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Budget deficit and inflation nexus in Uganda 1980–2016: a cointegration and error correction modeling approach

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Abstract

Background: One of the principal goals of monetary policy pursued by Central Banks worldwide is virtually price stability. Understanding inflationary dispositions and its determinants is therefore a critical issue from the monetary authorities, scholars and the policy makers viewpoint. The purpose of this paper is to investigate the budget deficit and inflation nexus for Uganda for the period 1980–2016. This is because budget deficit in Uganda has been one of the top topical issues of concern in the country's historical economic problems. The study employs the cointegration and error correction model (ECM) as well as the pairwise Granger causality. This is because the ECM technique has become a tool of choice for estimation and testing the multivariate relationships among the non-stationary data in much of the time series macro-econometrics.

Results: Results of the Granger causality test show that budget deficit Granger causes inflation in Uganda at a conventional level of significance. However, no feedback effect is observed. The cointegration results reveal a positive and statistically significant long-run relationship between the series, and the results of the ECM reveal that budget deficit causes inflation in Uganda only in the short run. Further, in Uganda, budget deficit affects inflation directly and indirectly through fluctuations in the nominal exchange rate and money supply.

Conclusions: The main conclusion from this analysis is the existence of the long-run relationship among inflation, budget deficit and money supply. This was thus an indication of Granger causality in at least one direction among the variables. However, the impact of trade balance and exchange rate were taken as exogenous. A long-run stationary relationship between the budget deficit, money supply, inflation, trade balance and the exchange rate has been found to hold for Uganda. The major implications for this study are that inflation in Uganda is caused by both monetary as well as fiscal factors. A comprehensive policy package involving budgetary, monetary as well as exchange rate policies is required to deal with inflation.

Keywords: Budget deficit, Inflation, Granger causality, Error correction model, Uganda

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1 Introduction

One of the principal goals of monetary policy pursued by Central Banks virtually in the entire world is price stability (Ekanayake 2013). Understanding inflationary dispositions and its determinants is therefore a critical issue and attracts interest from policy makers and the monetary authorities. Budget deficit is studied for Uganda because theoretically it could be a source of inflation especially with regard to how it is financed. In both the Keynesian and Monetarist frameworks, deficits tend to be inflationary. This is because, in the former, budget deficits stimulate aggregate demand, while in the latter, when monetization takes place, it leads to an increase in money supply, and ceteris paribus, increases the rate of inflation in the long run (Gupta 2013). Ideally, a positive shock to government expenditure should result in a supply-side response. However, if the increase in government expenditure generates demand pressure, this may cause inflationary tendencies.

However, evidence from the empirical studies provides mixed results. For example, Luis and Marco (2006) find a strong linkage between inflation and budget deficits in emerging economies characterized by episodes of high inflation rates, but it holds less strongly in developed countries. They argue that budget deficits result in higher inflation rates for countries where the inflation tax base is smaller and that less impact is felt in countries that have greater levels of monetization. A similar result is found by Levin et al. (2002) in a most recent study which analyzes 91 countries. They find a strong relationship between the budget deficit and inflation in countries that experienced high inflation and weak relationship in countries that experienced lower inflation (Levin et al. 2002).

A study by Muzafar et al. (2011) on developing Asian countries reveals that, in the long run, budget deficits are inflationary in developing countries. This is considered to be the case because many developing countries rely on the Central Banks to finance their deficits through printing money, which may result in greater excess aggregate demand than in increased aggregate supply. In Sri-Lanka, Ekanayake (2013) finds a weak relationship between the budget deficits and inflation. Interestingly, the relationship becomes stronger as the proportion of public expenditures allotted to wages increases. This implies that the inflation–deficit relationship is not only a monetary phenomenon, but that public sector wage expenditure is also influential in linking inflation and budget deficits.

In Pakistan, evidence from empirical studies provides mixed results. For example, studies by Shabbir and Ahmed (1994) reveal a positive and significant relationship between budget deficits and inflation, and an indirect relationship between budget deficits and money supply. They further argue that inflation is not only linked to budget deficits, but that the deficit is primarily funded through bank borrowing and ultimately seigniorage. However, findings by Mukhtar and Zakaria (2010) reveal a different picture for Pakistan; they do not find significant long-run connection between inflation and budget deficits. Instead, inflation is related to the money supply, yet no causal relationship is found between budget deficits and money supply. In Tanzania, Ndanshau (2012) find no causal effect from budget deficits upon inflation; instead, Granger causality is observed running from inflation to budget deficits. On the other

hand, in Nigeria, Oladipo and Akimbobola (2011) find a unidirectional causation running from budget deficits to inflation.

Some scholars, however, do not find a significant evidence of the direction of causality between inflation and the budget deficit (Viera 2000; Cevdet Akcay et al. 2001). This implies that neither inflation nor budget deficit Granger causes the other. On the other hand, other studies find bidirectional causation between deficits and inflation (Aghevli and Khan 1978; Marbuah and Mali 1997). These proponents were actually testing the Olivera–Tanzi effect which argues that the budget deficit does not only lead to inflation, but inflation also provides a feedback through lags in tax collection which leads to a reduction of real tax revenue and further leads to an increase in the budget deficit hence self a strengthening phenomenon (Tanzi 1991).

In Uganda, however, less effort has been made to study the connection between the budget deficit and inflation despite the fact that the country has been running deficit budgets over the years. This has been attributed to the low revenue mobilization compared to the increasing expenditure requirements. For example, in 2012, total revenue was at 17.2% of GDP compared to the expenditure requirements of 20.6% of GDP in the same period (MoFPED 2013). The economy therefore has been typified by relatively high budget deficit and inflation for a prolonged period of time. The few studies that have been conducted have also provided mixed results for the case of Uganda. For instance, Bwire and Nampewo (2014) examined the association between money creation, inflation and the budget deficit in Uganda over the period 1999Q4 to 2012Q3. Using vector error correction model (VECM) and a pairwise Engle–Granger causality test, a long-run relationship between the budget deficit, money supply, inflation and the nominal exchange rate was found to hold. However, their results showed that only money supply Granger causes inflation in the short run. Although results of Granger causality tests revealed a unidirectional causality running from inflation to the budget deficit, no statistically significant causation was found from the budget deficit to inflation or from the budget deficit to money supply in the short run.

In a supposedly related study (Alani 1995), the author analyzes the relationship between government deficits, money supply and inflation in Uganda using Quarterly data from 1985Q2 to 1993Q2. Applying Ordinary Least Squares (OLS) to the data set, the study revealed no association between budget deficit and inflation, although a short-run causation running from money supply to inflation was revealed. Most empirical studies in Uganda have majorly concentrated on the effects of the budget deficit on the exchange rate and the sustainability of the government deficit (Bagonza 2004; Birungi 1995; Alani 1995; Brownbridge and Kirkpatrick 2000). Most of these studies have been using single equation models where inflation is treated as an endogenous variable and the budget deficit as an exogenous variable among other variables using ordinary least squares (OLS) estimation technique. However, this approach rules out the possibility of bidirectional causation.

This therefore forms the basis of this study. This study contributes to the literature by examining the budget deficit–inflation nexus for Uganda, using annual data for the period 1980–2016. The ECM and Granger causality approaches were employed to investigate the interrelationship between the budget deficit and inflation. A chief uniqueness of this study in the context of the budget deficit–inflation nexus literature is in the use

of a rich dynamic approach that allows the short-run adjustments and long-run equilibrium relationships to differ. The debate concerning the relationship between budget deficit and inflation is still inconclusive. This study contributes to the debate for the case of Uganda since most of the studies have concentrated on the unidirectional causation running from the budget deficit to inflation (Bagonza 2004; Birungi 1995; Alani 1995; Brown bridge 2000).

Therefore, this study examines the nexus between budget deficit and inflation as well as their direction of causality in Uganda using annual time series for the period 1980–2016.

2 Literature review

There is an extensive deliberation regarding the budget deficit and the inflationary effects in the fiction of economic theory. Throughout the Keynes era, the classical economists attached strong value to a balanced budget, even though they did not analyze its bearing on the price levels. Apart from classical economists, Keynes saw the fiscal imbalances and the budget deficit mechanisms as amassed national demand (Levin et al. 2002). The underlying reason is that when budget expenditures upsurge, aggregate demand curve responds by shifting right, leading to an increase in both prices and production assuming aggregate supply is inelastic or perfectly elastic (Gupta 2013).

In the monetarist point of view, money supply drives inflation. If monetary policy is accommodative to a budget deficit, money supply continues to go up for a long time. Aggregate demand increases as a consequence of this deficit financing causing output to increase above the aggregate level of output. Growing labor demand increases wages, which in turn leads to a shift in aggregate supply in a downward direction. After some time, the economy returns to the natural level of output. However, this happens at the expense of permanent higher prices. According to the monetarist view, budget deficits can lead to inflation but only to the extent that they are monetized (Hamburger and Zwick 1981).

According to Olivera–Tanzi effect, the nexus between budget deficit and inflation exhibits a two-way interaction. That is, not only does the budget deficit through its impact on money aggregates and expectations produces inflationary pressures, but high inflation also has a feedback effect pushing up the budget deficit. Basically, the process works due to significant lags in tax collections. The problem lies in the fact that the time of tax obligation's accrual and the time of actual tax payment do not coincide, with the payment usually made at a later date. We may therefore have the following self-strengthening phenomenon. Persistence of budget deficit props inflation which in turn lowers real tax revenues, a fall in the real tax revenue then necessitates and further increases in the budget deficit and so on. In economic literature, this is referred to as the 'Olivera–Tanzi effect' (Olivera 1967).

The debate of Sarget and Wallace under the neoclassical theory enlightens the discussion on the relationship among the budget deficit and inflation. They discuss two types of the coordination between the monetary and the budget authorities which is effective in controlling the inflation. In the first type of the coordination in which the monetary authorities are dominant, monetary authorities announce the monetary base growth and budget policy. In the second type of coordination, in which the budget authorities are dominant,

budget policy sets its budget and announces the amount of money needed for monetary authorities through seigniorage and bond sales (Sargent and Wallace 1981)

The new classical economists oppose the misperception part of the theory and assert that such an assumption is inconsistent with the rational expectation theory. That is, the demand for goods is based on expected present value of the future taxes (Catao and Terrones 2001). Budget policy can influence the price level through aggregate demand changes; it should change the expected value of the future taxes, which occurs by altering the sounding. In this sense, budget deficits and taxation have equivalent effects on the economy hence the term the 'Ricardian equivalence theorem' (Catao and Terrones 2001). That is, there is no change in national saving, since an increase in private saving as faced by an equivalent decline in public saving. Because national savings, in turn, investment and aggregate demand do not change, one can argue that the budget deficit does not affect price levels.

Just like the theoretical literature, evidence from empirical literature concerning the direction of causality is also inconclusive. Some studies have found a unidirectional relationship running from the budget deficit to inflation and vice versa. While others have found a bidirectional relationship, some have actually found no relationship between these two variables. Some have found a unidirectional relationship running from the budget deficit to inflation, and these support the traditional approach to budget policy (Luis and Marco 2006; Hamburger and Zwick 1981). However, most of these studies have been using single equation models where inflation is treated as an endogenous variable and the budget deficit as an exogenous variable using ordinary least squares (OLS) estimation technique. Yet, such approach rules out the possibility of bidirectional causation. Recent studies of Ndanshau (2012) and Ekanayake (2013) used the cointegration and error correction model (ECM) but also concentrated on whether the budget deficit leads to inflation and ignored the aspect of feedback which can be done by making inferences using the short-run and long-run Granger causality within the framework of the VECM model. This forms the basis of this study.

3 Theoretical framework

The theoretical framework adopted by this study is borrowed from Solomon and Wet (2004) and Bwire and Nampewo (2014). This model links reactions of the government deficits to inflation as was developed by Aghevli and Khan (1977, 1978). According to Bwire and Nampewo (2014), for the case of a developing country like Uganda, the main sources of budget financing, excluding grants, are summarized in Eq. (3.1) below. Grants are excluded because they are not reliable sources of government revenue; grants solely depend on donor discretion, and may, as a result, present potential risks of financial vulnerability.

$$Gt + \frac{Dt-1}{Pt}[1 + rt - 1] = Tt + \left(\frac{Mt - Mt-1}{Pt}\right) + \frac{Dt}{Pt} + \Delta R \tag{3.1}$$

where G_t is the total government expenditure at time (t), $\frac{Dt-1}{Pt}(1 + rt - 1)$ is the discounted value of the real stock of accumulated government debt in the previous period with maturity value in the current period (t), Tt is the tax revenue at the current time (t), $\frac{Mt-Mt-1}{Pt}$ is the change in money supply or seigniorage revenue, $\frac{Dt}{Pt}$ = Captures domestic and external

This specification follows the one used by Catao and Terrones (2001) and is widely supported in the literature over the conventional scaling of the budget deficit to GDP. According to Catao and Terrones (2001), scaling the budget deficit by money supply is theoretically sound, and would measure the inflation tax base and capture the nonlinearity factor in the specification. This study, therefore, adopted the conventional measure of scaling the budget deficit by GDP. Rearranging Eq. 3.1 in terms of budget deficit given the purpose of the study, the final model for estimation is expressed in Eq. 3.2.

$$\pi = f\left(\frac{\text{FD}}{m}, \text{M2}, \text{TB}, \text{GDP}, \text{NER}\right) \tag{3.2}$$

where π = Inflation, M2 = Money supply Growth, TB = Trade Balance, GDPG = Gross Domestic Product Growth, NER = nominal exchange rate. Letting Consumer Price Index (CPI) denote π as a measure of inflation, budget deficit (BD) denote the term $\left(\frac{\text{FD}}{m}\right)$ as a measure of budget deficit as a percentage of GDP Eq. 3.2 was transformed into the following;

$$\text{CPI} = f(\text{BD}, \text{M2}, \text{TB}, \text{GDPG}, \text{NER}) \tag{3.3}$$

4 Empirical methodology

In order to capture the short- and long-run dynamics as well as the speed of adjustment between budget deficit and inflation for Uganda, the study adopts the ECM and the cointegration approach. According to Johansen study, Johansen (1988), the ECM technique has become a tool of choice for estimation and testing the multivariate relationships among the non-stationary data in much of the time series macro-econometrics. In this study, we adopt the following empirical ECM model based on the following regression equation.

$$\begin{aligned}\Delta\text{LCPI}_t = {} & \alpha_1 + \text{ECT\_1}(\text{LCPI}_{t-1} - \beta_0 - \beta_1\text{LBD}_{t-1} \\ & - \beta_2\text{LM2}_{t-1} - \beta_3\text{LTB}_{t-1} - \beta_4\text{NER}_{t-1} - \beta_5\text{GDPG}_{t-1}) \\ & + \sum \alpha_{11}(i)\Delta\text{LCPI}_{t-i} + \sum \alpha_{12}(i)\Delta\text{LBD}_{t-i} + \sum \alpha_{13}(i)\Delta\text{LM2}_{t-i} \\ & + \sum \alpha_{14}(i)\Delta\text{LTB}_{t-i} + \sum \alpha_{15}(i)\Delta\text{LNER}_{t-1} \\ & + \sum (\alpha_{16}(i)\text{DLGDPG} - i + Vt_n + \cdots)\end{aligned} \tag{3.4}$$

where $i = 1, 2, \ldots m$, m is the optimal lag length, Δ is the difference operator such that $\Delta\text{LCPI}_t = \log\Delta\text{CPI}_t - \log\Delta\text{CPI}_{t-1}$, ECT_1 is the equilibrium error. After estimating the ECM, we were able to obtain the speed of adjustment coefficient that corrects the disequilibrium in the system. Such coefficient therefore shows the rate at which the disequilibrium is corrected toward the long-run equilibrium. It should be noted that the ECM coefficient is the short-run coefficients and is used to explain the variations in inflation rate due to changes in all the independent variables used the analysis in the short run.

5 Data types and sources

The study uses secondary annual data. Data on government revenue and expenditure was sourced from the Ministry of Finance, Planning and Economic Development (MoFPED), while data on CPI which was used to measure inflation rate, gross domestic product growth

Table 1 The correlation matrix of the study variables *Source*: Correlation Output from Eviews 7

	DGDPG	DLBD	DLCPI	DLM2	DLNER	DLTB
DGDPG	1.000	−0.072	−0.186	−0.170	0.047	−0.257
DLBD	−0.071	1.000	0.266	−0.026	0.036	0.087
DLCPI	−0.180	0.269	1.000	0.311	0.087	0.302
DLM2	−0.101	−0.026	0.318	1.000	−0.493	0.390
DLNER	0.046	0.035	0.087	−0.479	1.000	−0.316
DLTB	−0.257	0.058	0.306	0.391	−0.315	1.000

Table 2 Unit root test results in levels

Variable	ADF-statistic	*P* value*	Phillips Perron statistic	*P* value*
LBD	−2.021655	0.2765	−1.97382	0.2963
LCPI	−1.608137	0.4666	−2.01114	0.2808
LNER	−1.179952	0.6658	−1.56894	0.78564
LTB	−2.278011	0.1848	−2.27125	0.18484
LM2	−0.659751	0.8428	−0.360105	0.9045

*Significant at 1%, **Significant at 5%, ***Significant at 10%

(GDPG), money supply (M2), nominal exchange rate (NER), Exports and Imports was sourced from World Development Indicators (WDI) CD-ROM.

6 Discussion of findings

6.1 Multicollinearity test results

The correlation matrix presented in Table 1 describes the statistical correlation between inflation, budget deficit, money supply, Trade balance and the Real Effective Exchange Rate.

The results presented in Table 1 clearly show that inflation, budget deficit, money supply, NER and trade balance are not highly correlated. This is due to the weak correlation among all the variables.

6.2 Unit root test results

Before the equations were estimated, unit root was tested using the ADF and the Phillips Perron tests, these were conducted both at level and first difference of the variables and the results presented in Table 2.

The ADF and PP statistics presented in Table 2 undoubtedly signify that all the variables used in the analysis contain unit root at level. This means that the budget deficit, inflation, NER, trade balance and money supply are non-stationary since the ADF and the PP statistics are statistically insignificant even at 10% level of significance. However, all the variables become stationary after the first difference. This indicates that all the variables are integrated of order one; that is, $I(1)$.

The results in Table 3 reveal that the all the variables become stationary and integrated of order zero. The stationarity of the variables at first difference was also confirmed by

Table 3 Unit root test results at first difference

Variable	ADF-statistic	*P* value*	Phillips Perron statistic	*P* value*
ΔLBD	−6.173942*	0.0000	−6.173942*	0.0000
ΔLCPI	−8.804995*	0.0000	−9.340695*	0.0000
ΔLNER	−4.735637*	0.0007	−12.58116*	0.0000
ΔLTB	−5.590252*	0.0001	−5.695656*	0.0000
ΔLM2	−5.002524*	0.0003	−5.043612*	0.0003

*Significant at 1%, **Significant at 5%, ***Significant at 10%

Table 4 Johansen's cointegration test results *Source*: Cointegration output from Eviews 7

Hypothesized no. of CE(s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.**
a) Unrestricted cointegration rank test (trace)				
None*	0.983186	168.0641	69.81889	0.0000
At most 1	0.502068	41.41225	47.85613	0.1759
At most 2	0.301950	19.79619	29.79707	0.4368
At most 3	0.232817	8.652780	15.49471	0.3985
At most 4	0.013994	0.436867	3.841466	0.5086
Hypothesized no. of CE(s)	**Eigenvalue**	**Max-eigen statistic**	**0.05 critical value**	**Prob.****
b) Unrestricted cointegration rank test (maximum eigenvalue)				
None*	0.983186	126.6518	33.87687	0.0000
At most 1	0.502068	21.61606	27.58434	0.2407
At most 2	0.301950	11.14341	21.13162	0.6330
At most 3	0.232817	8.215914	14.26460	0.3572
At most 4	0.013994	0.436867	3.841466	0.5086

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

*Denotes rejection of the hypothesis at the 0.05 level **MacKinnon–Haug–Michelis (1999) *P* values

the Phillips Perron test statistics. The PP statistics are significant, and the null hypothesis of unit root was rejected at 1% level of significance. This prompted the testing of cointegration of the variables since they were all integrated of the same order.

6.3 Testing for cointegration

The following step involved testing for cointegration using the Johansen's cointegration procedure to the variables so as to ascertain whether the variables were cointegrated. The Johansen's cointegration procedure was used because it detects the rank or number of cointegrating relations as opposed to the Engle Granger Methodology which only assumes one cointegrating equation regardless of the number of the series. The results of the test are presented in the Table 4.

The results in Table 4 indicate that the null hypothesis of no cointegration was rejected since both the trace statistic and maximum Eigen value indicated one cointegrating equation at 5% level of significance. For example, considering the trace statistic, 168.0641 far exceeds the critical value of 69.8 at 5% level of significance and taking into account the significant *P* value, the null hypothesis of zero cointegration was rejected. However,

Table 5 Results of the normalized cointegrating vector *Source*: Normalized output from cointegration test

DV: LCPI	Normalized cointegrating coefficients (std error in parentheses)				
	LBD	LM2	LNER	GDPG	LTB
Coefficient	0.268639	0.727232	− 0.036301	− 0.42564	3.780809
Std. errors	(0.0362)	(0.52112)	(0.00085)	(0.1558)	(0.53306)
t-statistic	7.27519	1.395517	− 42.7059	− 2.7312	7.092635

Table 6 Pairwise Granger causality tests *Source*: Output from Eviews 7

Null hypothesis	Obs	*F*-statistic	Prob.
LCPI does not granger cause LBD	35	1.34579	0.27791
LBD does not granger cause LCPI		2.91332	0.04813
LM2 does not granger cause LBD	35	1.66279	0.20911
LBD does not granger cause LM2		0.19423	0.82427
LM2 does not granger cause LCPI	35	2.36074	0.07006
LCPI does not granger cause LM2		1.12769	0.33911

the trace statistic of 41.4 was less than the critical value of 47.856 and considering the insignificant *P* value of 0.1759, the null hypothesis of at most one cointegrating equation could not be rejected as can be observed from part a of Table 4. The same conclusion was also true about the maximum eigen statistic since it indicated one cointegrating equation as indicated in part b of Table 4. The existence of cointegration among the variables was thus an indication of the existence of a long-run equilibrium relationship between the series.

Results in Table 5 indicate the cointegrating long-run estimates from which we reveal that the budget deficit has a positive and statistically significant impact on inflation in the long run. That is ceteris paribus, a 1% point increase in the ratio of budget deficit to GDP should lead to a long-term increase in inflation by 0.2686% points. This is in line with the expected sign. The t ratio statistic is 7.2752 which is highly statistically significant. The conclusion is consistent with the findings in similar studies by Solomon and Wet (2004), Catao and Terrones (2001) and Chaudhary and Ahmad (1995), among others. It is also consistent with the hypothesis that increases in the budget deficits are associated with increases in seigniorage in the long run. In addition, money growth has a positive long-run impact on inflation though the impact is not statistically significant. The results imply that a 1% point increase in M2/GDP is associated with a 0.727% points increase in inflation, holding other factors constant. However, an appreciation of the exchange rate leads to a decrease in the general price level in the long run. In addition, GDP growth has a negative impact on Inflation in the long run, that is, a 1% point increase in GDP growth leads to a decrease in inflation by 0.43% points in the long run.

6.4 Granger causality results

Granger causality hypothesis was tested to determine whether budget deficit and inflation do granger cause each other. This section therefore presents and discusses results from the Granger causality test, and results are presented in Table 6.

The granger causality results presented in the Table 6 indicate that some null hypothesis had to be rejected, while other could not be rejected. No statistically significant causation running from inflation to the budget deficit or from the budget deficit to money supply is found in the short run. As per the results, inflation does not granger cause the budget deficit, while the former granger causes latter at least at 10% level of significance. This is because, although the hypothesis could be rejected at 5% level of significant, it could not be rejected at 10%. The results therefore support the unidirectional assertion by theories such as the traditional approach to budget policy and empirical studies by Ahking and Miller (1985), Hamburger and Zwick (1981) and Rwegasira (1974) but contradicts with the Olivera–Tanzi effect theory and the Richadian Equivalence. It also contradicts empirical evidence by Aghevli and Khan (1978) and Barnhart and Mudell (1988) who found bidirectional causation. The results further indicated that while money supply granger causes inflation at least at 10% level of significance, there is no feedback causation running from inflation to money suppl. That is, changes in money supply granger cause variations in inflation and inflation does not provide a feedback effect to money supply.

6.5 Results of the error correction model (ECM)

Following the Granger-wise causality, cointegration and the unit root tests, it was ascertained that in addition to the variables being non-stationary, they were integrated of the same order and thus cointegrated. This was a necessary condition for using the ECM in the analysis. This is because when the variables are non-stationary but cointegrated, it implies that the model defines a long-run equilibrium relationship among the cointegrated variables. The ECM was therefore necessary in order to find out the measure of

Table 7 Results from the ECM estimation *Source*: Output from Eviews 7

Variable	Coefficient	Std. Error	*t*-statistic	Prob.
ECT_1	−0.930040	0.154850	−6.006077	0.0000
DLNER	1.192038	0.401578	2.968385	0.0076
DLTB	3.591705	0.712502	5.040976	0.0001
DGDPG	−0.102607	0.046167	−2.210796	0.0389
DLBD(−1)	0.142390	0.045383	3.138180	0.0370
DLM2(−1)	0.725815	0.191703	3.786931	0.0745
DLM2(−2)	1.730545	0.806075	2.146877	0.0442
DLTB(−2)	1.300755	0.629896	2.065030	0.0521
R-squared	0.811027	Mean dependent var		−0.076956
Adjusted *R*-squared	0.725989	SD dependent var		1.188151
S.E. of regression	0.621950	Akaike info criterion		2.149287
Sum squared residual	7.736430	Schwarz criterion		2.616352
Log likelihood	−22.23930	Hannan–Quinn criterion.		2.298705
F-statistic	9.537255	Durbin–Watson stat		1.520055
Prob(*F*-statistic)	0.000016			

the degree to which the variables respond to the deviation from the long-run equilibrium relationship. Subsequent to ECM estimation, the results are presented in Table 7.

7 Interpretation of the results

The summaries of short-run estimates derived from the error correction model are presented in Table 6. As can be observed, the speed of adjustment is statistically different from zero, and this means that variations in the price level and the budget deficit respond to the long-run equilibrium. Therefore, from Table 7, we are able to obtain the following relationships following Eq. 3.4.

7.1 Budget deficit and inflation

The results indicate that, in the Uganda's case, the budget deficit has a positive and statistically significant impact on inflation although the impact occurs with lags. The results indicate that the current budget deficit does not explain current inflation in Uganda. However, current inflation is explained by the deficit of the previous year. This implies that a 1% point increase in the budget deficit leads to a 0.1424% points increase in the rate of inflation the following year holding other factors constant. Therefore, our conclusion is that the budget deficit has a strong and significant impact on inflation both in the short and long run. The results therefore support the unidirectional assertion by theories such as the traditional approach to budget policy and empirical studies by Ahking and Miller (1985), Hamburger and Zwick (1981) and Rwegasira (1974) but contradicts with the Olivera–Tanzi effect theory and the Richadian Equivalence. It also contradicts empirical evidence by Aghevli and Khan (1978) and Barnhart and Mudell (1988) who found bidirectional causation.

It is therefore necessary for the government to reduce the deficit levels so as to stabilize prices in the Ugandan economy since the relationship between inflation and the budget deficit is a unidirectional one. The results are also contradicting with the findings by Bwire and Nampewo (2014). They analyzed the relationship between budget deficits, money creation and inflation in Uganda using quarterly data over the period 1999Q4 to 2012Q3. In their study, although the budget deficit does not have a positive and statistically significant impact on inflation in the short run, it has in the long run. Our study, however, using annual data over the period 1980–2012 finds a positive and statistically significant impact of the budget deficit on inflation both in short and long run.

7.2 Money supply and inflation

From the ECM results, monetary changes are essential determinants of the price level in Uganda. This is consistent with the monetarist perspective which argues that 'inflation is always and everywhere a monetary phenomenon'. The results of this study support evidence of studies by Dehaan and Zelhorst (1990) and Marbuah and Mali (1997). However, our results reveal that money supply causes inflation with a lag. The results indicated that keeping other things equal, a 1% point increase in money supply in the current year leads to 0.72% points increase in the general price level in the following year. Such changes in money supply commonly known as seigniorage are a result of the Central bank's policy of printing more money without a corresponding change in the level of output produced in an economy. This leads to a general increase in the price level.

7.3 Exchange rate and inflation

In accordance with the expectations of this study, the depreciation of the exchange rate leads to an increase in the general price level; that is, a one percentage point increase in the price of foreign currency in terms of the domestic currency leads to roughly 1.19% point increase in the general price level; Uganda keeps other factors constant. This result is consistent with studies by Khan and Ssnhadji (1996) that found a positive association between the exchange rate depreciation and inflation but contradicts studies by Rehman et al. (2008) who found no association between these variables. Generally, foreign financing of the budget deficit leads to changes in terms of the relative prices of the currencies depending on the demand and supply of these currencies.

8 Conclusion

The main conclusion from this analysis is the existence of the long-run relationship among inflation, budget deficit and money supply. This was thus an indication of granger causality in at least one direction among the variables. However, the impact of trade balance and NER was taken as exogenous. A long-run stationary relationship between the budget deficit, money supply, inflation, trade balance and the exchange rate has been found to hold for Uganda. Normalizing the only relation for the annual change of CPI reveals that all variables in the model had a positive and significant long-run association with inflation. It implies that increases in the ratios of the budget deficit to GDP, M2/GDP, and depreciation in the exchange rate should each lead to a long-term increase in inflation. Results of Granger causality tests reveal unidirectional causality running from budget deficit to inflation and from money supply to inflation in the short run. No statistically significant causation is found from inflation to the budget deficit or from the budget deficit to money supply in the short run. From such analysis, it can be seen that inflation is not only caused by monetary factors but by budget factors as well.

9 Recommendations

The study establishes that in Uganda, inflation is caused by both monetary factors as well as budget factors. A comprehensive policy package is thus required to deal with inflation; these are budget, monetary as well as exchange rate policies. There is need for vigorous measures to fast-track the development of domestic capital market but in the same way adopt a restrictive but relatively flexible monetary policy in which the supply of money is constrained to grow steadily at the rate of real output. Since money growth is greatly influenced by the expansion of credit, there is need to limit government borrowing to finance deficits. It is thus necessary to develop the domestic capital markets by making returns on the securities more attractive to the public. This will reduce dependence on the government borrowing on the banking sector which is inflationary. It is also necessary for the government to reduce the deficit levels and resort to just spending what is available; this is in order to reduce the level of changes in prices in the economy which have had adverse effects on the economy where majority of the citizens are living below one USD per day. Since the sources of financing the deficit such as "deficit Monetization" lead to inflation, it is necessary for the government to realize this and resort to none or less inflationary sources such as non-bank borrowing. It is also necessary

for the government to have a strict policy to affect the demand and supply of foreign exchange; this is because the market mechanism alone cannot control the depreciation of the shilling.

Abbreviations
ADF: The Augmented Dickey Fuller unit root test; AS-AD: Aggregate supply-aggregate demand; BD: Budget deficit; BOU: Bank of Uganda; CPI: Consumer Price Index; ECM: Error correction model; ECT: Error Correction Term; GDP: Gross Domestic Product; GE: Government expenditure; GNP: Gross National Product; IMF: International Monetary Fund; MoFPED: Ministry of Finance Planning and Economic Development; NER: Nominal exchange rate; OECD: Organisation for Economic Co-operation and Development; PE: Public expenditure; PP: Phillips Perron test; WDI: World Development Indicators.

Authors' contributions
SK is the main author of the manuscript, and he initiated the research idea, undertook literature review, developed the theoretical framework, collected and analyzed the data from the different sources. EB is a co-author of this manuscript. He approved the research idea, supported the theoretical underpinning of the research paper, undertook quality assurance and supported the empirical data analysis and generation of policy implications. Both authors read and approved the final manuscript.

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Availability of data and materials
This study covered the period 1980–2012 and it used secondary annual data. Data on government revenue and expenditure was sourced from the Ministry of Finance, Planning and Economic Development (MoFPED) available at 'http://finance.go.ug/funding-release' while data on CPI which was used to measure inflation rate, gross domestic product growth (GDPG), money supply (M2), nominal exchange rate (NER), Exports and Imports was sourced from World Development Indicators (WDI) CD-ROM accessed at (https://data.worldbank.org/country/uganda?view). However, all data analyzed during this study are available on request from the corresponding author.

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