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An analysis of the dynamics of petroleum prices and inflation in Malawi

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A B S T R A C T

Owing to the immense negative effects brought about by inflation on the economies globally, politicians and policymakers are preoccupied with finding ways of controlling inflation. This study, therefore, set out to find out how prices of petroleum products, namely; diesel, paraffin, and petrol, affect inflation in Malawi. It employs the autoregressive distributed lag (ARDL) model using time series data on inflation and prices of petroleum products collected from the Reserve Bank of Malawi (RBM) and Malawi Energy Regulatory Authority (MERA). The empirical findings show that the price of petrol, the price of diesel, and the price of paraffin have a statistically positive effect on inflation in Malawi, both in the short run and the long run. These findings imply that increases in the prices of these commodities will lead to increases in inflation both in the short run and the long run. The study, therefore, recommends that policymakers need to make sure that prices of petroleum products are kept as low as possible to control inflation in Malawi. This can take the form of ensuring the existence of huge foreign exchange reserves to be used to stabilize the foreign exchange market, to ensure that the Malawi Kwacha does not depreciate anyhow.

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1. Introduction

Globally, inflation—which is defined as a persistent rise in an economy's price level (Mishkin, 2004)—has long been seen as a significant issue that has to be resolved. In essence, politicians and policymakers are preoccupied with controlling inflation because it has numerous undesirable effects in any economy. In general, inflation has a negative impact on an economy because it breeds uncertainty, which impedes economic growth. For instance, it is more difficult to understand the information provided by prices of goods and services in an economy when the general level of prices is fluctuating quickly. This makes it more difficult for customers, firms, and the government to make decisions (Mishkin, 2004). Furthermore, inflation complicates future planning by making it harder for households to determine how much money to set up for future goods and services such as child's college education. Furthermore, inflation strains a country's social fabric which might result in conflicts between or among different groups of people in a country because it brings competition among the different groups of people in the country as they try to make sure that their income keeps up with the rising level of prices in the country (Mishkin, 2004).

Thus, it is abundantly clear from the foregoing that inflation brings about unspeakable negative effects to individuals, business firms, and the government. Hence, solving the inflation problem has always been an overriding goal of governments worldwide, so much so that the governments' monetary policies have always incorporated inflation control as one of their goals. However, as pointed out by Mishkin (2004); in order to adequately control inflation, one needs to understand something about its causes. In the literature, the debate regarding the causes of inflation is typically centered on

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two approaches: the monetarist approach and the structuralist approach, as per Ocran (2007). The monetarist approach underscores the connection between money supply and prices, positing that an economy's inflation rate is induced by an ongoing increase in the money supply. Thus, monetarists stress that "inflation is always and everywhere a monetary phenomenon". Consequently, monetarists advocate for policies that are designed to restrict the money supply, regardless of whether it is domestic or foreign. Monetarists, therefore, argue for policies that aim at curbing the money supply, whether domestic or foreign. In contrast, the structuralist perspective attributes inflation to structural factors, including cost-related pressures, such as import prices, and the functionality of the market. In particular, the structuralist approach attributes inflation to structural and cost-push factors, such as an increase in import prices and a shortage of aggregate supply.

In Malawi, petroleum and petroleum products, commonly known as fuel, constitute a large proportion of imported goods. Malawi imports a lot of fuel because it is one of the most widely used sources of energy in the country, as it has no oil deposits (Taulo et al., 2015). Some of the uses of the imported fuel include running the country's vehicles and generators, powering industry and manufacturing, and providing the country with electricity in the absence of hydro power. It is worth noting that access to electricity in Malawi is only at 13.4 percent of the population, which is much lower than the Sub-Saharan Africa region's average of 47.9 percent (McCauley et al., 2022). The most commonly used fuels in Malawi include petrol, diesel, and paraffin. Petrol and diesel are petroleum products which are, particularly, important to Malawi's economy because they power many of the country's transportation fleets and the trucks that deliver goods to markets, and transport fertilizer that farmers use to grow crops. Additionally, petrol and diesel are used to generate electricity. Paraffin, on the other hand, is mainly used in hurricane and pressure lamps, even though its small percentage is used for cooking (Gamula et al., 2013). As much as 85.9 percent of the population of Malawian households use paraffin for lighting, while only 1 percent of the population use paraffin for cooking (Gamula et al., 2013). Changes in fuel prices can therefore have a significant effect on the Malawian economy as they can affect all other industries in terms of transport and logistics, which, as a consequence, can affect the country's inflation.

The relationship between oil prices and inflation has attracted a lot of attention from scholars. For example, Ha et al., (2023) used a factor-augmented vector autoregression model to assess the effect of oil prices on global inflation, and shocks to the price of oil were found to have a statistically significant effect on inflation in three-quarters of the countries that were under investigation. Furthermore, the study established that shocks to the price of oil tended to account for a far larger portion of the fluctuation in inflation in the industrialized economies and the net energy-importing countries. Kpodar and Liu (2022) examined the distributional implications of the impact of fuel price increases on inflation across developed and developing countries. The study found that fuel prices were associated with high inflation and that fuel price changes had a stronger positive impact on the prices paid by consumers in emerging nations. Furthermore, the study found that increases in gasoline prices caused a decrease in households' purchasing power across all income groups, however, the impact on the wealthiest households was greater than that on the poorest households. Similarly, Boyd-Swan and Herbert (2012) used data from the Worldwide Communications LifeStyle Survey to assess the impact of gasoline prices on the subjective well-being of consumers in the United States. The study found that increases in gasoline prices negatively affected one's perceptions regarding their quality of life.

Nevertheless, despite the importance of petroleum products in the share of imported goods in Malawi, there is a paucity of empirical literature that explicitly links fuel with inflation dynamics in Malawi. Many studies on the determinants of inflation in Malawi have focused on exchange rate volatility and growth in money supply (Simwaka et al., 2012) or interest rate and import prices (Chavula, 2019). No study has explicitly linked inflation with the prices of petroleum products in Malawi. Therefore, this study bridges this knowledge gap by empirically determining the effect of petroleum products on inflation in Malawi. Thus, it poses the following question: which petroleum product's price influences inflation in Malawi? The following are the null hypotheses tested by the paper: (1) changes in price of diesel have no influence on inflation in Malawi, (2) changes in price of petrol have no influence on inflation in Malawi, and (3) changes in price of paraffin have no influence on inflation in Malawi. The findings of this study offer a comprehensive grasp of how different petroleum products contribute to Malawi's inflation. An understanding of the role played by petroleum products in the determination of inflation in Malawi can help policymakers design sound petroleum products pricing policies in order to mitigate their effects on inflation in Malawi, since petroleum products constitute an important component in the manufacture of many products (Bank of England, 2021).

2. Research methodology

This study investigates how the changes in prices of petroleum products affect inflation in Malawi using time series data obtained from the Malawi Energy Regulatory Authority (MERA) and the Reserve Bank of Malawi (RBM). In particular, data for the prices of diesel, petrol, and paraffin have been obtained from MERA, while inflation data have been obtained from the RBM. In order to adequately examine which petroleum product price changes affect inflation, the study utilized the autoregressive distributed lag (ARDL) approach to cointegration, particularly, the bounds testing approach as advocated by Pesaran et al., (2001). The ARDL approach to cointegration is advantageous because, in contrast to traditional cointegration tests, it does not require unit-root or stationarity pre-testing, and it avoids classifying the independent variables of interest into integrated of order zero [I (0)] or integrated of order one [I (1)] (Pesaran et al., 2001).

According to Gujarati (2004), the generic ARDL model was expressed as follows:

$$Y_t = \mu + \sum_{i=1}^{p} \gamma_i Y_{t-i} + \sum_{i=1}^{r} \beta_i X_{t-i} + \delta W_{t-1} + \varepsilon_t \quad (1)$$

where:

Y_t is the inflation value at time t,
Y_{t-1} represent the lagged values of inflation,
X_{t-i} represent the lagged values of the prices of the petroleum products,
W_{t-i} represent the lagged independent variables associated with long-run elasticities,
ε_t is the error term, which is assumed to be serially uncorrelated and homoscedastic.

This study acknowledges that the error correction model (ECM) is the most often used method for estimating the long-run relationship between a dependent variable and other explanatory variables (Engle & Granger, 1987). However, because it places limitations on the model, the ECM is inappropriate in the ARDL approach (Pesaran et al., 2001). As a result, this study used the method developed by Pesaran et al. (2001), which involved estimating the ARDL model in two steps. In the first stage, the long-term relationship between the variables under study was examined, and in the second stage, the coefficient of the long-term relationship and the related error correction models were estimated. The ARDL model for inflation, petrol price, diesel price, and paraffin price was, therefore, expressed as follows:

$$\begin{aligned} \Delta INFLATION_t = \alpha_0 &+ \sum_{j=1}^{k} \beta_0 \Delta INFLATION_{t-j} + \sum_{j=1}^{l} \beta_1 PDIESEL_{t-j} + \sum_{j=1}^{m} \beta_2 \Delta PPETROL_{t-j} \\ &+ \sum_{j=1}^{n} \beta_3 \Delta PPARAFFIN_{t-j} + \mu_0 INFLATION_{t-j} + \mu_1 PDIESEL_{t-j} + \mu_2 PPETROL_{t-j} \\ &+ \mu_3 PPARAFFIN_{t-j} + v_t \end{aligned} \quad (2)$$

where:

k, l, m and n indicate the optimum lag length of the variable under investigation,
ΔINF_t represents the differenced value of inflation measured in Malawi Kwacha,
$\Delta PDIESEL_{t-j}$ represents the differenced value of price of diesel measured in Malawi Kwacha,
$\Delta PPETROL_{t-j}$ represents the differenced value of price of petrol measured in Malawi Kwacha,
$\Delta PPARAFFIN_{t-j}$ represents the differenced value of price of paraffin measured in Malawi Kwacha,
$\beta_1, \beta_2, \text{ and } \beta_3$ are the estimated short-run coefficients;
$\mu_1, \mu_2, \text{ and } \mu_3$ are the estimated long-run coefficients; and
v_t is the error term.

The estimation was done using STATA version 15.0.

3. Results and discussion

3.1 Diagnostic test results

Before estimating the ARDL model as specified in Eq. (1), the study conducted various tests, namely; the multicollinearity test, unit root test for stationarity, the Breusch-Pagan test for heteroscedasticity, the Ramsey RESET test, and the Breusch-Godfrey Lagrange Multiplier (LM) test for autocorrelation. Table 1 reports the multicollinearity test results.

Table 1
Multicollinearity test results

Variable	VIF	1/VIF
PDIESEL	1648.07	0.000607
PPETROL	1302.02	0.000768
PPARAFFIN	120.76	0.008281
Mean VIF	1023.62	

Table 1 shows that the mean VIF value for all of the explanatory variables included in the ARDL regression model was 1023.62. This suggests that the variables utilized in the ARDL model had a serious multicollinearity issue because all of the regressors had VIF values higher than 10. Thus, in order to account for the multicollinearity issue, the research used two ARDL regression equations, removing the price of petrol and diesel, respectively (Gujarati, 2004).

It is worth noting that even though the ARDL model does not require pretesting of a variable for stationarity, it is important to know the stationarity properties of the variables used in the ARDL model. This is the case because the tabulated F-values have upper and lower bounds, which assume that all variables are I (1) stationary and I (0) stationary, respectively (Pesaran et al., 2001). In situations where the computed F-statistic falls between the upper and lower boundaries, determining whether a variable is I (1) stationary or I (0) stationary aids in drawing conclusions. Two of the most popular techniques for determining whether a series is stationary are the Phillips-Perron (PP) unit root test and the Augmented Dickey-Fuller (ADF) unit root test. However, the ADF test was applied in this investigation. The ADF test statistic is given as:

$$\Delta Y_t = \beta_i Y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + v_t \quad (3)$$

where:

$\Delta Y_{t-i} = (Y_{t-1} - Y_{t-2})$ and v_t is the white noise error term

Table 2 reports the unit root test results.

Table 2
Unit root test results

Variable	ADF Test Statistic	Level of Difference	1% critical value	5% critical value	10% critical value
INFL	-6.164***	1st	-3.562	-2.920	-2.595
PDIESEL	-13.116***	1st	-3.562	-2.920	-2.595
PPETROL	-14.356***	1st	-3.562	-2.920	-2.595
PPARAFFIN	-9.847***	1st	-3.562	-2.920	-2.595

*** *represent significance at 1% level of significance.*

As indicated in Table 2, the variables used in the ARDL model became stationary after the first differencing, as is usually the case with many time series, implying that each variable needed to be differenced once so as to make it stationary, something that was duly done by the study.

When determining the ideal lag length for a time series, the most popular methods are the Hannan-Quinn Information Criterion (HQIC), the Schwarz-Bayesian Information Criterion (SBIC), and the Akaike Information Criterion (AIC). Given that the ARDL model calculates the optimal lag length by estimating (p+1) k regressions, where p is the maximum number of lags to be used and k is the number of variables in the equation, it is always necessary for the criterion to be sufficiently parsimonious to allow the study to arrive at a given fit with the fewest number of parameters per observation (Gujarati, 2004). Table 3 reports the lag length determination results for the study.

Table 3
Lag length determination results

Lag	Degrees of Freedom	AIC	HQIC	SBIC
0	16	-1.25199	-1.19774	-1.11357
1	16	-5.25788	-4.98664	-4.56579
2	16	-5.53323*	-5.045*	-4.28747*
3	16	-5.36284	-4.65763	-3.56341
4	16	-5.28598	-4.36378	-2.93288

* denotes optimal lag length

Table 3 shows that all three optimal lag length selection criteria settled for 2 lags as the optimal length. Hence, the study used 2 as the optimal lag length and estimated an ARDL (2,2,2) model.

Table 4 reports the results for the other diagnostic tests.

Table 4
Diagnostic test results for the ARDL model

Test	Null hypothesis	Test statistic	P-value	Decision
Breusch-Pagan Test for Heteroscedasticity	Constant variance	Chi2(1) =0.04	0.8422	The constant variance null hypothesis is not rejected.
Ramsey RESET Test	Model has no omitted variables	F (3,3) =0.34	0.8012	The null hypothesis of no omitted variables in the model cannot be rejected.
Breusch-Godfrey LM Test for Autocorrelation	No serial correlation	Chi2(1) =0.03	0.8733	The no serial correlation null hypothesis cannot be rejected.

As shown in the Table 4, all three tests failed to reject the null hypotheses, suggesting that the ARDL model had no heteroscedasticity problem, it was correctly specified with no omitted variables, and that it contained no autocorrelation problem. These results imply that the ARDL model could be fitted to, adequately, explain the problem at hand.

3.2 Descriptive Statistics

Having presented diagnostic test results, the study then presents summary statistics for the variables used in the ARDL model, as shown in Table 5.

Table 5
Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
INF	65	15.977	7.257	6.6	36.4
PPETROL	65	478.899	410.788	46.1	1990.9
PDIESEL	65	473.168	412.676	41.2	1920
PPARAFFIN	65	366.608	304.999	31.4	956

As shown by Table 5, among the petroleum products used, the price of petrol has the highest mean value of about MK478.90 with maximum and minimum values of MK1990.90 and MK46.10, respectively. On the other hand, the price of paraffin has the lowest mean value of about MK366.61with maximum and minimum values of MK956 and MK31.40, respectively. With respect to standard deviation, **Table 5** shows that the price of diesel has the largest standard deviation of about MK412.68, whereas the price of the lowest standard deviation of about MK305.00. This suggests that there was more variability in the price of diesel than in the prices of petrol and paraffin.

3.3 Inferential Statistics

In order to determine the existence of a long-run relationship among the variables used in the ARDL model, a bounds test was carried out, and it yielded an F-statistic of 4.813 with associated lower bound value and upper bound value of 3.17 and 4.14, respectively, at 5 per cent level of significance. This suggests that there is an existence of a statistically significant long-run relationship among the variables used in the ARDL model. Hence, the study estimated the ARDL model with an error correction term to take care of the long-run relationship among the variables. The results of the ARDL model are presented in Table 6 and Table 7. In particular, Table 6 presents the ARDL (2,2,2) results for coefficient estimates for inflation excluding the price of diesel, while Table 7 presents the ARDL (2,2,2) results for coefficient estimates for inflation excluding the price of petrol.

Table 6
ARDL (2,2,2) Results for coefficient estimates for inflation, excluding the price of diesel

INFLATION	Coefficient	Std. err.	t-statistic	p-value	[95% conf.	Interval]
ADJ						
L1.	-0.179***	0.059	-3.010	0.004	-0.298	-0.060
LONG-RUN						
PPETROL	1.894*	0.983	1.930	0.059	-0.077	3.866
PPARAFFIN	2.359*	1.198	1.970	0.054	-4.762	0.043
SHORT-RUN						
INFLATION						
LD.	0.301**	0.126	2.400	0.020	0.049	0.553
PPETROL						
D1.	0.395**	0.163	2.420	0.019	-0.722	-0.068
LD.	0.421**	0.157	2.680	0.010	-0.735	-0.107
PPARAFFIN						
D1.	0.328*	0.172	1.900	0.062	-0.017	0.674
LD.	0.542***	0.172	3.150	0.003	0.197	0.887
CONSTANT	34.797	14.358	2.420	0.019	6.010	63.584

*** indicates significance at the one percent level,
** indicates significance at the five percent level, and
* indicates significance at the ten percent level.

Table 6 indicates that around 18 percent of the ARDL model's disequilibrium is being addressed in the short run, with a statistically significant speed of adjustment parameter of -0.179. Furthermore, a negative coefficient for the speed of adjustment parameter indicates that the model will eventually converge. Table 6 further demonstrates a statistically significant short run relationship between inflation and the price of petrol and price of paraffin in Malawi, based on the link between the variables included in the ARDL model. Specifically, it suggests that a one-unit increase in the price of gasoline will result in a 0.421-unit short-term increase in inflation. This finding is statistically significant at the five percent significance level (p-value<0.05). Similarly, Table 6 demonstrates that the price of paraffin has a statistically significant positive effect on inflation in the short-run (p-value<0.01), indicating that a unit increase in paraffin prices will result in a short-term inflation increase of 0.542 units. Additionally, Table 6 demonstrates that the price of gasoline and paraffin have an impact on Malawi's inflation over the long term in addition to having a short-term favorable effect. For instance, a unit increase in the price of petrol will lead to a 1.89 unit increase in inflation in the long run (p-value<0.1), whereas a unit increase in the price of paraffin will lead to a 2.36 unit increase in inflation in the long run (p-value<0.1). Having determined

the effect of the price of petrol and the price of paraffin on inflation, the study now presents the effect of the price of diesel on inflation in **Table 7.**

Table 7
ARDL (2,2,2) Results for coefficient estimates for inflation excluding price of petrol

INFLATION	Coefficient	Std.error	t-statistic	p-value	[95% conf.	interval]
ADJ						
INFLATION						
L1.	-0.175***	0.059	-2.940	0.005	-0.294	-0.056
LONG-RUN						
PDIESEL	2.230*	1.178	1.890	0.064	-0.131	4.592
PPARAFFIN	2.787*	1.444	1.930	0.059	-5.683	0.109
SHORT-RUN						
INFLATION						
LD.	0.299**	0.126	2.380	0.021	0.047	0.550
PDIESEL						
D1.	0.443**	0.180	2.470	0.017	-0.803	-0.083
LD.	0.470***	0.173	2.710	0.009	-0.817	-0.123
PPARAFFIN						
D1.	0.397**	0.197	2.020	0.048	0.003	0.791
LD.	0.628***	0.201	3.130	0.003	0.225	1.030
CONSTANT	36.106	14.299	2.530	0.015	7.439	64.774

*** denote significance at 1 per cent level of significance.
** denote significance at 5 per cent level of significance.
* denotes significance at 10 per cent level of significance.

Table 7 shows that approximately 17.5% of the ARDL model's disequilibrium is being addressed in the short-run, since the speed of adjustment parameter of -0.175 is statistically significant at the 1% level of significance (p-value<0.01). Moreover, since the speed of adjustment parameter has a negative coefficient, it means that the model will achieve convergence in the long run. Table 7 further demonstrates a statistically significant short-run relationship between Malawi's diesel prices and inflation. It demonstrates that, specifically, a one-unit increase in diesel prices will result in a 0.47-unit short-term increase in inflation. This finding is statistically significant at the one percent significance level (p-value<0.01). In a similar vein, Table 7 indicates that the price of diesel has a statistically significant positive effect on inflation (p-value<0.1) in the long-run. This means that a unit increase in diesel prices will result in a 2.23 unit increase in inflation over time.

4. Conclusions and policy recommendations

This study set out to empirically determine how prices of different petroleum products influence inflation in Malawi. The following were the null hypotheses tested by the study: (1) changes in price of diesel have no influence on inflation in Malawi, (2) changes in price of petrol have no influence on inflation in Malawi, and (3) changes in price of paraffin have no influence on inflation in Malawi. The results have shown that, both in the short-run as well as in the long-run, the prices of petrol, diesel, and paraffin have a statistically significant positive effect on Malawi's inflation. Accordingly, a rise in the price of any of these goods is likely to raise inflation in Malawi both in the short-run as well as the long-run. This finding conforms with Salisu et al. (2017), who found that there exists a statistically significant relationship between oil price and inflation in the long run, and that oil price exerts a greater impact on net oil-importing countries than on net oil-exporting countries.

Policy recommendation emanating from the foregoing finding is that, in order to control inflation, policymakers need to make sure that prices of petroleum products are kept as low as possible. This can take the form of ensuring the maintenance of huge foreign exchange reserves to be used to stabilize the foreign exchange market, to ensure that the Malawi Kwacha does not depreciate anyhow.

As is always the case with many studies, it has to be pointed out that this study was not without limitations. As a matter of fact, there are different energy commodities such as electricity, charcoal, and firewood whose price increases can equally have an influence on inflation in Malawi, but they have not been considered in this study. Hence, future studies should analyze the dynamics of energy prices and inflation in Malawi to give a much clearer picture of how the changes in the price of energy commodities influence inflation in Malawi.

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