inflationary pressure in Sierra Leone.

10. The Consumer Price Inflation is the retail price increase as measured by the year on year percentage change in Consumer Price Index (CPI). CPI is the official measure of inflation in Sierra Leone.

11. The HP filter is a model free-based approach used to decompos a time series into its trend and cyclical components. Therefore, it is an algorithm that smoothens the original time series.

12. The civil war broke out in 1991 and its end was officially declared in January 2002.

13. See Appendix Table 1 for a complete listing of all variables and their abbreviations.

14. The deviations from GDP and pump price of fuel were made stationary by HP-filtering.

15. For full test details, see Johansen (1991).

16. The agricultural sector is dominated by small scale farmers, and production is almost entirely subsistence and few cash crops such as cocoa, coffee and piassava are produced for the export market.

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Appendix A

Table 1A: List of abbreviations

No.	Variable Name	Abbreviation
1	Consumer Price Inflation	P
2	Real Gross Domestic Product (GDP)	Y
3	Money Supply	M
4	Treasury Bill Rate	R
5	Brent Price per Barrel	BP
6	Domestic Pump Price of Fuel	PP
7	Exchange Rate	E
8	The difference between GDP and natural GDP	Y_{gap}
9	Monetary disequilibrium from the cointegrated money demand equation	ECM_{md}
10	Error correction representing disequilibrium from the pump price	ECM_{PP}
11	War Dummy	D_w

Table 2A: Summary statistics of selected variables in log levels

Statistical Measure	CPI	Broad Money	NEER	Petroleum Price	RGDP	T-Bill Rate
Mean	3.927	10.994	5.334	8.277	13.388	3.127
Median	4.297	10.958	5.199	8.487	13.392	3.060
Maximum	5.289	13.407	7.314	9.636	13.817	4.412
Minimum	1.119	8.295	4.404	5.830	12.954	2.319
Std. Dev.	0.975	1.369	0.766	1.055	0.263	0.478
Skewness	-0.917	-0.060	0.587	-0.495	-0.024	0.825
Kurtosis	3.187	1.821	2.451	2.308	1.797	3.420
Jarque-Bera	11.902	4.919	5.815	5.041	5.013	10.032
Probability	0.003	0.085	0.055	0.080	0.082	0.007
Sum	329.881	923.485	442.706	687.027	1111.167	259.519
Sum Sq. Dev.	78.945	155.620	48.073	91.226	5.687	18.769
Observations	84	84	83	83	83	83

Table 3A: Johansen's maximum likelihood cointegration test

No. of cointegrating vectors	Eigenvalue	Trace test		Maximum eigenvalue test	
		Statistic	1% Critical Value	Statistic	1% Critical Value
None *	0.4103	83.4595	84.45	36.9735	39.79

Notes:
(i) Trace test indicates 1 cointegrating vector at both 5% and 1% levels.
(ii) Max-eigenvalue test indicates 1 cointegrating vector at both 5% and 1% levels.

Appendix Table 3B

Cointegrating Eq: CointEq1	
LMS(-1)	1.000000
LY(-1)	-1.311307 (0.11089) (-11.8258)
LTB(-1)	-0.386196 (0.09964) (-3.87590)
LP(-1)	-1.347455 (0.05213) (-25.8464)
c	13.13776

Error Correction:	D(LM)	D(LY)		D(LTB)		D(LP)
CointEq1	-0.048163 (0.01826) (-2.63800)	0.044378 (0.01851) (2.39800)		0.525468 (0.08713) (6.03053)		0.043713 (0.01398) (3.12787)
D(LM(-1))	0.518149 (0.14955) (3.46482)	0.045267 (0.15159) (0.29863)		0.032099 (0.71372) (0.04497)		-0.071877 (0.11447) (-0.62791)
D(LM(-2))	0.158237 (0.13475) (1.17433)	-0.019889 (0.13658) (-0.14562)	-0.671931 (0.64309) (-1.04485)	-0.019889 (0.13658) (-0.14562)	-0.671931 (0.64309) (-1.04485)	-0.019889 (0.13658) (-0.14562)
D(LY(-1))	0.093538 (0.13296) (0.70349)	0.440173 (0.13478) (3.26595)	-0.309610 (0.63458) (-0.48790)	0.440173 (0.13478) (3.26595)	-0.309610 (0.63458) (-0.48790)	0.440173 (0.13478) (3.26595)

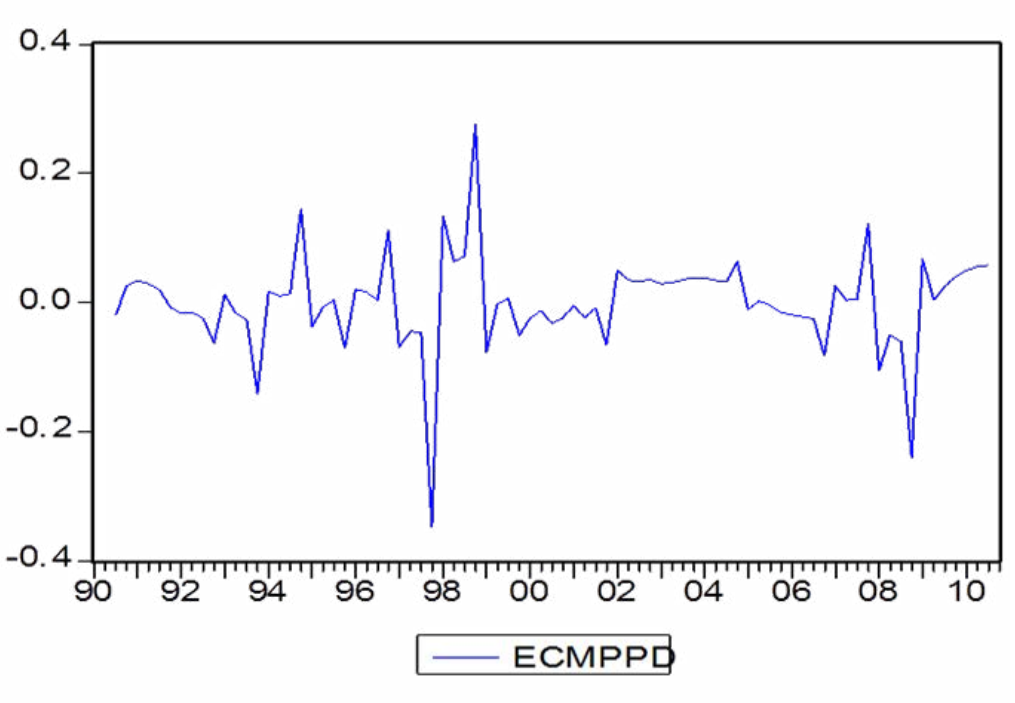
continued next page

Appendix Table 3B Continued

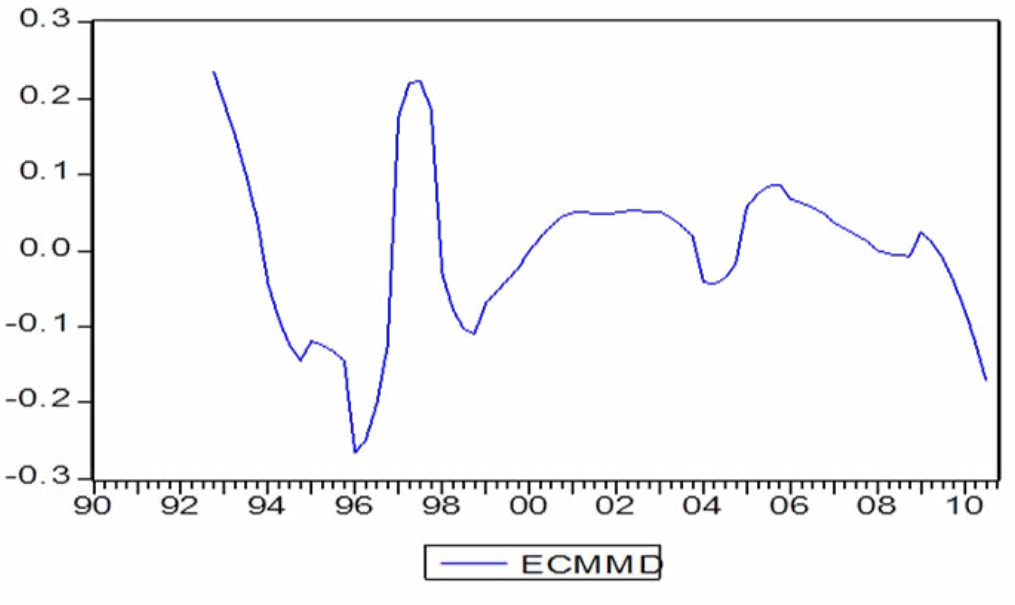
Error Correction:	D(LM)				D(LY)		D(LTB)		D(LP)
D(LY(-2))	0.109232				0.060805	-0.427330	0.060805	-0.427330	0.060805
	(0.12451)				(0.12621)	(0.59422)	(0.12621)	(0.59422)	(0.12621)
	(0.87732)				(0.48179)	(-0.71914)	(0.48179)	(-0.71914)	(0.48179)
D(LTB(-1))	0.025644				0.010842	0.560108	0.010842	0.560108	0.010842
	(0.03253)				(0.03297)	(0.15523)	(0.03297)	(0.15523)	(0.03297)
	(0.78842)				(0.32886)	(3.60821)	(0.32886)	(3.60821)	(0.32886)
D(LTB(-2))	-0.007925	0.008846	0.294304	0.012205	-0.007925	0.008846	-0.007925	0.008846	-0.007925
	(0.03529)	(0.03578)	(0.16844)	(0.02702)	(0.03529)	(0.03578)	(0.03529)	(0.03578)	(0.03529)
	(-0.22454)	(0.24726)	(1.74720)	(0.45178)	(-0.22454)	(0.24726)	(-0.22454)	(0.24726)	(-0.22454)
D(LP(-1))	-0.022198	-0.157686	-0.132544	0.640503	-0.022198	-0.157686	-0.022198	-0.157686	-0.022198
	(0.20758)	(0.21041)	(0.99070)	(0.15890)	(0.20758)	(0.21041)	(0.20758)	(0.21041)	(0.20758)
	(-0.10694)	(-0.74942)	(-0.13379)	(4.03098)	(-0.10694)	(-0.74942)	(-0.10694)	(-0.74942)	(-0.10694)
D(LP(-2))	0.000130	-0.004415	0.657266	0.265002	0.000130	-0.004415	0.000130	-0.004415	0.000130
	(0.18967)	(0.19225)	(0.90520)	(0.14518)	(0.18967)	(0.19225)	(0.18967)	(0.19225)	(0.18967)
	(0.00069)	(-0.02296)	(0.72610)	(1.82530)	(0.00069)	(-0.02296)	(0.00069)	(-0.02296)	(0.00069)
C	0.016250	0.008402	0.016873	0.009284	0.016250	0.008402	0.016250	0.008402	0.016250
	(0.00564)	(0.00571)	(0.02690)	(0.00431)	(0.00564)	(0.00571)	(0.00564)	(0.00571)	(0.00564)
	(2.88277)	(1.47044)	(0.62720)	(2.15169)	(2.88277)	(1.47044)	(2.88277)	(1.47044)	(2.88277)
R-squared	0.522994				0.483968		0.548355		0.832286
Adj. R-squared	0.462528				0.418555		0.491104		0.811026
Sum sq. resids	0.043221				0.044408		0.984467		0.025324
S.E. equation	0.024673				0.025009		0.117753		0.018886
F-statistic	8.649444				7.398699		9.578110		39.14875
Log likelihood	190.2693				189.1721		63.67521		211.9185
Akaike AIC	-4.451095				-4.424002		-1.325314		-4.985642
Schwarz SC	-4.155484				-4.128391		-1.029703		-4.690031
Mean dependent	0.056296				0.004057		-0.009214		0.045565
S.D. dependent	0.033654				0.032798		0.165066		0.043445

Determinant Residual Covariance: 4.12E-13
Log Likelihood: 695.2308
Akaike Information Criteria: -16.07977
Schwarz Criteria: -14.77908

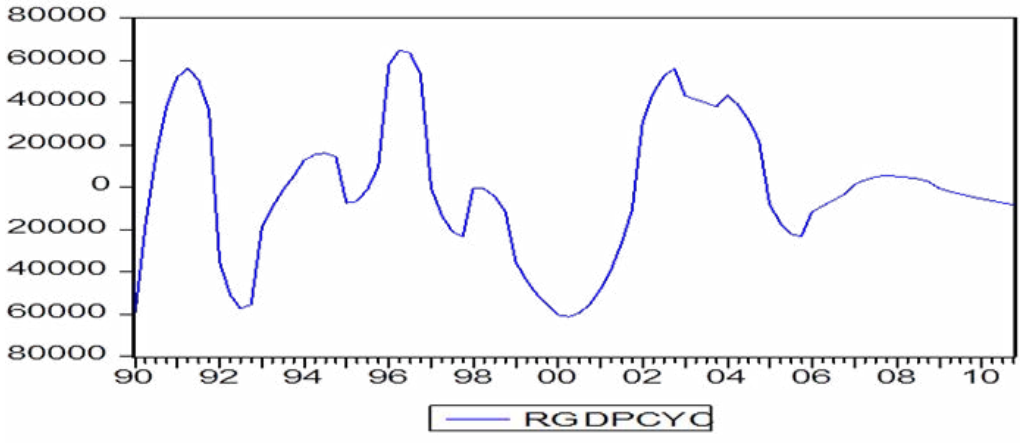
Appendix Figure 1: Disequilibrium in petroleum pump price



Appendix Figure 2: Disequilibrium in money supply



Appendix Figure 3: Disequilibrium in output



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