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Macroeconomic Impact of Budget Deficits in Papua New Guinea

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Abstract

Papua New Guinea's (PNG) fiscal policy in recent years has been characterised by persistent budget deficits and growing debt levels, warranting an assessment on the impact of these deficits. This paper examines the macroeconomic impact of budget deficits using selected economic data over the review period 1980 to 2018. The paper finds that while raising debt levels, budget deficits have been modest in stimulating economic growth, with government spending largely ineffectual, impacting inflation and monetary conditions, with elements of fiscal dominance. The Central Bank's ability to influence money supply and interest rates, and hence inflation remains a challenge in the presence of persistent budget deficits. This is further constrained when lending rates and inflation rise in response to fiscal deficits rising the cost of fiscal operations. Budget deficit shocks drive budget deficits further, which suggests that fiscal policy is set independently from endogenous economic shocks.

Key words:

Budget deficits, fiscal policy, monetary policy, deficit financing, sovereign debt, fiscal dominance, interest rates, money supply

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1. Introduction

Fiscal deficits typically associated with expansionary fiscal policies, and their impact on the economy is a policy initiative widely discussed and debated amongst policy makers, academics and researchers across all economies. It occupies great attention given its far-reaching implications. Budget deficits arise when governments spend beyond their revenue in a budgetary or fiscal year. When such an imbalance occurs, the shortfall in revenue is usually met by borrowing, selling of government assets, obtaining foreign aid from development partners and agencies, or borrowing from the central bank. Budget deficits are a common occurrence in many economies, depending on the fiscal policies and objectives pursued (Auerbach 2009). The impact that a deficit has on an economy depends on how it is financed and where it is expended. Borrowing is the foremost conventional method of deficit financing and adds to the public debt level, while asset sale to finance budget deficit, generally, does not affect the net worth of a country as the asset is simply converted to the liquid form–cash. Studies show that borrowing from the domestic financial markets to finance expenditure will likely raise interest rates, crowding out private sector investment (example Hauner 2006; Easterly and Schmidt-Hebbel 1993). Funding the budget deficit by borrowing from the central bank can lead to increased money supply and inflation (Richard et al 1990; Rao 2000; Rousseau and D'onofrio 2013; Orphanides 2017). Alternatively, borrowing from foreign capital markets poses exchange rate risks and uncertainties as movements in exchange rate will affect debt repayments and have implications on balance of payments (Herr and Priewe 2005). Excessive fiscal deficits financed through borrowing could also potentially lead to a debt crisis as debt level become unsustainable (Easterly and Schmidt-Hebbel 1993). Government spending on high return public investment projects that make the borrowing worthwhile, may often be the optimal policy choice for a country, while spending in areas of low or zero return, compounds the reliance on debt (example, Burnside and Dollar 2000; Kraay and Nehru 2006). The ensuing accumulation of public debt can be a serious policy concern if it reflects the type of fiscal policy that cannot ensure long-term solvency. For instance, if the government does not have a systematic mechanism that can reduce the debt–GDP ratio, broad measure of a country's ability to repay its debt, when it is high and rising, public debt may accumulate unabated and eventually become unsustainable (Lee *et al*. 2018). Persistent and excessive deficits are a serious concern when a country's ability to repay its debt in the long-term is impaired.

Not all deficits are similar in nature and are a derivative of expansionary fiscal policies. Budget deficits may arise from underperforming revenue or overspending expenditure, both as a result of adverse shocks or simply under budgeting; or it may be an expansionary fiscal policy, that is, a planned increase in expenditure or a planned forgoing of revenue such as reduction in tax rate or tax exemptions extended to a particular industry or sector. Moreover, causality between budget deficits and economic performance as measured by GDP may not necessarily hold. For instance, government

may plan a balanced budget but a fall in aggregate demand (for example, a fall in commodity prices) may lead to a decline in the tax collections and therefore government revenue. Budget deficit, lower private investment and lower GDP therefore are eminent. It would be misleading to conclude that the deficit is a cause of the fall in GDP. In contrast, what we are more interested in is how an increase in government investment or spending (and hence a deficit) or tax cuts (and hence a fall in revenue and increase in the deficit) affect the economy, both in the short and long term. Some of the more fundamental issues when considering the justification of budget deficits include; Short-term temporary deficits as a counter-cyclical policy that will be recovered when the economy returns to normalcy through increase spending to stimulate the economy during recessions.

PNG's fiscal policy in recent years is characterised by persistent budget deficits and growing debt levels, warranting an assessment on impact of these deficits. Hence, we undertake an empirical analysis by employing the Structural Vector Autoregressive (SVAR) and Vector Error Correction Models (VECM) similar to Vuyyuri and Sesahiah (2004), Georgantopoulos and Tsamis (2011), Lwanga and Mawejje (2014) and Brima and Mansaray-Pearce (2015) amongst others, in our paper. While studies on fiscal deficits in developing economies are numerous, there is limited literature with specific reference to PNG. What has been the impact of budget deficits on economic growth, inflation, money supply, exchange rate and interest rates? The results suggest that budget deficits in PNG have been inadequate in stimulating economic growth, that overall, Government spending remains largely ineffective while affecting inflation and monetary conditions, suggesting elements of fiscal dominance. Excess government investment may bring about a negative effect on the economy, due to government investment crowding-in from the monopoly of government activities that causes the allocation of resources to be not fully utilized. The Central Bank's ability to influence money supply, lending rates and inflation remains a challenge in the presence of persistent budget deficits, which affect the mentioned variables negatively. This is further constrained when lending rates increase in response to deficits. Budget deficit shock is still the most important factor in driving budget deficits, which suggests that fiscal policy is set independently, contrary to the belief that fiscal policy and in particular, government revenue largely respond endogenously to economic shocks.

The rest of the paper is structured according to the following. In section 2 we discuss the background to the study particularly the stylised facts and the existing fiscal policy framework. Section 3 covers the literature review, followed by the empirical analysis in section 4, results and analysis in section 5, and finally in section 5 we discuss the conclusion in this paper.

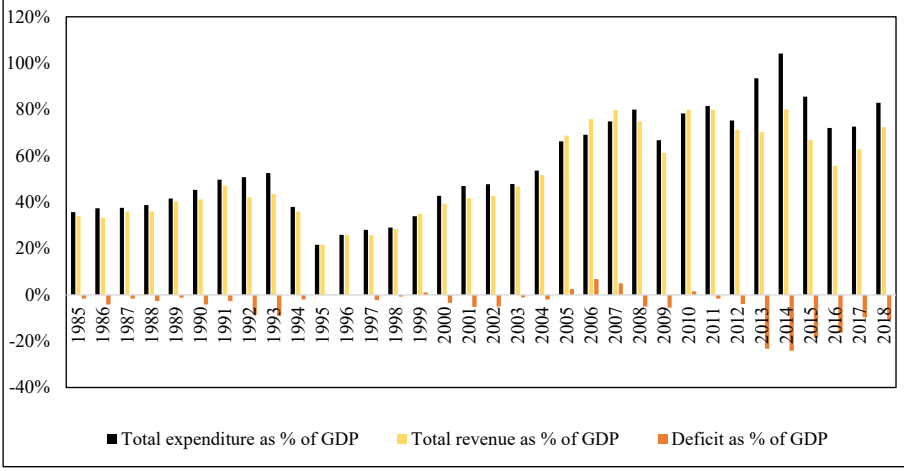
2. Background to Study

2.1 Macroeconomic setting

PNG's fiscal landscape is characterised mostly by deficit budgets. Starting 2013, the deficit levels were amplified by unprecedented expansionary fiscal policy. The higher deficits starting in 2013 were mostly a result of lower than budgeted revenues and higher expenditures driven by overspending in some key expenditure category (Figure 3). In the early 1980s to 2000, commitments to development agendas especially investments in public infrastructures took the centre stage in the policies of the successive governments, which led to a steady increase in expenditure. From 2005 to 2007, small surpluses were recorded that were attributed to the high international commodity prices during that period. Instead of fiscal consolidations, these surpluses were reallocated in the supplementary budgets. The following years that had supplementary budgets reflected reappropriation of expenditure due to lower than anticipated revenue collections. The construction of the PNG LNG Project in 2009 saw an influx of foreign exchange, which led to a build-up in foreign exchange reserves at the Central Bank. In line with this increase in revenue, expenditure increased slightly giving rise to a smaller deficit. However, in the subsequent years, from 2013 to 2018, expenditure increased significantly as the then government pursued expansionary[2] fiscal policies. As a result, the ratio of government expenditure-to-GDP rose from about 35.7 percent in 1985/1986 to around 82.9 percent [3]in 2017/2018, and the ratio of revenue-to-GDP from 34.1 percent to 72.4 percent during this period, which implied a financing gap.

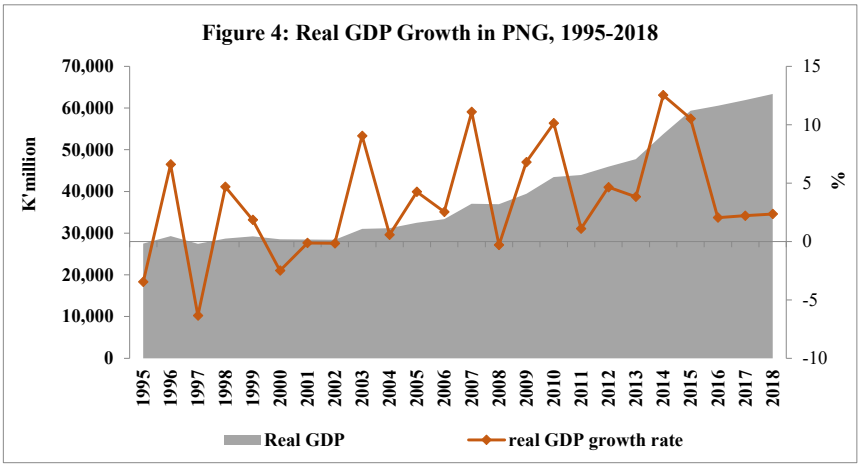
[2] It borrowed heavily in anticipation of the future revenue streams expected from the PNG LNG project.
[3] GDP figures are sourced from World Bank in these calculations.

Figure 3: Government Revenue and Expenditure as % of GDP

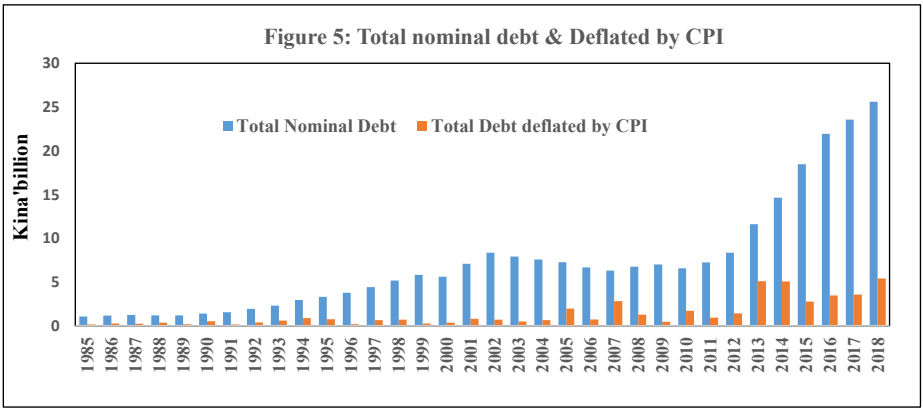


PNG experienced years of sustained economic growth from early 2000s to 2014 (Figure 4). Between 2003 and 2008, growth was largely driven by high international commodity prices, which subsided after the Global Financial Crisis (GFC) in 2008. The GFC did little to dampen growth, as the economy recovered on the back of the construction phase of the PNG LNG project immediately in 2009. In 2014, GDP growth reached an unprecedented high of around 14.0 percent. However, government revenue[4] collection remained lower than expenditure, which reflected factors such as poor tax administration that exacerbated non-compliance issues, tax holidays given to large companies in the extractive sector and the provisions under PNG LNG Project Development Agreements (PDAs) to keep export proceeds offshore for settling of its liabilities. With a decline in international oil and gas prices, export revenue declined, resulting in a higher fiscal deficit in 2014 and the subsequent years.

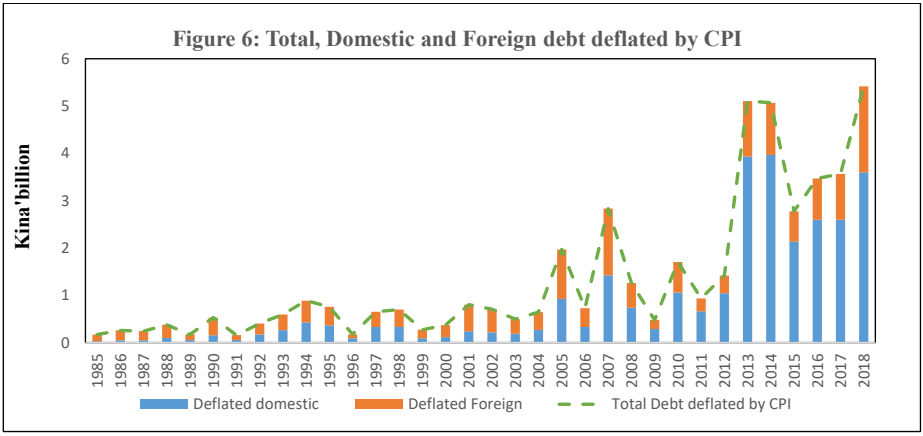
[4] This was mainly attributable to provisions under the LNG Project Development Agreements (PDAs) to keep export proceeds offshore.



The years of sustained economic growth was accompanied by persistent budget deficits that had increased the country's total public debt level. Between mid-1980s and early 1990s PNG's nominal public debt increased steadily. In the late 1990s, nominal public debt began to rise quickly because of excessive borrowing to fund the deficits (Figure 5). The debt levels resurged after 2000 – as the demands for a growing economy increased and peaked in 2002, before slowing down until 2010. Thereafter, the level of debt has grown at a higher rate over the last decade.

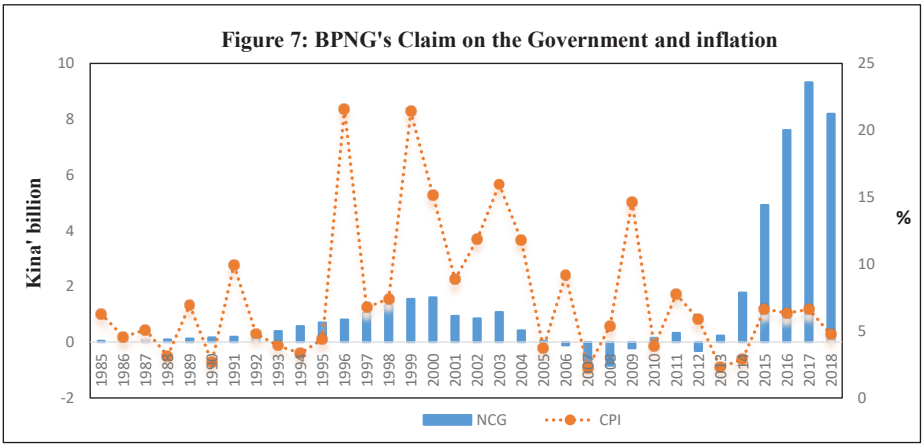


The price level was fairly stable[5] during 1980s and so real debt grew in tandem with nominal debt. However, after 1990 nominal debt increased substantially, but the fluctuations in total real debt were considerably smaller (Figure 6). From 1985 to 2003, real foreign debt fluctuated mildly peaking at election periods. While in the first half of 1990s a large proportion of this domestic finance was provided by the central bank. After 2004, the fluctuations became relatively larger with spikes in 2005 and 2007 before surging in 2013. During these periods, the increase in real total debt reflected heavy reliance on domestic financing.

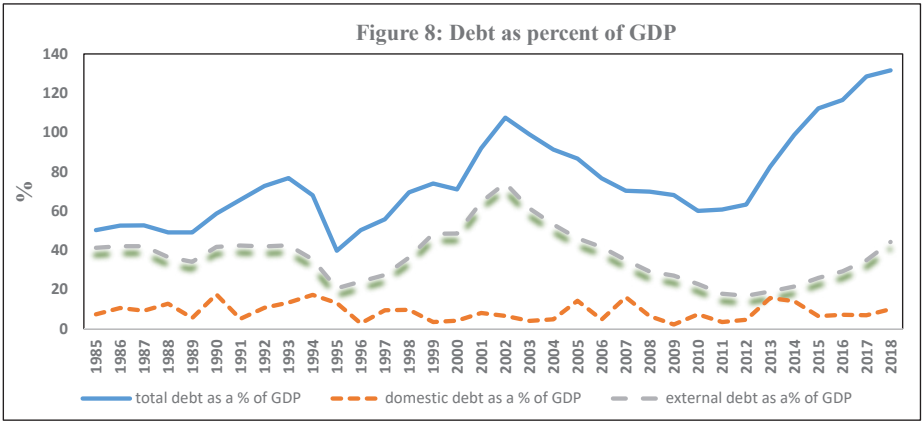


From the mid to late 1990s, there was continuous borrowing from the Central Bank. While the weakening of the national currency (kina) after it was floated in 1994 may have helped explain inflation trends during that period, the consequences of government borrowing were also evident in the inflation outcomes (Figure 7). After the Central Bank Act of 2000[6], which placed statutory limits on government borrowing from the Central Bank, domestic debt has been financed largely by the financial institutions through the issuance of government securities. Inflation was relatively stable, despite the persistent fiscal deficits and growing debt levels with inflation last peaking at 14.7 percent in 2009.

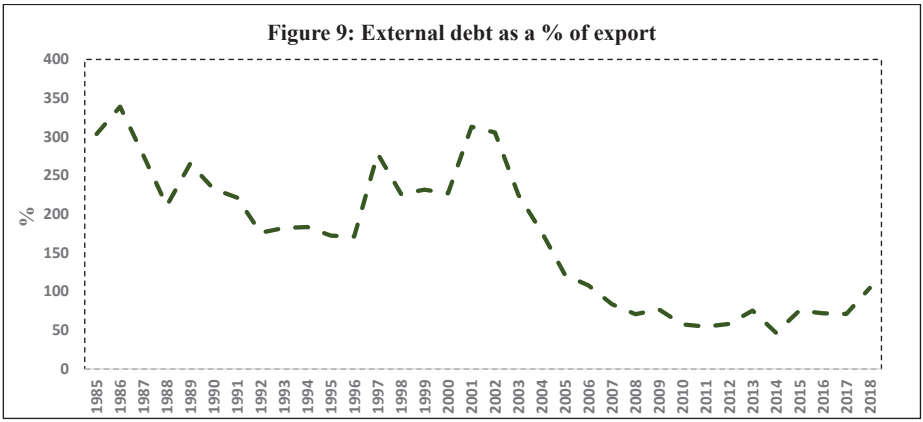
[5] A fixed exchange rate regime a major factor for price stability during that period.
[6] In tandem with a structural adjustment programme in which assets were sold and debts were repaid.



Total debt as a percentage of GDP has increased over the last decade (Figure 8). Public debt grew at a much faster rate than GDP, posing serious policy concerns particularly the trade-off between debt servicing and service delivery, and the subsequent rise in interest rates. The burden of servicing the debt meant less funding available for delivery of basic services and infrastructure developments.



In the late 2000s, the Government's expenditure did not induce growth in exports (Figure 9). However, even with good export growth strategies international commodity prices will continue to dictate movements in the exchange rate, thus causing uncertainty in the repayment of foreign currency denominated loans. Given these arguments, some countries have developed fiscal rules guiding their composition of domestic and external debt.



Since 2006, external debt as a percentage of export earnings has remained relatively stable at around 50.0 percent, unlike previous years, which were higher and more volatile. This could suggest that the level of external debt appears to be much more sustainable than in 2000, and the increase in debt since 2014 does not seem to have changed this ratio much.

2.2 Fiscal policy framework

PNG's fiscal policy framework consists of a number of targets and principles that are primarily intended to ensure the long-term sustainability and transparency of fiscal policy. Some parts of the framework are regulated by legislation, while others are a result of practices that have evolved over the years. Typically, the fiscal policy framework includes either a net borrowing or a net lending target for the government. These targets are supported by debt anchors for the general government consolidated gross debt. The framework also includes an expenditure ceiling[7]. The budgetary targets, the fiscal balance target, the debt anchor and the expenditure ceiling, make up the core of the fiscal policy framework along with a stringent central government budget process, external monitoring and transparency. Following the balance of payments crisis in the late 1990s, PNG has undertaken structural reforms to stabilize the economy. On the fiscal front, the Government attempted some fiscal consolidations, guided by two medium-term fiscal strategies (MTFS). The 2002–2007 MTFS set the target for a balanced budget, which was achieved in 2004. The 2008–2012 MTFS added rules to mitigate fiscal impacts of resource revenue volatility by imposing a ceiling of 8.0 percent of GDP on the non-resource budget deficits. Under these two policies, there were some successes in fiscal consolidation[8] efforts. A reasonable macroeconomic goal for fiscal policy is to lower the debt-to-GDP

[7] This excludes interest on the central government debt.
[8] Government debt was brought down from 70.4 per cent of GDP in 2002 to 22.3 per cent of GDP in 2011.

[9]ratio. In order to achieve this, borrowing has to be reduced, implying greater efforts to improve tax collection and restraints on expenditure, complimented by effective spending for growth. PNG's Fiscal Responsibility Act (FRA) 2006 legislated the debt limit to 30.0 percent of GDP. The Act was amended in 2019 increasing the limit to 45.0 percent.

3. Literature Review

The literature on budget deficits is extensive with studies done in both emerging and developing economies. The relationship between budget deficits interest rates, GDP growth, current account balance, exchange rates and inflation can be described by the neoclassical, Keynesian and Ricardian theories. The neoclassical model assumes that budget deficits will raise current expenditure; and for the case of a closed economy under full employment, increased expenditure will lead to high interest rates, reduced national savings and future investments. While for a small open economy, the increased expenditure will have no effect on interest rates, albeit lead to increased foreign borrowing resulting in the appreciation of the local currency (Mankiw and Ball 1995). The Keynesian theory states that an increase in government spending leads to an increase in aggregate demand, leading to employment of redundant resources, which translates to increase in output (Berheim 1989). This implies that budget deficits should not have a negative effect on economic growth; instead, it is applied to stimulate economic demand and activity. On the other hand, the Ricardian view is that budget deficits have no effect on growth and development: deficits lead to increase in government debt with future taxes and present value equal to the value of the debt (Seater, 1993 and Berheim, 1989).

A large part of the literature shows that budget deficits are inflationary. Catao and Terrones (2005) found a strong link between deficits and inflation when analyzing a sample of 107 industrialized countries over the years 1960 to 2001. McMillin (1986) also found similar evidence that budget deficits lead to inflation. Similarly, for South East Asia, studies[10] show that fiscal deficits, including money supply, are positively correlated with inflation (Nguyen 2014). Studies on sub-Sahara African countries show similar findings: Wire and Nampewo (2014) found a positive long-run relationship between budget deficits and inflation in Uganda. In Nigeria, studies showed the country's fiscal expenditure to be overinflated and largely unproductive (Edame and Okoi, 2015). There are contrasting findings when examining budget deficits and interest rates. Evans (1985) and Barro (1987) found no causal relationship between budget deficits and interest rates in the US. However, Hoelscher (1986) and Cebula and Koch (1989) found that budget deficits contribute to higher interest rates. For budget

[9] The Debt-to-GDP ratio is an indicator broadly accepted as showing a country's ability to repay its public debt.

[10]The study covered Bangladesh, Cambodia, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam in the period of 1985-2012 using Panel data.

deficits and exchange rates, Sachs (1985) and later Krugman (1995) argued that lower budget deficits depreciates the value of a currency, while Evans (1986) argued that a lower deficit may lead to an appreciation in the short run. Evans (1987) further argued that if budget deficits affect aggregate demand, this might lead to inflation causing the domestic currency to depreciate. However, this depends on the exchange rate regime under which the economies operate (Turnovsky and Wohar 1987). Studies have shown that budget deficits contribute to money supply, and inflation, crowding out private sector credit (example, Allen and Smith 1983). While in Zambia, the lack of policy coordination between fiscal and monetary policy negatively affects macroeconomic outcomes, with the former the dominating policy (Patrick and Longa, 2014).

In the region, a study on Pacific Island Countries (PICs) by Gani (1997) showed that budget deficits exert negative effects on economic growth, compared to other macroeconomic policy variables. In contrast, Jarayama and Lau (2008) found a causal relationship running from budget deficits to exports and in turn output; and a short run bi-directional causal relationship between economic growth and external debt. While studies on fiscal deficits are numerous for PICs economies, there is limited literature with specific reference to PNG. What has been the impact of budget deficits on the major macroeconomic indicators? In particular, what has the influence been on inflation, money supply, exchange rates, interest rates and GDP growth? This study attempts to fill this gap in the literature. Essentially, we ask if the Government's budget deficits has had the desired outcome or effect on the economy with respect to the indicators tested as well as its long-term sustainability and policy implications.

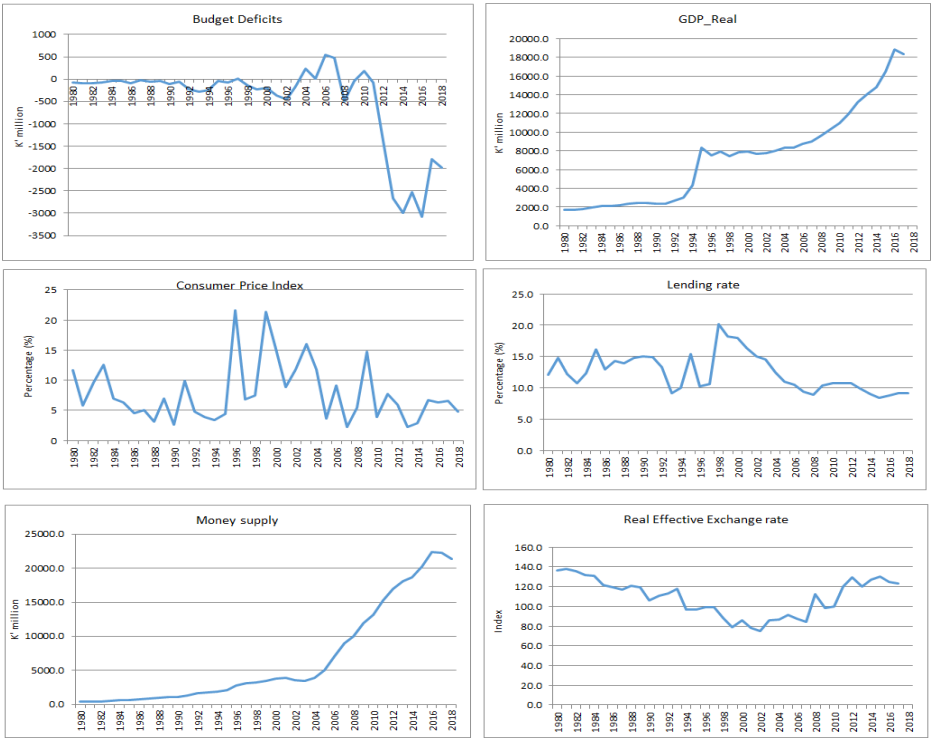
4. Empirical Analysis

We employ a Vector Error Correction model (VECM) and Structural Vector Autoregressive (VAR) model in this paper, while examining the macroeconomic impact of budget deficits on PNG's economy. The results generated from these models are well suited and useful in addressing the policy questions framed, where we discuss each in turn.

4.1 Data and methodology

The paper uses six variables: fiscal balance, broad money supply, real effective exchange rates, real GDP growth rates, inflation and lending rates based on annual data series for sample periods 1980 – 2018 (Figure 1). Data are converted to natural log form, except for inflation and lending rates in the analysis. All data sourced from various publications of the Bank of PNG's, *Quarterly Economic Bulletin*.

Figure 1: Time Series graphs of level variables



4.2 Model diagnostics and specifications

The unit root tests are performed on the variables using the Augumented Dickey-fuller test based on Mackinon one-sided p-values (Table 3). Results show all variables to be non-stationary at levels, except for budget deficit, which is stationary at the 10.0 percent level of significance. Transforming the variables into first difference makes the variables stationary indicating the variables to be difference stationary and integrated of order one I(1).

Table 3: Augment Dickey- Fuller unit root test

Variables	With constant		With constant and trend		With no constant or trend	
	Levels	First difference	Levels	First difference	Levels	First difference
Budget deficit	-1.0724	-5.5264***	-3.8261**	-2.0902	-0.6639	-5.5377***
Money supply	-0.5817	-2.2328	-2.6277	-3.5743*	-0.0921	-1.8898*
Real exchange rate	-1.7617	-2.1718	-3.1451	-1.9358	-0.9221	-6.5093***
Real GDP	1.3881	-5.1527***	-1.2070	-5.5023**	3.5141	-4.2255***
Consumer price index	-1.9726	-9.0008***	-1.9539	-8.8662***	-0.9529	-9.1249***
Lending rates	-1.7617	-6.7028***	-2.6164	-6.6765***	-0.5683	-3.7004***

Notes: *Indicates significance at the 10.0%; ** significant at the 5.0%; *** significant at the 1.0% percent

Table 4: VAR Lag order selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-301.3098	NA	1.704699	17.56056	17.82719	17.65260
1	-122.5162	286.0697	0.000504	9.400924	11.26734*	10.04521
2	-89.46696	41.54757	0.000722	9.569541	13.03574	10.76607
3	-29.85041	54.50656*	0.000328*	8.220024*	13.28601	9.968803*

Note: * indicates lag order selected by the criterion; LR: Sequential modified LR test statistics (each test at 5% level); FPE: Final Prediction Error; AIC: Akaike Information Criterion; SC: Schwarz Information Criterion; HQ: Hannan-Quinn Information Criterion

From the VAR lag length selection criterion (Table 4), the LR, FPE, AIC and HQ selection 3 lags as the optimal number of lags to be used in the lag order. While we are mindful of the need to have precision estimates in our model selection, a more parsimonious model is desirable and useful in explaining our target variable – budget deficits. Hence, in our estimation process we move from 3 to 1 lag as our preferred lag order, given the lack of statistically significant coefficient estimates in lags 2 and 3.

Table 5: Johansen Test for Cointegration

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of (CEs)	Eigenvalue	Trace Statistics	0.05 critical values	Prob **
None*	0.645266	91.82039	83.93712	0.0119
At most 1	0.444125	54.51042	60.06141	0.1347
At most 2	0.407589	33.37078	40.17493	0.2042
At most 3	0.218222	14.52279	24.27596	0.4939
At most 4	0.111836	5.660141	12.32090	0.4787
At most 5	0.037890	1.390569	4.129906	0.2789

Note: Trace test indicates 1 cointegrating eqn(s) at the 0.01 level; *denotes rejection of the hypotheses at the 0.05 level;** MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of (CEs)	Eigenvalue	Max-Eigen Statistics	0.05 critical values	Prob **
None*	0.645266	37.30996	36.63019	0.0146
At most 1	0.444125	21.13965	30.43961	0.4461
At most 2	0.407589	18.84798	24.15921	0.2227
At most 3	0.218222	8.862653	17.79730	0.6098
At most 4	0.111836	4.269572	11.22480	0.5859
At most 5	0.037890	1.390569	4.129906	0.2789

Note: Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.01 level; *denotes rejection of the hypotheses at the 0.05 level; ** MacKinnon-Haug-Michelis (1999) p-values

The Johansen test for cointegration indicates one cointegrating equation for both the Trace test and the Maximum-eigenvalue test statistics in our system at the 5.0 percent level of significance. This indicates that there is some long-run equilibrium relationship tying the variables together, represented by some linear combination of them. Ignoring this aspect in our time series data may lead to spurious regression problems if non-stationary series are arbitrarily regressed against each other. Hence, we can model this relationship using a Vector Error Correction model (VECM).

In our empirical approach, we estimate the VAR model specification according to the following for our innovation accounting; i.e., impulse responses, variance decompositions and historical decompositions:

$$LBD = \delta_0 + \sum_{j=1}^{k} \delta_{1j} LBD_{t-j} + \sum_{j=1}^{k} \delta_{2j} LMS_{t-j} + \sum_{j=1}^{k} \delta_{3j} LREER_{t-j} + \sum_{j=1}^{k} \delta_{4j} LRGDP_{t-j} + \sum_{j=1}^{k} \delta_{5j} CPI_{t-j} + \sum_{j=1}^{k} \delta_{6j} RATE_{t-j} + \varepsilon_{1t}$$

We estimate the Vector Error Correction model for all endogenous variables in the VAR system in order to carrying out our causality tests over the short and long run components of the model, with the estimation according to the following:

$$\Delta LBD_t = \sum_{j=1}^{k} \delta_{1j} \Delta LBD_{t-j} + \sum_{j=1}^{k} \delta_{2j} \Delta LMS_{t-j} + \sum_{j=1}^{k} \delta_{3j} \Delta LREER_{t-j} + \sum_{j=1}^{k} \delta_{4j} \Delta LRGDP_{t-j}$$
$$+ \sum_{j=1}^{k} \delta_{5j} \Delta CPI_{t-j} + \sum_{j=1}^{k} \delta_{6j} \Delta RATE_{t-j} + \delta_7 C_t + \vartheta_1 LBD_{t-j} + \vartheta_2 LMS_{t-j}$$
$$+ \vartheta_3 LREER_{t-j} + \vartheta_4 LRGDP_{t-j} + \vartheta_5 CPI_{t-j} + \vartheta_6 RATE_{t-j} + u_{1t}$$

The relevant diagnostic tests such as the residual tests for serial correlation using the autocorrelation plots (Appendix 3) indicate no autocorrelation observed in the residuals where residuals are uncorrelated with any of its past values, while the residual plots (Appendix 5) show residuals to be zero-mean reverting and normally distributed (Appendices 4 & 6). The Breush-Pagan test (Appendix 7) for Heteroskedasticity indicates no Heteroskedasticity in the residuals i.e., the variance of the residuals are constant over the observations. For stability of our budget deficit model the CUSUM and CUSUM squared test are performed where the results (Appendix 8 & 9) indicate relative stability of our regression model at the 5.0 percent level of significance. Hence, we can conclude that the cointegrating vector that links budget deficit and the variables in our model is stable.

5. Results and discussions

From the VAR model, we use the results generated from the Factor Error Variance Decomposition (FEVD) and Historical decompositions, while the VECM give us the granger causality tests for the short and long-run relationships between budget deficits and the variables of interest. We first start with interpretation of our results generated from the VECM model.

5.1 Granger Causality tests

The Granger causality test is a statistical hypothesis test for determining whether one variable is useful in forecasting or explaining movements in another (Granger 1969). In this analysis, the Granger Test for causality is used to determine the direction of causality between budget deficits and the other variables in the model. A time series of budget deficits is said to Granger cause the other variables in the model if it can be shown, usually through a series of t-test and F-tests on lagged values of budget deficits (and with lagged values for the other variables of interest), that the values of budget deficits provide statistically significant information about the future value of these other variables.

Table 6: Granger Causality using VECM

Error correction:	D(LBUD_DEF)	D(LMS)	D(LREER)	D(LRGDP)	D(PRICE)	D(RATE)
CointEq1	-0.336286	0.013039	0.007281	0.009493	0.620984	-0.02349
	(0.18370)	(0.00357)	(0.00479)	(0.00632)	(0.18797)	(0.13872)
	[-1.83065]*	[3.65448]***	[1.51905]	[1.50252]	[3.30359]***	[-0.14669]
D(LBUD_DEF(-1))	-0.081168	0.002523	0.002155	-0.013589	-0.833859	-0.018761
	(0.17310)	(0.00336)	(0.00452)	(0.00595)	(0.17712)	(00.13072)
	[-0.46892]	[0.75034]	[0.47717]	[-2.28252]***	[-4.70775]***	[-0.14353]
D(LMS(-1))	8.473485	0.284393	-0.262257	-0.193942	-32.88427	-0.771289
	(7.80188)	(0.15154)	(0.20357)	(0.26834)	(7.98345)	(5.89179)
	[1.08608]	[1.87671]*	[-1.28830]	[-0.72275]	[-4.11905]***	[-0.13091]
D(LREER)(-1))	-1.051853	0.303883	-0.155741	-0.542965	-3.74213	-4.283717
	(7.45347)	(0.14477)	(0.19448)	(0.25636)	(7.62693)	(5.62868)
	[-0.14112]	[2.09907]**	[-0.80082]	[-2.11801]**	[-0.49040]	[-0.76105]
D(LRGDP(-1))	2.683552	0.149913	-0.029565	0.372336	13.26574	0.134464
	(4.70995)	(0.09148)	(0.12289)	(0.16199)	(4.81957)	(3.55684)
	[0.56976]	[1.63871]	[-0.24057]	[2.29844]**	[2.75248]***	[0.0.3780]
D(PRICE(-1))	0.162704	0.009150	0.003656	0.003138	-0.173493	-0.113045
	(0.13261)	(0.00258)	(0.00346)	(0.00456)	(0.13570)	(0.10014)
	[1.22693]	[3.55225]***	[1.05652]	[0.68804]	[-1.27854]	[-1.12883]
D(RATE(-1))	0.027999	0.005180	-0.007582	-0.0.24107	0.30529	-0.269564
	(0.27475)	(0.00534)	(0.00717)	(0.00945)	(0.28115)	(0.20749)

	[0.10191]	[0.97070]	[-1.05769]	[-2.55101]**	[1.08590]	[-1.29919]

Note: * indicate 10.0% level of significance; ** indicates 5.0% level of significance *** indicates 1.0% level of significance (Standard Error) [t-statistics]

Table 6 displays the results of Granger Causality test using VECM. In the short run, a unidirectional causal relationship is observed between budget deficits and inflation at the 1.0 percent level of significance, running from budget deficits to prices. Budget deficits lead to increase in prices in the case of PNG, and it is consistent with many other literatures that persistent budget deficits often lead to inflationary pressures (example, Fischer *et al*., 2002; Catão and Terrones, 2003). The results also show a unidirectional causal relationship between budget deficits and real GDP in the short run at the 1.0 percent level of significance, running from budget deficits to real GDP. This suggests that sustained budget deficits have impact on economic growth in PNG. We also note a unidirectional causal relationship between money supply and inflation at the 1.0 percent level of significance, running from money supply to prices. We note also a short-run unidirectional causal relationship at the 5.0 percent level of significance between money supply and real exchange rates running from real exchange rate to money supply. We note a unidirectional causal relationship at the 1.0 percent level of significance between inflation and real GDP, running from GDP to prices, which suggest demand side pressures on inflation. The error correction term for the budget deficit is -0.33 and is statistically significant, which implies that 33.0 percent of the deviation from the long-run equilibrium is corrected in every period. This confirms that there is a statistically significant long-run cointegrating relationship between budget deficits and the macroeconomic variables of interest.

5.2 Pairwise Granger causality test

Table 7: Pairwise Granger Causality test results

Sample: 1980 – 2018				
Lags:1	Obs.	F-Statistics	Prob.	Results
Null Hypothesis:				
LMS does not Granger Cause LBUD_DEF	38	0.37242	0.5456	Accept
LBUD_DEF does not Granger Cause LMS		11.7331	0.0016	Reject
LREER does not Granger Cause LBUD_DEF	38	2.11774	0.1545	Accept
LBUD_DEF does not Granger Cause LREER		3.04355	0.0898	Accept
LRGDP does not Granger Cause LBUD_DEF	37	0.00641	0.9366	Accept
LBUD_DEF does not Granger Cause LRGDP		0.80326	0.3764	Accept

PRICE does not Granger Cause LBUD_DEF	38	9.63073	0.0038	Reject
LBUD_DEF does not Granger Cause PRICE		0.69192	0.4112	Accept
RATE does not Granger Cause LBUD_DEF	38	0.00838	0.9276	Accept
LBUD_DEF does not Granger Cause RATE		0.21188	0.6481	Accept
LREER does not Granger Cause LMS	38	0.38983	0.5364	Accept
LMS does not Granger Cause LREER		0.00757	0.9312	Accept
LRGDP does not Granger Cause LMS	37	0.05842	0.8105	Accept
LMS does not Granger Cause LRGDP		3.60723	0.0660	Accept
PRICE does not Granger Cause LMS	38	0.07361	0.7877	Accept
LMS does not Granger Cause PRICE		0.12126	0.7298	Accept
RATE does not Granger Cause LMS	38	0.41163	0.5253	Accept
LMS does not Granger Cause RATE		2.97359	0.0935	Accept
LRGDP does not Granger Cause LREER	37	0.05842	0.7877	Accept
LREER does not Granger Cause LRGDP		3.60723	0.7298	Accept
PRICE does not Granger Cause LREER	38	0.45326	0.5052	Accept
LREER does not Granger Cause PRICE		5.37755	0.0264	Reject
RATE does not Granger Cause LREER	38	0.45262	0.5055	Accept
LREER does not Granger Cause Rate		0.06717	0.7970	Accept
PRICE does not Granger Cause LRGDP	37	1.62398	0.0196	Reject
LRGDP does not Granger Cause PRICE		0.50592	0.4818	Accept
RATE does not Granger Cause LRGDP	37	5.99746	0.0196	Reject
LRGDP does not Granger Cause RATE		1.42791	0.2404	Accept
RATE does not Granger Cause PRICE	37	11.4891	0.0017	Reject
PRICE does not Granger Cause RATE		0.23713	0.6293	Accept

From the pairwise granger causality test in Table 7, results show a unidirectional causal relationship running from budget deficits to money supply, which implies that budget deficits granger cause money supply in PNG. However, the link from money supply to inflation is absent in that money supply does not granger cause inflation. On the other hand, our results show a unidirectional causal relationship running from prices to budget deficits in that prices granger cause budget deficits. Our results also show unidirectional causal relationship between budget deficits and real exchange rate, running from budget deficits to real exchange rate. However, the results do not show any causal relationships between budget deficits and economic growth and between budget deficits and lending rates, hence they are statistically independent from each other.

5.3 Variance decomposition

In our estimated VAR model, the Forecast error variance decomposition is used in uncovering the interrelationships amongst the variables in the system. The variance decomposition tells us the proportion of the movements in a sequence due to its own shocks versus shocks to the other

variables. The Variance decomposition also enables us to determine how much of the variability in the variable is lagged by its own variance. It also shows us which of the variables is "stronger" in explaining the variability in the other variables in the system over time. The variance decomposition shows how much of the future uncertainty of one variable is due to future shocks into the other variables in the system, which evolves over time, so the shocks may be not very important in the short- run but very important in the long run. The variance decomposition indicates the amount of information each variable contributes to the other variables in the autoregressive process. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. In this analysis, we are particularly interested in budget deficits contributions in explaining the variation in the other variables.

Table 1: Variance decomposition of budget deficits

Period	S.E	lbud_def	lms	Lreer	lrgdp	price	rate
1	3.152	100.000	0.000	0.000	0.000	0.000	0.000
2	4.175	76.181	0.084	0.008	7.024	14.399	2.301
3	4.416	69.810	0.775	0.010	6.594	17.415	5.392
4	4.807	63.670	2.702	0.925	5.592	16.025	11.082
5	5.176	59.171	3.492	0.957	5.468	16.762	14.147
6	5.465	55.990	4.235	0.915	5.059	17.475	16.322
7	5.755	53.466	4.989	0.988	4.670	17.574	18.310
8	6.037	51.325	5.523	1.015	4.447	17.817	19.871
9	6.300	49.534	5.971	1.018	4.237	18.075	21.163
10	6.553	48.031	6.375	1.035	4.042	18.231	22.283

Results in Table 1 indicate that after period 2, price pressures explain about 14.0 percent of the variations in budget deficits. Price pressures are persistent over the forecast horizon in explaining variations in budget deficits, and points to the fact that price increases drives up the cost of living and general Government expenses, with a subsequent increase in the need to finance these expenses. Real GDP growth explains about 7.0 percent in the variations in budget deficits, so as the economy grows this has implications on Government's ability to finance budget deficits. Lending rates explain about 2.3 percent in period 2, then increases thereafter over the sample period, suggesting concerns for crowding-out effect on the private sector.

Table 2: Variance decomposition of money supply

Period	S.E	lbud_def	lms	Lreer	lrgdp	price	rate
1	0.070	20.758	79.241	0.000	0.000	0.000	0.000
2	0.143	25.437	64.007	2.025	3.999	0.121	4.408
3	0.204	27.006	58.870	1.220	6.681	0.701	6.148

4	0.254	27.072	57.863	0.874	7.451	0.065	6.671
5	0.297	26.792	57.563	0.731	8.060	0.073	6.778
6	0.335	26.586	57.248	0.631	8.640	0.070	6.822
7	0.369	26.493	57.027	0.558	9.003	0.066	6.849
8	0.400	26.424	56.902	0.509	9.229	0.065	6.867
9	0.429	26.360	56.804	0.474	9.413	0.065	6.882
10	0.456	26.314	56.723	0.446	9.559	0.064	6.892

Results in Table 2 indicate that over 20.0 percent in the variation in money supply is explained by budget deficits in period 1. Over 9.0 percent in the variation is explained by real GDP, while over 6.0 percent in the variation is explained by lending rates. Budget deficits have the largest contribution in explaining changes in money supply in PNG, as financing requirements lead to an expansion in money supply.

Table 3: Variance decomposition of real exchange rate

Period	S.E	lbud_def	lms	Lreer	lrgdp	price	rate
1	0.089	9.214	2.153	88.631	0.000	0.000	0.000
2	0.119	5.607	1.374	91.005	1.603	0.315	0.094
3	0.140	4.307	1.228	92.168	1.366	0.307	0.622
4	0.159	3.412	1.242	93.090	1.143	0.302	0.800
5	0.176	2.865	1.261	93.783	1.011	0.269	0.808
6	0.191	2.470	1.255	94.189	0.975	0.256	0.852
7	0.206	2.195	1.246	94.476	0.943	0.257	0.879
8	0.219	1.985	1.247	94.719	0.899	0.250	0.896
9	0.232	1.814	1.247	94.906	0.873	0.244	0.913
10	0.244	1.678	1.245	95.052	0.854	0.241	0.926

In the variance decomposition in exchange rate movements shown in Table 3, budget deficits explain over 9.0 percent of the variation in the exchange rate movements in period 1 – the impact is almost immediate on the exchange rate before easing-off over the forecast horizon - while money supply explains over 2.0 percent of the variation. These suggest that a lot of government financing and therefore spending induce import demand.

Table 4: Variance decomposition of real GDP

Period	S.E	lbud_def	lms	Lreer	lrgdp	price	rate
1	0.119	1.029	9.003	2.488	87.478	0.00	0.000
2	0.199	3.623	5.649	7.854	76.974	0.000	5.898
3	0.266	5.665	4.225	8.346	74.163	0.325	7.568
4	0.320	5.796	3.475	8.939	73.076	0.127	8.404
5	0.363	6.097	3.178	9.299	72.400	0.143	8.880
6	0.402	6.246	3.004	9.414	72.078	0.147	9.108

7	0.438	6.325	2.866	9.521	71.861	0.156	9.268
8	0.471	6.378	2.769	9.613	71.678	0.162	9.397
9	0.502	6.425	2.698	9.671	71.546	0.165	9.491
10	0.531	6.416	2.640	9.718	71.445	0.169	9.564

In Table 4, budget deficits explain just over 1.0 percent of the variation in real GDP growth in period 1, then increases to around 6.0 percent over the forecast period, which suggests that there is some element of growth in the economy with respect to budget deficits. Lending rates explain over 9.0 percent of variations in real GDP over the forecast horizon, suggesting a less elastic relationship between interest rates and credit and investments in the immediate period, but it does affect credit, investments and hence growth in the forecast horizon. Money supply explains over 9.0 percent of the variation in period 1, while exchange rates explain over 9.0 percent in average over the forecast horizon.

Table 5: Variance decomposition of price

Period	S.E	lbud_def	lms	Lreer	lrgdp	price	rate
1	3.702	1.340	0.496	1.075	1.220	93.399	0.000
2	5.394	13.014	1.484	2.327	0.750	51.394	9.920
3	5.910	11.534	3.044	9.696	0.850	45.198	8.944
4	6.371	10.890	2.789	9.181	0.959	49.542	8.975
5	6.883	11.579	2.798	8.733	0.907	48.676	9.518
6	7.291	11.421	3.096	9.749	0.780	47.483	9.573
7	7.662	11.332	3.148	10.037	0.702	47.936	9.727
8	8.035	11.422	3.182	10.082	0.654	47.991	9.893
9	8.387	11.424	3.263	10.322	0.600	47.788	9.998
10	8.720	11.411	3.315	10.506	0.558	47.792	10.079

In Table 5, budget deficits explain over 13.0 percent of the variation in prices in period 2, then averages 11.0 percent over forecast horizon. The effect on prices suggests that budget deficits often lead to build-up in inflationary pressures. The real exchange rate explains over 10.0 percent in the changes in prices after period 7 indicating the level of exchange rate pass-through to inflation, while lending rates and money supply explain around 9.0 percent and 3.0 percent of the variation, respectively.

Table 6: Variance decomposition of lending rate

Period	S.E	lbud_def	lms	Lreer	lrgdp	price	rate
1	2.533	7.059	0.548	11.192	1.220	0.003	79.975
2	3.285	11.996	0.857	17.908	0.750	0.315	68.171
3	3.722	15.977	1.527	17.520	0.850	0.538	63.586
4	4.195	19.582	1.495	17.238	0.959	0.433	60.290
5	4.610	20.949	1.375	18.520	0.907	0.389	57.856

6	4.970	21.985	1.398	18.909	0.780	0.338	56.586
7	5.314	23.020	1.409	18.940	0.702	0.300	55.626
8	5.638	23.719	1.388	19.190	0.654	0.266	54.779
9	5.942	24.251	1.382	19.834	0.600	0.240	54.139
10	6.232	27.725	1.381	19.484	0.558	0.219	53.630

In Table 6, budget deficits explain over 20.0 percent in the variation in lending rates over the forecast horizon, while real exchange rates explain around 20.0 percent in the variation in lending rates. Money supply explains over 1.0 percent in the variation. The impact of budget deficits on lending rates may suggest some crowing-out effect as government competes with firms for domestic banking system liquidity. The variance decomposition results in tables 1-6 are presented graphical in Figure 4 below.

Figure 4: Variance decomposition plots

5.4 Historical decomposition

Figure 5: Historical Decomposition plots

Using the historical decomposition results as depicted in Figure 5, we analyze the individual contributions of each structural shock to the movements in the variables in the system over the sample period. Each graph plots the de-trended data series and the contribution to that series due to each shock. The historical decomposition is a much more useful decomposition than the FEVD, since it shows what is driving each individual variable over time (Beveridge and Nelson 1981). In the decomposition of budget deficits (top left panel), real exchanges (dark green line) and inflation shocks (light green line) are most notable, in driving the movements in budget deficit. These suggest that the cost factors of meeting both domestic and external debt obligations largely explain movements in budget deficits. It is worth noting that the budget deficit shock is still the most important factor driving budget deficits, which would suggest that fiscal policy is set independently of other economic forces. For the historical decomposition of money supply (top right panel), budget deficit shocks explain a large part of the movement (indicated by the blue line). This is consistent with our prior expectations of factors that make-up money supply. In the real exchange rate movements (middle left panel), budget deficits shocks are visible in parts-in that budget deficits shocks explain some of the movements in the real exchange rate. In the historical decomposition of real output (middle right panel), real exchange rate shocks are significant in explain its movements, similarly for inflation and lending rates (bottom panels).

6. Conclusion

The paper examines the impact of budget deficits in PNG on selected macroeconomic variables using the VECM and VAR models, for the sample periods 1980-2018. For fiscal policy considerations, budget deficits aimed at stimulating economic growth are negligible, which suggest that overall government spending remains sluggish. Excess investment by the government may bring about a negative effect on the economy, due to government investment crowding-in from the monopoly of government activities that causes the allocation of resources to be not fully utilized. The growth motivations are further constrained when lending rates increase in response to deficits. Budget deficits remain unsustainable and less effective as suggested by recent rise in debt levels and low growth. Gradual fiscal consolidation and effective government spending may be pursued in the short to medium term to rein in rising debt levels and assist with sustainable macroeconomic policies.

For the Monetary Authority, the ability to influence money supply, lending rates and inflation remains a challenge in the presence of persistent budget deficits – given elements of fiscal dominance. The pass-through to inflation is observed directly and via its impact on money supply and exchange rates. The price increases feeds back into budget deficit financing through rise in cost of government operations, particularly debt servicing and recurrent spending, suggesting wage-price spiral. Further work can be undertaken integrating commodity cycles using a fiscal and monetary

policy mix setting. It would also be useful to look at other key variables such as international commodity prices, employment and the evolution of interest rate spreads in PNG, and how government revenues and expenditures respond to these changes.

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Appendix

Appendix 1: VEC Residual Serial Correlation LM tests

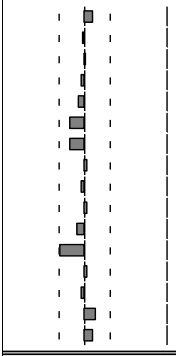
Sample: 1980 - 2018						
Included observations: 36						
Null hypothesis: No serial correlation at lag h						
Lag	LRE stat*	df	Prob	Rao F-stat	df	Prob
1	37.51623	36	0.3995	1.049152	(36,77.4)	0.4197
2	35.15836	36	0.5084	0.970237	(36,77.4)	0.5281
Null hypothesis: No serial correlation at lags 1 to h						
Lag	LRE stat*	df	Prob	Rao F-stat	df	Prob
1	37.51623	36	0.3995	1.049152	(36,77.4)	0.4197
2	78.99896	72	0.2675	1.087020	(72,65.7)	0.3667
*Edgeworth expansion corrected likelihood ratio statistics						

Appendix 2: VEC residual Portmanteau Tests for Autocorrelations

Null hypothesis: No residual autocorrelation up to lag h					
Sample 1980 - 2018					
Included observations: 36					
Lags	Q-Stat	Prob.*	Adj Q-Stat	Prob.*	df
1	14.60867	---	15.02606	---	---
2	46.46562	0.9675	48.75695	0.9448	66
3	83.79190	0.9053	89.47652	0.8074	102
4	119.8214	0.8659	130.0097	0.6737	138
5	159.3917	0.7794	175.9624	0.4441	174
6	195.2823	0.7589	219.0310	0.3203	210
*Test is valid only for lags larger that the VAR lag order. df is degrees of freedom for (approximate) chi-square distribution after adjustments for VEC estimation (Bruggem ann et al. 2005)					

Appendix 3: Autocorrelation functions

Date: 10/17/19 Time: 16:52
Sample: 1980 2018
Included observations: 37
Q-statistic probabilities adjusted for 7 dynamic regressors



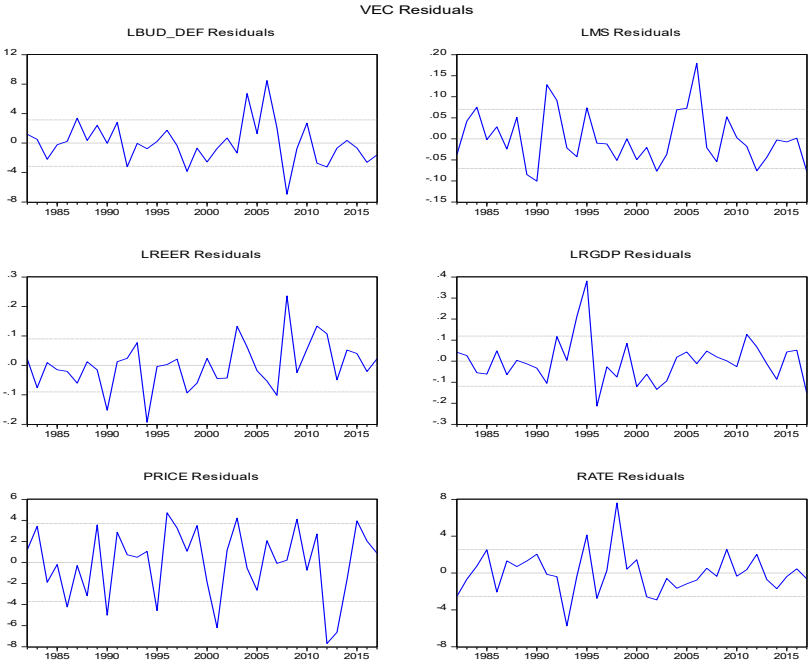
	Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
1			1	0.101	0.101	0.4118	0.521
2			2	-0.012	-0.022	0.4177	0.812
3			3	0.006	0.009	0.4191	0.936
4			4	-0.033	-0.035	0.4672	0.977
5			5	-0.070	-0.064	0.6903	0.983
6			6	-0.184	-0.174	2.2636	0.894
7			7	-0.172	-0.146	3.6897	0.815
8			8	0.030	0.051	3.7353	0.880
9			9	-0.028	-0.046	3.7766	0.925
10			10	0.029	0.026	3.8215	0.955
11			11	-0.083	-0.130	4.2081	0.963
12			12	-0.305	-0.365	9.5912	0.652
13			13	0.028	0.004	9.6370	0.723
14			14	-0.032	-0.087	9.7018	0.784
15			15	0.145	0.187	11.075	0.747
16			16	0.100	0.054	11.758	0.760

*Probabilities may not be valid for this equation specification.

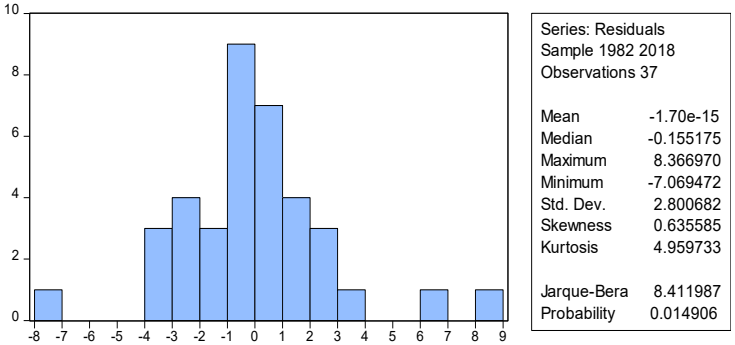
Appendix 4: VEC residual Normality test

Orthogonal Normality Tests								
Null Hypothesis: residual are multivariate normal								
Sample: 1980 – 2018; included observation: 36								
Component	Skewness	Chi-square	Prob*	Kurtosis	Chi-square	Prob.	Jarque-Bera	Prob
1	0.638934	2.449416	0.1176	4.868725	5.238201	0.0221	7.687617	0.0214
2	0.310641	0.578988	0.4467	2.700190	0.134829	0.7135	0.713817	0.6998
3	-0.049310	0.014589	0.9039	3.273566	0.112257	0.7376	0.126846	0.9385
4	0.936715	5.264609	0.0218	5.120330	6.743700	0.0094	12.00831	0.0025
5	-0.472002	1.336717	0.2476	2.266642	0.806720	0.3691	2.143437	0.3424
6	0.206682	1.336717	0.6127	3.880013	1.161635	0.2811	1.417940	0.4922
joint		9.900623	0.1289		14.19734	0.0275		0.0197
*Approximate p-values do not account for coefficient estimation								

Appendix 5: VEC residual plots



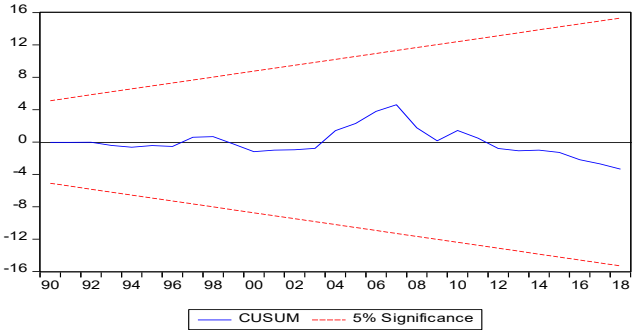
Appendix 6: Histogram for normality test



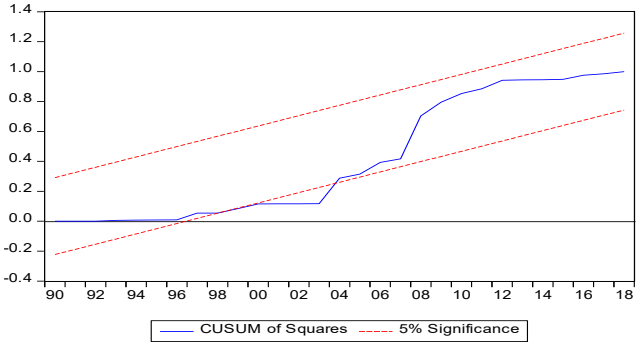
Appendix 7: Heteroskedasticity Test

Heteroskedasticity Test: Breush-Pagan-Godfrey			
Null Hypothesis: Homoscedasticity			
F- statistics	1.144652	Prob. F(12,24)	0.3729
Obs *R square	13.46798	Prob. Chi-square(12)	0.3360
Scaled explained SS	16.38064	Prob. Chi-Square(12)	0.1744
Test equation: Dependent variable: RESID^2 Method: Least squares Sample: 1982-2018 Included observations: 37			

Appendix 8: Stability diagnostic CUSUM test



Appendix 9: Stability diagnostics CUSUM square test



Appendix 10: Cointegration plot