An empirical study on the dynamic effects of fiscal shock on the economy of Papua New Guinea.

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AN EMPIRICAL STUDY ON THE DYNAMIC EFFECTS OF FISCAL SHOCK ON THE ECONOMY OF PAPUA NEW GUINEA

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ABSTRACT

The recent global recession has renewed interest in empirical studies on the effects of fiscal shocks. Ramey and Shaprio (1998) defined "fiscal shock" as an unpredicted increase in government spending caused by events that are exogenous to changes in the business cycle. Since independence in 1975, Papua New Guinea (PNG) experienced several unanticipated events that triggered sudden increases in government spending but there is no evidence of research done on it. Thus, this thesis aims to investigate the effect of non-systematic discretionary government spending measures on the output of PNG. The empirical analysis will provide estimates of government spending multipliers at different time horizons to assess the efficacy of government spending policies to stabilize domestic output. My empirical approach adopts the Structural Vector Autoregressive. The analysis finds that government spending impact multiplier is 0.06 and the cumulative multiplier after the fourth quarter is 0.21. The cumulative multiplier indicates that it takes at least five years for the increment in GDP to exceed the cumulative expenditure shock. The empirical results drawn from this study suggest that government spending has not been highly effective in stabilizing output in the short run.

Keywords: Fiscal shock; Discretionary fiscal policy; two-country model; Fixed exchange rate; Flexible exchange rate; Structural VAR; Elasticity; Impulse response; Fiscal Multiplier.

PREFACE

This thesis was a result of research motivation developed through mini class projects. The Econometrics II and Time series projects have ignited my interest in research. After completing the two projects, I felt that the best way to conceptualize the theory learned in a practical policy setting was through research. Even though this research work was very challenging for me; it was rewarding when applying the theoretical knowledge acquired in class to analyze real-life implications of economic policy. The success of this study would not have been possible without the assistance of the faculty members, especially the professors who guided me throughout the entire process. I believe that this thesis will stimulate future interests in empirical research in areas of fiscal policy shock in Papua New Guinea.

ACKNOWLEDGMENTS

I would like to thank my thesis supervisor Dr. Ellis for guiding me closely throughout the entire duration of my research. His door was always open whenever I had questions about my research and writing. His consistent guidence helped me to accomplish this paper.

Also, I would like to extend my gratitude to my other two thesis committees, Dr. Liu, and Dr. Barnette for their invaluable comments on the paper. A special thank you to Dr. Liu for proof checking my implementation of the econometric procedure in the E-View. Besides my professors, I am also grateful to my student colleague, Mr. Tyler Conklin for his editorial assistance on the preliminary draft of the paper.

Finally, I must express my very deepest gratitude to the Department of Economics for accepting my application to study economics at the Kent State University. In addition, I am sincerely indebted to the Fulbright Commission for the financial assistance, which turned my dream of obtaining a Masters qualification in economics into reality. The knowledge and skills acquired from this unique graduate, economics program will go a long way to help me contribute to the development of Papua New Guinea in my future endeavors.

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1. INTRODUCTION

The recent global recession has renewed interest in empirical studies on the effects of fiscal shocks (Kamps & Caldara, 2008). However, researchers mainly focused on the developed nations. There is only a small literature that examined the effects of fiscal shocks in small open economies. Some of the earlier works done in the case of developing economies were mainly for the peripheral European nations such as Albania, Spain, and Croatia and Asian countries. So far, no specific literature studied the case of Papua New Guinea (PNG), which motivated this thesis.

Ramey and Shaprio (1998) defined "fiscal shock" as an unpredicted increase in government spending caused by events that are exogenous to changes in the business cycle. Following Ramey and Shapiro, numerous studies (for example, Blanchard & Perotti, 2002; Fatás & Mihov, 2011) added tax shock to the analysis. Two central assumptions are used to specify fiscal shocks in a time series model. Firstly, the events that trigger shock in government expenditure and tax decisions do not correlate with changes in the business cycle (Ramey & Shaprio, 1998). Secondly, given the lags in the decision and implementation of fiscal policy suggests that there is little or no systematic discretionary policy response to unanticipated movement in activity within a quarter (Blanchard & Perotti, 2002).

Since independence in 1975, PNG experienced several unanticipated events that triggered sudden increases in government spending over the years. The main episodes which fit the criteria for fiscal shock are the Bougainville crisis of 1989, the Rabaul volcano eruption of 1994, and the 1997 El Nino weather phenomena. These episodes triggered significant increases in government spending. The only study done related to this issue, to the best of my knowledge is Kannapiran (1998), that used the Two-Stage Least squared and Vector Error Correction methods to derive a macroeconomic model for PNG. However, his methodologies do not allow us to generate the impulse responses of the macroeconomic variables. The dynamic responses are essential to determine the direction, intensity, and duration of the effects of fiscal shock. Therefore, this paper aims to investigate the macroeconomic implications of using non-systematic discretionary fiscal policy measures on domestic output. The empirical study will provide answers to the fundamental query about the direction, intensity, and duration of the macroeconomic consequences of fiscal shocks in PNG.

Principally, there have been four different methodologies developed to study the macroeconomic effects of fiscal shocks. Ramesy and Shapiro (1998) developed the narrative /event-study approach. Fatás and Mihov (2001) used the traditional Recursive or Cholesky decomposition approach introduced by Sims (1980). Blanchard and Perotti (2002) developed the Structural Vector Autoregressive (SVAR) procedure, and Mountford and Uhlig (2005) adopted the sign restriction methodology proposed by Uhlig (2005). The related studies that followed have used those four methods.

After careful assessment of the different methodologies and based on the data availability, I selected the SVAR approach developed by Blanchard and Perotti (2002). An excellent element of this method is, it permits us to filter out the effects of systematic discretionary fiscal measures and automatic stabilizer that can mask the results of the fiscal shocks. The analysis finds that government spending impact multiplier is 0.06 and the cumulative multiplier after the fourth quarter is 0.21, reflecting the effects of increased imports and crowding out. The cumulative multiplier indicates that it takes at least five years for the increment in the Gross Domestic Product (GDP) to exceed the cumulative expenditure shock.

The rest of the paper is in the order of sections from 2 to 8. Section 2 presents the historical narrative that discusses the structure and important macroeconomic policy developments between 1976 and 2014. Section 3 provides a detailed literature review on the different methodologies highlighted above. Section 4 discusses the underlying economic theory the paper adopted to conceptualize the characteristics of the PNG economy. Section 5 describes the data, while section 6 lays out the econometric procedure for implementing the SVAR method. It also explains the methodologies used in estimating the elasticity coefficients for the automatic stabilizer. Finally, sections 7 and 8 present the empirical results and conclusion of the paper, respectively.

2. HISTORICAL NARRATIVE

This section covers the major macroeconomic policy developments in PNG from 1976 to 2014. It describes the structure of the economy and the episodes that triggered shocks in government spending.

2.1 Structure of the economy and key macroeconomic policy developments

The ‘agriculture, forestry and fishing,' ‘mining and quarrying’ and ‘wholesale and retail trade’ sectors comprise a large share of PNG’s GDP. Table 1[1]shows that on average these sectors contributed over 50 percent of the GDP. The ‘mining and quarrying’ sector is responsible for most of the structural changes and growth in the economy since independence. Development of the financial market occurred recently following the inception of the floating exchange rate regime and the subsequent structural adjustment programs and liberalization of the economy (Money & Banking in Papua New Guinea, 2007.p.47).

[1] For all the tables mentioned henceforth, refer to Appendix E.

Between 1976 and 1994, PNG pursued a fixed exchange rate regime known as the "Hard Kina" policy. Although Capital inflow was welcomed, the government used some Exchange control measures to regulate large swings in capital flight that would harm the economy. The capital flows recorded during the fixed exchange rate era were mostly foreign direct investments (FDI) associated with the resource sector activities. The FDI, drawdown of external government loans, international grants and export receipts are the primary sources of foreign currency earnings for the country. However, since the introduction of the flexible exchange rate in October 1994, capital flows slightly increased as transactions in portfolio investments improved, enhanced by the introduction of the stock market[2] and improvements in the payment system. Despite that, the financial market is less integrated with the global financial markets.

The country heavily depends on exports for foreign currency and national income, and imports for consumption of producer and consumer goods. According to Blyth (1991), PNG has a high marginal propensity to import. The aggregate import on average comprises about 30 percent of the total GDP (see Table 2). Between 1976 and 2014, the aggregate trade volume of the country as a share of GDP averaged 82 percent, indicating that developments in the global markets would have a significant bearing on the PNG's economy. Kauzi and Sampson (2009) estimated that a 10 percent increase in commodity prices caused a 4 percent instant appreciation in the kina and 6 percent appreciation after two quarters. That supports the view that PNG's economy is vulnerable to international financial market shocks. Figure 1[3] shows the developments in the balance of payments (BOP) and Capital flows between 1976 and 2014.

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[2] PNG's stock market is called the Port Moresby Stock Exchange begun its operations in April 1999 (http://www.pomsox.com.pg/about-pomsox/history/).

[3] The primary axis reads the overall BOP positions and the secondary axis reads the capital flows.

As part of the earlier reforms to liberalize the economy, the government enacted the Central Bank Act 2000[4], which granted the Bank of PNG (BPNG) monetary policy autonomy. Accordingly, the BPNG has shifted its conduct of monetary policy towards adopting market-oriented policy instruments such as the Central Bank Bills. The independence of the monetary policy means that money supply is exogenously determined and that has significant implications on the effectiveness of fiscal policy.

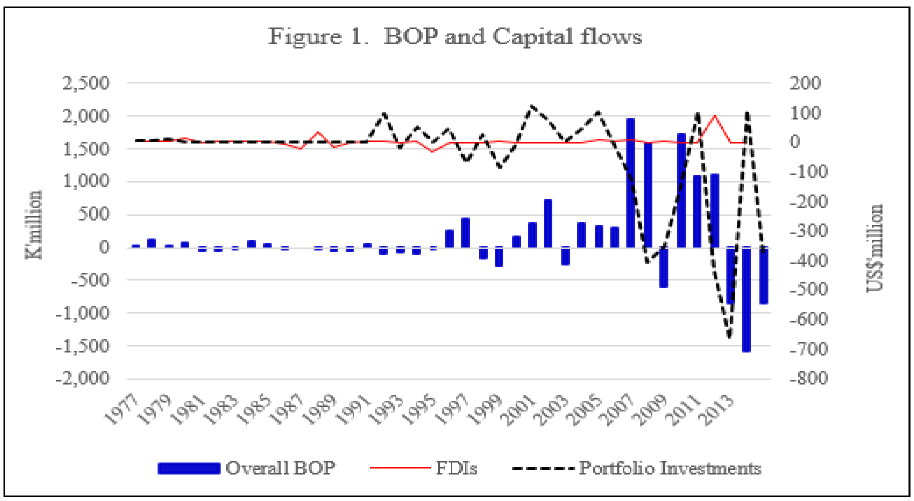

Figure 1. BOP and Capital flows

Source: Quarterly Economic Bulletin (QEB), IMF & World Bank database, and author's calculation.

Table 2 shows that the gross national saving on average is about 30 percent of the total GDP, which is almost the same as the imports and government expenditure shares of GDP. If the marginal propensity to save is high and the households follow the Ricardian equivalence logic, fiscal expansion, whether it be debt-financed spending rise or reduction in tax might not adequately stimulate the economy. However, given the fact that the financial market is still in its infancy, there are limited opportunities for individuals to invest in interest-earning assets or

[4]Copy of the Act can be accessed from, https://www.bankpng.gov.pg/downloads/legislation/

borrow to smoothen consumption, so the Ricardian logic is unlikely to hold. Using a simple aggregate expenditure approach, Gipe (2014) estimated that the marginal propensity to save for PNG is 0.08, which supports the claim that Ricardian logic does not hold.

Fiscal policy has been a vital policy tool of the government in supporting development and growth in the economy. The annual average government expenditure and tax revenue as shares of total GDP are 32 percent and 19.7 percent, respectively. In most parts of the periods under review, the government was running the economy on deficit budgets as shown in Figure 4. The primary sources of tax revenue are personal income taxes, company profit taxes, goods and services tax (GST), and international taxes[5]. The company profit taxes and personal income taxes comprise a significant share of total tax revenue. Therefore, any adjustment in these two components of tax will affect private investment and consumption of the firms and households and their cascading effects on domestic output will be substantial. However, taxation is a discretionary fiscal policy measure and usually pursued through proper legislative processes. The Appropriation Act permits the secretary of the Treasury Department to borrow for stabilization purpose at any time of the year if necessary (National Budget, 2016. p 26 & 54). Thus, any unpredicted surge in government spending to stabilize the economy in the short-run is financed by debt.

Understanding the structural underpinnings of the PNG economy provides an intuitive expectation about the effectiveness of fiscal policy in stabilizing output that the study intends to examine. The Mundell-Fleming model predicts that in a small open economy like PNG, fiscal policy will have a predominant effect on the domestic economy under the fixed exchange rate regime than monetary policy. The opposite is true under the flexible exchange rate regime

[5] International taxes consist of excise duties, import duties and export taxes.

because the money supply is exogenously determined and that usually limits the potency of fiscal policy. In both cases, factors such as the marginal propensities to save and import, the degree of capital mobility and openness of the economy usually affect the fiscal multipliers (Ilzetzki, Mendonza & Vegh, 2012), which measure the effectiveness of fiscal policy impact on domestic output. For example, we know that PNG has a high marginal propensity to import so increase in government spending induced imports will lower the magnitude of government spending multiplier. The theoretical explanation on the effects of those factors on the fiscal multipliers is deferred to later discussion. We now turn the discussion to the series of episodes that triggered shocks in government spending.

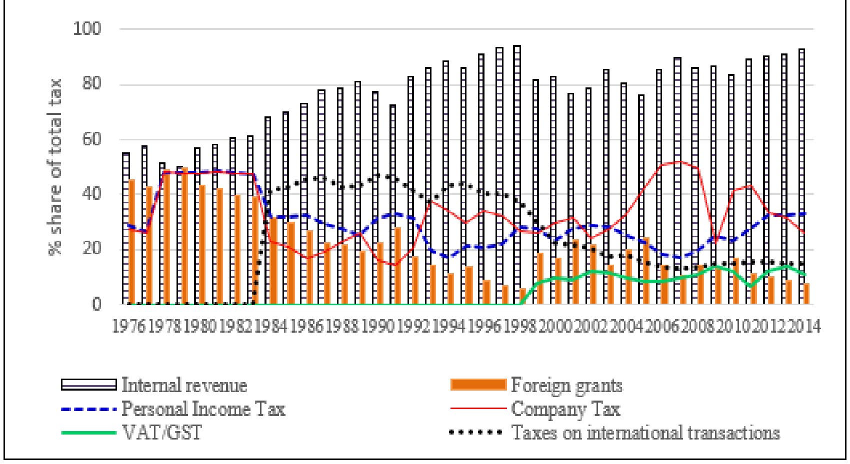

Figure 2. Major components of Tax and revenue sources

Source: QEB publications, and author's calculation.

2.2 Episodes defining the spending shock

Between 1976 and 2014, the main internal shocks that affected the fiscal operations and domestic output were the Bougainville crisis of 1989, the Rabaul volcano eruption of 1994 and the 1997 El Nino weather phenomena. These unforeseen events triggered an unexpected surge in government spending. The selection of the events was based on the economic significance of the regions affected and magnitude of the rise in government spending around the times of the shocks.

An internal conflict in 1989 between the government and the landowners of the Paguna mine in the Bougainville province led to the closure of the copper mine and a decade of civil war. The civil war erupted in April 1989 adversely affected the fiscal operations of the government and economic growth. In the third quarter of the year when the crisis started, real government spending increased by K51.8 million, which was 19.3 percent of the total spending. However, due to lack of institutional information, I was unable to disentangle the portion of the military expenses.

Between 1990 and 1994, PNG experienced numerous natural disasters such as earthquakes, volcano, landslides, and floods. The most devastating natural disaster in history was the volcano eruption of September 1994 in the East New Britain province. This catastrophe wrecked the entire beautiful town of Rabaul, incurring an estimated damage cost of US$400 million[6], which was 26 percent of the budget outcome for that year. During that quarter of the year, real government spending increased considerably by K368.8 million, accounting for 35.4 percent of the total expenditure in that period.

In 1997, the El Nino weather phenomena caused widespread frost and drought, severely affecting about 85 percent of the population living in the rural area (Allen &Bourke, 2001). Most of the government disaster relief funding ended up in imports of food. For example, according to Allen and Bourke, the government imported 5500 tonnes of rice to support the people affected.

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[6] Information was assessed from Asian Disaster Reduction Centre website. http://www.adrc.asia/publications/databook/ORG/databook_20th/PNG.pdf

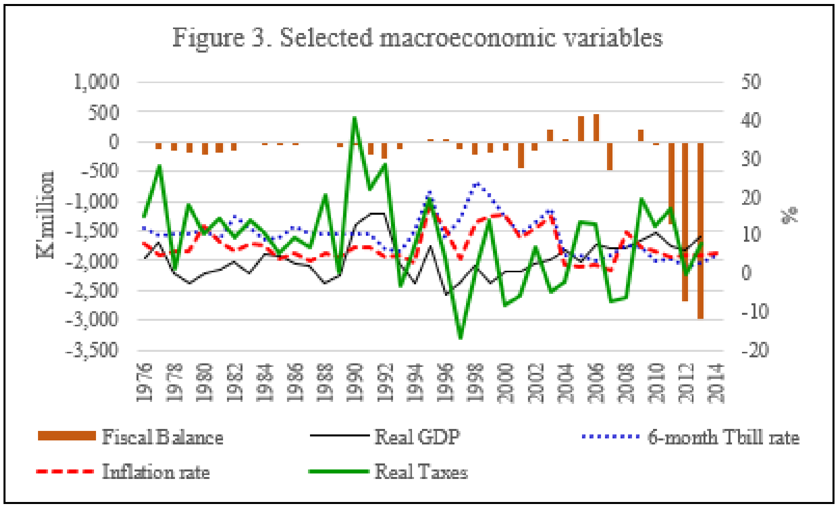
In the September quarter when this weather phenomenon was observed, real government spending increased by K463.1 million, consisting of almost 50 percent of the total expenditure for that period. Again, constrained by the absence of detailed fiscal information, I could not identify the exact amount of spending on disaster relief programs.

The expenditure developments since 2009 reflect the government's expansionary fiscal efforts to counteract the supply side shock in the domestic factors of production, caused by the construction of the US$10 billion Liquefied Natural Gas project[7]. This stabilization policy action was a systematic discretionary response and does not fit the criteria for fiscal shock. However, it is worth mentioning for trend analysis sake.

The battery of effects of the three episodes on output and tax revenue were detrimental. The Bougainville crisis led to the shutdown of the copper mine that used to support the economy with foreign currencies, tax income, and employment. The volcano eruption damaged the entire Rabaul town beyond repair, displacing about 152 thousand people. The surrounding cocoa and copra plantations were also destroyed. Similarly, the El Nino weather phenomena reduced the agricultural production and temporarily halted operations of the two large mines, namely the Ok Tedi copper mine and Pogera Goldmine. This situation was further exacerbated by the spillover

[7] Employment and business subcontract opportunities associated with the LNG project lured labour and capital from other sectors, hence shrinking growth in the traditional sectors like agriculture. Therefore, fiscal stimulus at the time of the project construction was to counteract this effect. After the project construction in 2014, the government continued the fiscal stimulus programs to keep the economy afloat.

effects of the Asian Financial crisis on commodity prices. The macroeconomic impact of these events can be inferred from Figure 3[8].



Source: Quarterly Economic Bulletin of the Bank of Papua New Guinea, and author's

Based on those above, the intuitive expectation is that suppose the supply side shock is predominant; it can offset the effect of government spending in the short run. Nevertheless, in the long term, the supply side shock should diminish as output recovers, supported by systematic discretionary fiscal policy response. Figure 4 reveals that interest rate was high around 10 percent during the periods when the shocks happened, which can also mask the impact of government spending. The question about the direction, intensity, and duration of the macroeconomic consequences of fiscal shock is an empirical issue that the study addresses in the later sections.

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[8] The primary axis of the graph reads the fiscal balance, while the secondary axis reads the other variables. The real tax and GDP are expressed in annual growth rates.

3. LITERATURE REVIEW

There has been a growing interest in empirical studies on the effects of fiscal shocks on economic activity in recent times (Kamps and Caldara, 2008). The VAR technique became the cornerstone econometric tool in the study of fiscal shock. So far, four different methodologies developed to study fiscal shocks are: 1) the narrative /event-study developed by Ramesy and Shapiro (1998); 2) the traditional Recursive or Cholesky decomposition approach introduced by Sims (1980) and applied by Fatás and Mihov (2001); 3) SVAR approach of Blanchard and Perotti (2002); and 4) the sign restriction approach proposed by Uhlig (2005). Since there were no earlier studies conducted for PNG, the paper decided only to review the empirical methodologies.

Ramey and Shapiro (1998) introduced the narrative or event study approach to investigate the economic effects of substantial US government spending on the Korean war, Vietnam war and Reagan military build-up. They argued that the advent of those surges in government spending were exogenous and unrelated to the business cycle change in the U.S economy. Accordingly, they created dummies for the dates of the war-episodes, intended to disentangle the effects of the exogenous spending shock from the regular spending that is not addressed by the standard VAR. Later, Edelberg et al. (1999) extended the analysis by treating the "Ramey-Shapiro events" exogenous in the VAR. Similarly, Burnside et al. (2004) and Eichenbaum and Fisher (2004) augmented the approach with the inclusion of taxes in the equation. An important critique of this method is that other shocks occurring around the same time can pollute the results (Perotti, 2005; Kamps & Caldara, 2008).

The Recursive approach developed by Sims (1980) is easy to implement because it does not require any strict restriction. However, the ordering of the variables is essential. The ordering can be based on the causal relationships between the variables or economic theory. For example, Fatas and Mihov (2001) ordered government spending first, followed by output then taxes. The underlying assumption was that government spending is exogenous and hence, orthogonal to GDP and taxes. Tax decisions were assumed to be based on expenditure plans but most contemporaneously relate to the changes in economic conditions. Fundamentally, the results are sensitive to the ordering of the variables. Perotti (2005) argued that ordering the fiscal variables first restricts their elasticities to output, price and interest rate to be zero. He also claimed that since the fiscal variables are components of the GDP, they cannot follow the assumption used in the monetary policy analysis. For example, ordering government spending after the output implicitly assumes that there is 100 percent contemporaneous crowding out of private sector spending. Likewise, setting tax after output omits its effect on the contemporaneous response of private consumption.

The approach that was widely used in recent times is the SVAR methodology that Blanchard and Perotti (2002) adopted from Bernanke and Mihov (1998) to examine the dynamic effects of fiscal shocks on output in the US for the post-war period. The advantage of this method is, the identification of fiscal shocks filters out the automatic effects of government spending and taxes on business cycle developments. Fundamentally, the identification strategy is strictly based on two assumptions: fiscal shocks are purely exogenous, and more than a quarter are required for the government authorities to learn about development in the economy then formulate and implement the appropriate “systematic” discretionary measures.

Perotti (2005) extended the analysis with the inclusion of the price level and the interest rate. Both papers showed that the residuals of the reduced-form VAR were linear combinations of the “automatic” and “systematic discretionary” response of fiscal variables to changes in economic activity, and “random discretionary” fiscal shocks. This approach seemed to be quite superior to the other methods. However, Blanchard and Perotti admitted that their method does not adequately address the potential impact of anticipated fiscal policy (Blanchard and Perotti, 2002. p.18). That is, fiscal policy changes are usually publicized before their implementation, and if the public factors the announcement in their forecast then this could weaken the assumptions of the restriction. Later, Perotti argued that the public might not take the fiscal announcement at “face value” because “The yearly budget is often largely a political document, which is discounted by the private sector as such; any decision to change taxes or spending in the future can be modified before the planned implementation time arrives…” (Perotti, 2005.p.14).

The final methodology is the sign restriction approach, developed by Uhlig (2005) and applied in Mountford and Uhlig (2005) to study the effects of fiscal shocks on the U.S economy. The authors claimed that unlike the formerly discussed approaches, the sign restrictions do not require detailed information about the system of taxes, transfers, and history of policy decisions. Moreover, it does not impose restrictions on the contemporaneous relationship of the reduced-form residuals and the structural innovations (Caldara and Kamps, 2008). Instead, the primary identification technique is to impose the sign restrictions directly on the impulse responses of the variables.

Mountford and Uhlig argued that other shocks can co-occur around the time of the fiscal shock and need to be addressed in the specification of the model. Hence, they differentiated four shocks in the VAR identification as the business cycle shock, monetary policy shock and fiscal policy (expenditure and tax) shock. In the VAR, the fiscal shock was set orthogonal to the other two shocks. This identification approach was said to filter out the automatic responses of the fiscal variables. The vital element of that approach is that the restrictions on the impulse responses captured the effect of anticipated fiscal policy on the economy (Perotti, 2005.p.8). The sign restriction was applied later by Peersman (2005), Fry and Pagan (2007) and Dungey and Fry (2007) to examine multiple shocks. Although the restrictions can capture anticipated fiscal shocks, they failed to define the timing of the shocks (Perotti, 2005). Also, the assumptions excluded the "non-Keynesian" or "expansionary fiscal contraction" output responses to fiscal shocks (see Perotti, 2005. P.7; Caldara & Kamps, 2008.p.4).

After evaluating all the different approaches, I selected the SVAR approach used in Blanchard and Perotti (2002) and Perotti (2005). An excellent feature of this methodology is such that we can filter out the automatic stabilizer effects that would mask the impact of fiscal policy shock on the economy. Also, the SVAR approach allows us to treat the spending and tax shock independent of each other. This thesis acknowledges that this method does not address the effect of expectation in the specification of the shock, which is captured by the sign restrictions approach. Notwithstanding this problem, Perotti's argument that the public does not take fiscal announcement at face value given that annual Budget is a political document subject to changes during the year validates the use of SVAR. However, my definition of the fiscal variables and calculation of the relevant coefficients of various elasticities are slightly different due to numerous data issues. The explanation of the SVAR and the elasticity calculation procedure are presented in the methodology section.

Generally, through the literature search, I found that nearly all the studies on fiscal shocks were done for the advanced and emerging economies, notably the OECD nations and India. A relatively small volume of literature studied the case of small-open economies but especially for the European peripherals. Ranvik and Žilić (2011) used the SVAR approach to examine the effects of fiscal shock in Spain found the fiscal shocks had the highest impact on interest rate and lowest on inflation. For Albania, Mançellari (2011) revealed that tax-cut stimulus had the largest cumulative multiplier on GDP, while the capital expenditure had a profound multiplier impact on output than current spending. We noticed that a significant drawback of the SVAR procedure is that it does not capture expectations.Thus, Rosoiu (2015) using the data for Romania concluded that excluding uncertainty in the estimation of spending impact on GDP can result in bias estimates.

In the case of PNG, no specific literature investigated the dynamic effects of fiscal shocks on the economy. Kannapiran (1998), using quarterly data (1977q1-1995q4) estimated a macroeconomic model for PNG. He used the Two-stage Least Square and Cochrane-Orcutt methods to estimate the behaviorial equations. His findings indicated that fiscal policy did not influence domestic real interest rate and inflation but affected the imports through induced spending. However, the empirical methods he adopted does not allow us to examine the dynamic effect of policy variables on output. Part of his analysis used the Vector Error Correction approach that mostly calculates the short-run speed of adjustment, which measures how long after a shock would it take for the long-run relationship between the two variables to be restored. Again this does not allow us to study the dynamic effects of policy shock on the economy. Therefore, I selected the SVAR approach that also permits us to calculate the fiscal multipliers, using the structural impulse responses of the variables in the system.

4. ECONOMIC THEORY

Most of the related studies used sophisticated modern macroeconomic models (see for example; Ramey & Shaprio,1998; Burnside, Eichenbaum & Fisher, 2004) to motivate macroeconometric models. However, this paper only utilizes the theoretical model to conceptualize the characteristics of the PNG economy that will draw a prior for the empirical analysis. The study adopted the short-run analysis of the Mundell-Fleming (MF) framework from the two-country model analyzed by Frenkel and Razin (1978)[9]. The purpose here is mainly to characterize the PNG economy and theoretically analyze the short-run implications of the fiscal policy change on output under the different exchange rate regimes. This exercise will also identify the underlying variables that will enter the SVAR system.

4.1. Analytical Framework

In a setting of a two-country model in the world economy, we refer one as the home (domestic) economy and the other as the foreign economy. We assume that each of the economy produces a distinct good: the home economy produces good *x*, and the foreign produces good *n*. Further, the home level of output is denoted by Y, while foreign economy's output level is by Y*. It is important to note that in the subsequent analysis, the variables marked with an asterisk represent those for the foreign economy and non-asterisk are for the domestic economy. For simplicity, we shall focus on the home economy to specify the behavioral functions. In this respect, the budget constraint of the local economy is

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[9] For consistency, most of the algebraic notations were replicated.

$$Z_t + M_t - B_t^p = P_t(Y_t - T_t) + M_{t-1} - R_{t-1}B_{t-1}^p, \tag{1}$$

where, B_t^p represent the home currency denominated one-time private sector debt obtained in period t, and the R_t denotes unity plus the nominal interest rate on the debt. The right-hand side of the equation explains that the resources available at time t to individuals are disposable income $P_t(Y_t - T_t)$, where Y_t and T_t are domestic output and taxes. Moreover, individuals hold certain assets which supplement their spending. The net value of the asset carried forwarded over time from $t - 1$, is defined as money, M_{t-1}, which is net of debt obligation, $R_{t-1}B_{t-1}^p$. Henceforth, we symbolize the net asset as A_{t-1}. The left-hand side of the equation represents how the individuals would allocate their resources. They can spend on goods and services, Z_t, hold in the form of money, M_t and bonds, $-B_t^p$.

Consistent with the MF assumption, the price level, P_t is assumed to be fixed and normalized to one so that nominal and real spending, E_t are equal. In the similar manner, the real interest rate is set as $r_t = R_t - 1$. Now if the demand is dependent on the resources and the interest rate, we express the functions for spending and money demand, respectively, as

$$E_t = E(Y_t - T_t + A_{t-1}, r_t), \tag{2}$$

$$M_t = M(Y_t - T_t + A_{t-1}, r_t). \tag{3}$$

To keep the analysis simple, Frenkel and Razin assumed the marginal propensity to spend and save from disposable income are same as those from the assets. That assumption is crucial when deriving the size of the fiscal multiplier later in the discussion. Given the budget constraint, they excluded the demand for bonds and assumed that the relationship between desired spending and money holdings in relation to the resource are positive and negative against the interest rate, respectively.

With the resources on hand, the domestic private sector can spend between the home goods, C_{xt} and foreign goods, C_{nt} so that the real value of spending is $C_{xt} + P_{nt}C_{nt}$, where P_{nt} is the relative price of good n in terms of good x. By the law of one price, it is assumed that price equalizes across countries engaging in trade. When the home country trades, its relative share of spending on imports (goods x) is denoted by $\beta_n = \frac{P_{nt}C_{nt}}{E_t}$. Likewise, the government also spend on domestic and foreign goods. The real value of government spending as a share of the home country's GDP is, G_t. The government's share of imports is, $\beta_n^g = \frac{G_t}{P_{nt}}$. For the foreign economy, I characterized the set of functions and government spending in a similar way but with asterisks. The exports of home country become the imports of the foreign private sector and government. The foreign economy's share of imports for the private sector is, $\beta_x^* = \frac{C_{xt}^*}{P_{nt}E_t}$ and its corresponding real government spending share of good x is β_x^{g*}.

In conformity with the purchasing power parity hypothesis, the relative price, P_{nt} of good x can be equal to the nominal exchange rate, $P_{nt} = e_t P_t^* / P_t$. This specification postulates that equilibrium in the world economy depends on the exchange rate regime. This leads us to the discussion of the fiscal policy impact under alternate exchange rate regimes.

4.2. Impact of Fiscal policy under Fixed exchange rate regime

The necessary conditions for the world economy equilibrium are that the markets for the commodity (goods), money and bond must clear. Under the fixed exchange rate system, the MF theory stipulates that there is free capital mobility so that foreign and domestic assets (money) are perfectly substitutable. This means that interest rate parity holds and, assuming further that the private sector does not expect future devaluation or revaluation, the international bond market equilibrium occurs where the domestic bond rate, r_t is equal to that of the foreign bond, r_t^*. Similarly, a single equilibrium can specify the equilibria in the money market, where the demand for and supply of world money equalizes. The arbitrage condition of $r_t = r_t^*$ and the notion that the world money supply is distributed through international asset swaps signify the functioning of capital mobility.

However, during the fixed exchange rate era, we noticed that capital flows in PNG were mostly in the form of FDIs. We barely saw activity in portfolio investments, suggesting that there was no active cross-border borrowing or lending by the private sector, such that $B_t^{p*} = 0$. Therefore, the resources available to the public are disposable income, $(Y_t - T_t)$ and money, M_t. Against the backdrop of these conditions, I assume that the domestic interest rate does not depend on the world interest rate. If there is restraint or absence of capital mobility, Frenkel and Razin (1978) stated that "…the short-run equilibrium would have determined the levels of domestic and foreign output from the goods-market equilibrium conditions." In addition, the Portfolio balance approach states that due to risks, the assumptions of perfect capital mobility and substitutability of domestic and foreign assets do not necessarily hold for small-open economies. Aipi and Lloyd (2012), found that PNG's real exchange rate is highly dependent on the Terms of trade than the interest rate differential. This statement is true for PNG given the underdeveloped structure of the financial market (Irau, 2012). Accordingly, the short-run domestic goods market equilibrium condition is,

$$Y_t = (1-\beta_n)E(Y_t - T_t + M_{t-1}, r_t) + (1-\beta_n^g)G_t + \bar{e}\bar{D}^*, \tag{4}$$

where $\bar{e}$ symbolizes the fixed exchange rate[10] becomes the relative price of imports in terms of exports since price is fixed and $\bar{D}^* = \beta_x^* E^*$ is the world demand for PNG's exports. This equilibrium condition determines the short-term value of output for the predetermined amount of resources and a given fiscal policy.

The domestic interest rate being independent of the world interest rate does not mean that money supply is exogenous because, with the fixed exchange rate, monetary policy is still ineffective. Given the fact that $B_t^p = 0$, deficit or surplus in the trade balance will affect the international reserves of the Central Bank who pursues to maintain the exchange rate at certain levels. This indicates that change in the quantity of money depends on the position of the current account. The corresponding money market and BOP equilibrium conditions are represented as

$$M_t = M(Y_t - T_t + M_{t-1}, r_t), \tag{5}$$

$$M_t - M_{t-1} = \bar{e}\bar{D}^* - \beta_n E(Y_t - T_t + M_{t-1}, r_t). \tag{6}$$

In deriving the equations (4), (5) and (6), the bond market was excluded by Walras's law with a further assumption that spending and taxes of foreign government were zero. The equation (6) indicates that changes in the quantity of money in the domestic economy depend on the changes in the BOP position. To keep the analysis simple, I assume that the capital flow is zero due to

[10] The $\bar{e}$ is quoted directly as unit price of foreign currency expressed in domestic currency. Hence, a rise (fall) in $\bar{e}$ reflects a devaluation (revaluation) of the domestic currency. Same interpretation is true for floating exchange rate.

underdeveloped local financial market structure. Hence, there is no instantaneous exchange of assets that would determine the quantity of, M_t. The change in the money stock is primarily associated with the development in the current account.

The macroeconomic effects of fiscal policy can be assessed by analyzing the changes in the equilibrium of the goods and money markets, and the BOP position. The impact of change in government spending on output derived by equation (A10) in Appendix A is

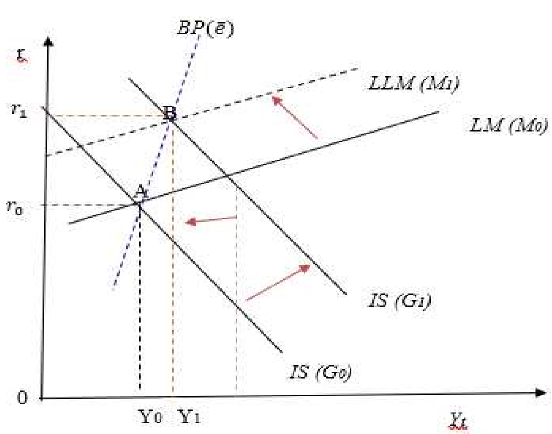
$$\frac{dY}{dG} = \frac{\overbrace{(1-a^g)}^{+}(\overbrace{M_r}^{-}+\overbrace{\beta_n E_r}^{-})}{\underbrace{(s+a)}_{+}\left(\underbrace{M_r}_{-}+\underbrace{\beta_n E_r}_{-}\right)+\underbrace{(M_y+a)}_{+}\left(\underbrace{1-\beta_n}_{+}\right)\underbrace{E_r}_{-}} > 0. \tag{8}$$

With $M_y > 0$, $M_r < 0$ and $E_y < 0$ the fiscal multiplier is $\frac{dY}{dG} > 0$. Equation (8) shows that government spending multiplier depends on the size of the marginal propensities to save and import, government's share of imports and the crowding out effects. To understand this, I use graphical analysis to explain the relationship between the goods market, money market and BOP position with respect to increased government spending.

The MF analysis in Figure 4 is a theoretical representation of the structure of the PNG economy in the pre-1994 era. During the period of fixed exchange rate regime, capital flows in PNG were relatively small, consisting mostly of FDIs associated with the resource sector. There was barely any activity in portfolio investments due to less developed domestic financial markets. While capital inflows were welcomed, certain restrictions were imposed on the outflows to support the exchange rate regime. These developments imply that capital flow was insufficient. Given this, and the fact that PNG has a high marginal propensity to import, the BOP curve (BP) is steep. Accordingly, the LM curve is relatively flat indicating that the money demand is less sensitive to the interest rate adjustments. The initial equilibrium level of money, M_0 and government spending, G_0 are indicated by point A. At that level, the BOP is also in equilibrium (BOP=0).

The increased government spending leads to a rightward shift in the IS curve (i.e., $IS(G_0)$ to $IS(G_1)$). As a result, domestic output increases, and this boosts imports, which causes deficit in the current account. This means that the demand for foreign currency to pay for imports rises, which exerts upward pressure on the exchange rate. Because the exchange rate is fixed, the Central Bank cannot allow the exchange rate to appreciate so it, intervenes in the foreign exchange market by selling foreign currencies in exchange for the domestic currency. Such action reduces the money supply and a leftward shift in the LM curve (*LM (M_0) to LM (M_1)*), raising the interest rate. At the new equilibrium point B, we find that increase in the interest rate has crowded out economy activity.

Figure 4. Short-run effects of increased government spending under no capital mobility and fixed exchange rate regime.



Source: Author's modification of Bird (2007), textbook version.

Given the above analysis we find that under the fixed exchange rate regime and no capital mobility, the factors that affect the strength of fiscal spending on domestic output are the marginal propensities to save and import, and the crowding out effect through the interest rate. The theoretical results indicate that government spending in PNG is less effective under the fixed exchange rate regime.

4.3. Impact of Fiscal policy under Flexible exchange rate regime

This section deals with the implication of fiscal policy under the floating exchange rate regime and no capital flow mobility. In contrast to the fixed exchange rate system, the domestic currency is nontradable and its relative price measured by the exchange rate, e, is freely determined by the market forces in the world foreign exchange market. Under this alternate exchange rate system, we maintain the fixity of price assumption, thus the nominal exchange rate becomes an essential element in the terms of trade and uncovered interest rate functions. In addition, I assume that expectation does not play a role in altering the nominal exchange rate. A further assumption is that, the BPNG can adjust money supply by influencing domestic credit creation and intervention in the foreign exchange market. Given the fact that domestic financial market is less developed, I maintain the assumption that the private sector does not transaction in foreign bonds (i.e. $B_t^{p*} = 0$). Likewise, foreign investors do not invest in PNG's interest earning assets. Based on these assumptions, the equilibrium conditions for the goods market, money market and the BOP under no capital mobility, respectively, are

$$Y_t = (1 - \beta_n)E(Y_t - T_t + A_{t-1}, r_t) + (1 - \beta_n^g)G + e_t\bar{D}^*, \tag{9}$$

$$\bar{M} = M(Y_t - T_t + A_{t-1}, r_t), \tag{10}$$

$$0 = e_t\bar{D}^* - \beta_n E(Y_t - T_t + A_{t-1}, r_t). \qquad (11)$$

Following the inception of the flexible exchange rate regime, there were some activities in portfolio investments. However, since the domestic private sector does not trade in foreign bonds, the arbitrage condition, $r_t = r_t^*$ does not hold. Instead, the internal market factors of the demand and supply affect the domestic interest rate. The equation (11) indicates that adjustments in the exchange rate will always restore equilibrium in the BOP position (i.e. BOP=0) irrespective of the shift in the IS or LM curve.

To assess the implications of fiscal policy shock on the economy, I differentiated equations (9), (10) and (11) simultaneously as shown in Appendix B. The solution represented by equation (12) informs that the marginal propensity to save, S, government share of imports, a^g and crowding out effect, $E_r M_y$ affect the impact of higher government spending on domestic output. For example, if the crowding out effects is large, that will reduce the spending multiplier impact on output.

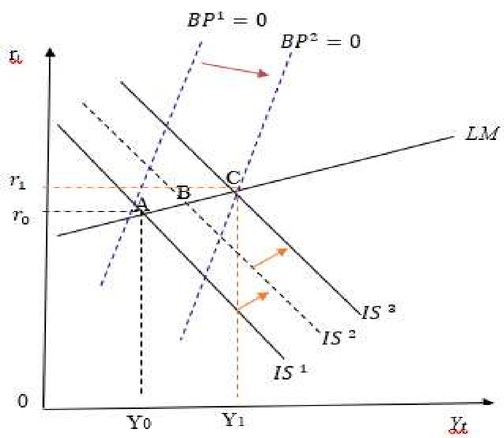
$$\frac{dY}{dG} = \frac{(1-\overbrace{a^g}^{+})\overbrace{M_r}^{-}}{\underbrace{SM_r}_{-}+\underbrace{E_r M_y}_{-}} > 0\ . \qquad (12)$$

Unlike the fixed exchange rate case, the solution in equation (12) does not contain the marginal propensity to import, which should be one of the private sector factors affecting the spending multiplier. A possible explanation is, the domestic value of PNG's exports ($e_t\bar{D}^*$) must adjust exactly to compensate for the increase in imports to bring about BOP equilibrium. Under no capital mobility and a flexible exchange rate, the current account must be equal to zero for there to be BOP equilibrium, as shown in equation (11).

Again, I will use graphical analysis to explain the implications of increased government spending on the PNG economy. Figure 5 illustrates how equilibrium in the economic system changes when government increases spending. Due to no capital mobility and the assumption that $B_t^{p*} = 0$, the BP curve remains steep and the LM schedule is quite flat. The shape of the LM curve imply that money demand is less sensitive to changes in the interest rate. Hence, there is less or no effect of exchange rate adjustments on the LM curve.

Given a level of output (Y_0) and an exchange rate, an increased government spending creates excess demand, leading to an outward shift in the IS curve (IS^1 to IS^2). Consequently, domestic output improves, causing import to increase and the domestic currency to depreciate. A depreciation in the domestic currency means an increase in the exchange rate indicated by rightward shift in the BP curve (BP^1 to BP^2). As a result, the domestic currency value of PNG's exports ($e\overline{D}^*$) should increase, leading to a further shift in the IS schedule (IS^2 to IS^3) and the new equilibrium is achieved at point C. The rightward shift in the IS schedule is followed by rise in the domestic interest but the net effect of the increase in output is large.

Figure 5. Short-run effects of increased government spending under no capital mobility and flexible exchange rate regime



Source: Author's modification of Bird (2007), textbook version.

The analysis herein suggests that under the floating exchange rate regime and no capital mobility, higher government spending is efficient to stabilize output in PNG. The private sector factors that affect the spending multiplier in PNG are the marginal propensity to save and crowding out effect of interest rate. The underdeveloped domestic financial market prevents cross-border private sector lending and borrowing, hence money demand is less sensitive to the changes in the interest rate. It seems that the net effect of increase in output is huge, suggesting that initial increased government spending is stimulative under the flexible exchange rate regime and zero capital mobility.

5. DATA DESCRIPTION

The dataset for the paper contains quarterly series for periods covering 1976-Q1 to 2014-Q4, mainly drawn from the Quarterly Economics Bulletin (QEB) publications of the BPNG and World Bank database. The set of macroeconomic variables selected for the empirical analysis are those featured in the two-country model of the small open economy. The definitions of the baseline variables were adopted from Blanchard and Perotti (2002), except that the fiscal variables are only a net of the interest payments for the reasons explained in the subsequent section.

5.1 Data Issues

The baseline variables are the GDP and its deflator, government spending, and taxes. The total gross government spending consists of current and capital expenditure, and the tax revenue comprises the direct and indirect tax receipts. The other macroeconomic variables of interest are the total imports, 6-month Treasury bill rate (referred henceforth as just the interest rate) and the total GDP for OECD nations. As stated earlier, the transfer payments could not be subtracted from spending and taxes because the data was reported in aggregate. The aggregate figures contained some expenditures that directly linked to the events regarded as the cause of the spending shocks. For example, emergency disaster relief funding is usually reported under transfers (National Budget, 2016. p. 26 & 54). The transfer payments deducted from government spending and tax revenue in Blanchard and Perotti (2002) were mainly social benefit expenses of the government. Given the fact that there was lack of information at the time of the research, it was difficult to disentangle the social benefit contributions of the state from the transfer payments. That is one of the issues that I intend to address in a future research if data is available.

The data transformation and seasonal adjustment were done consistent with other related studies (see for example de Costro & de Cos, 2006; Ravnik & Zilic, 2011; Yadav, Upadhyay & Sharma, 2012) that followed Blanchard and Perotti. Hence, using the GDP deflator, all the quarterly series were transformed into real terms and then, seasonally adjusted using the X-12 method of the U. S. Census Bureau. The adjusted series was finally expressed in the form of the natural logarithm of empirical analysis, except the total GDP for OECD nations and the nominal interest rate. A detailed description of the variables is provided in Table 3.

The nonexistence of appropriate variables and lack of quarterly series for some variables were major challenges the study encountered. Thus, it is imperative to explain the measures taken to refine the raw data. None of the sources contained a full set of quarterly historical series for all the variables, so I had to merge the data from various reports. An agnostic approach was taken to reconcile the data from multiple reports before consolidating the series for the variable of interest. For instance, I used the quarterly macroeconomic data of 1976 to 1995 for PNG from Kannapiran (1998) and reconciled against the QEB reports. The QEB publications dating back from 1990 did not have the quarterly data nor the reports for those periods available on the website. Therefore, I used the various tables from the book, 'Money and Banking in Papua New Guinea' (2007) to obtain the historical data, yet they were in annual series.

The GDP and its deflator available were in annual figures, so I interpolated them into quarterly series using the linear method. Moreover, the GDP data used is an aggregate series computed by the production approach[11]. The quarterly post-1990 set of the fiscal variables were cumulative figures, so I obtained the difference for each quarter. The BOP data series for pre-1980 and fiscal series for pre-1991 periods were interpolated into quarterly frequency from the annual figures by the quadratic method, but they did not generate a robust result. Therefore, I merge the quarterly data represented in real terms supplied by Dr. Kannapiran. There are no quarterly series for those variables in the IMF and World Bank database for PNG, particularly for the mentioned periods. The selection of the interpolation method was purely based on the

[11] Since the GDP computed by the Income and Expenditure methods were not updated since 2004, we could not use the components of GDP like private consumption and investment in the analysis.

eyeballing of the raw data in levels. Figure 6[12] illustrates the original and seasonally adjusted series for the variables of interest.

5.2. Statistical Properties

In any time-series econometric analysis, it is a conventional practice to ensure that all the variables must be stationary of the same order of integration. If at least one of the variables in the system has a unit root, the analysis is said to have the so-called "spurious regression" problem. In compliance with this rule, I tested for the stationarity of the variables using the Augmented Dicky Fuller (ADF), Philips Perron (PPP) and Kwiatkowski-Philip-Smith-Shin (KPSS) unit root tests. The first two tests have the same null hypothesis that variable has a unit root, so a rejection of the null means that a variable is stationary. The latter test, however, has the null that contrasts with the two previous tests. If the KPSS test fails to reject the null, it means that the variable is stationary. The unit root test results of all the variables are presented in Table 4.

The ADF and PP tests found the Log_Y_t and Log_P_t stationary after the first difference, but the KPSS test discovered only the Log_Y_t had no unit root after first difference. The rest of the variables in levels according to the ADF and PP tests were stationary at the 5 percent level of significance. The KPSS test confirmed similar results but at varying degree of significance. All the three tests confirmed that Log_G_t, Log_T_t, and Log_M_t were trend stationary. Furthermore, in both levels and first difference, all the variables were found to have a constant. The constant and trend findings are essential as they will be used later to augment the empirical model.

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[12] All the figures mentioned henceforth are provided in Appendix F.

Even though some variables are not stationary at the level, we can still analyze data in levels following other related studies (see for example; Perotti, 2002; de Castro & de Cos, 2006; Heppke-Falk, Tenhofen & Wolf, 2006). The underlying reason stated by Ravnik and Žilić (2011, p.39) is, "…because of our primary interest in the dynamics, rather than parameter estimation." That partly implies the concern to preserve the long-run relationship between the variables that is lost when taking the first difference. Accordingly, I tested for the long-run relationship between the variables using the Johansen cointegration test and the results are presented in Table 5. The Trace and Maximum eigenvalues found evidence of some cointegration relationships between the variables, albeit mixed outcomes.

For robustness purposes, I conducted the regressions on the two detrended set of series, the first differenced series and the series detrended by the Hodrick and Prescott (HP) filter (Yadav, Upadhyay & Sharma, 2012). I also included a deterministic trend in the benchmark model following Blanchard and Perotti (2002). I used E-Views version 10 to conduct the empirical analysis.

6. EMPIRICAL METHODOLOGY

As stated earlier, the paper uses the SVAR approach of Blanchard and Perotti (2002) for the object of the study. Despite the slight difference in the definition of the fiscal variables and numerous data issues in general, I view this research as setting the stage for further work in the future. For the sake of consistency, the notations from Blanchard and Perotti (2002), and Perotti (2005) were maintained. Due to data limitation, the research was unable to test the effects of fiscal shock under the different exchange rate regimes. Instead, I created a dummy to capture the effects of the change in the exchange rate policy. In what follows, I present the methodological procedure of the SVAR framework and the approach adopted to estimate the output and price elasticity coefficients of fiscal variables.

6.1. The VAR model specification

The VAR has been the workhorse for modern macroeconomic analysis of dynamic effects of economic policy (Lutkepohl, 2005). The benchmark VAR model follows Perotti (2005) and contains Log_G_t, Log_T_t, Log_Y_t, Log_P_t and R_t. Moreover, Log_M_t was purposely included to explain the size of the fiscal multiplier as indicated by the two-country model analysis. Following common practice (for example, Lutkepohl, 2005), I set the k-dimensional vector of the endogenous macroeconomic variables, X_t in the unrestricted VAR model with lag p as

$$AX_t = \mathrm{A}_0 + B(L)X_{t-1} + \varepsilon_t, \tag{12}$$

where X_{t-1} is the lagged endogenous variables, A is a (k x k) vector of structural coefficients, A_0 is a (k x 1) vector of constants whose mean is nonzero, $E(x_t) \neq 0$, $B(L)$ is the autoregressive lag polynomial, and the ε_t is a (k x 1) vector of structural residuals where $E(\varepsilon_t) = 0$, $E(\varepsilon_t {\varepsilon_t}') = \Sigma_\varepsilon$, $E(\varepsilon_t {\varepsilon_s}') = 0$ for $s \neq t$. Accordingly, the reduced form VAR is,

$$X_t = \delta + A(L, q)X_{t-1} + U_t, \tag{13}$$

where $\delta = A^{-1}A_0$ is a vector of constants, $U_t = A^{-1}\varepsilon_t$ is a vector of reduced-form innovations and $A(L, q)$ is the quarterly autoregressive lag polynomials that permits the coefficients of each quarter for the endogenous variables to depend on their past values. The reduced-form residual, $U_t \equiv (u_t^g, u_t^t, u_t^y, u_t^p, u_t^r, u_t^m)$, is a white noise process and has a non-singular covariance matrix Ω. I augmented the benchmark model with inclusion of the foreign GDP (Y_t^*) to account for the effects of exogenous changes in the global economic environment and a dummy variable for the change in the exchange rate regime (*Exdum*). Selection of the exogenous variables is consistent with the specification of the two-country model.

The model (13) is a six-variable VAR system that can be estimated by Ordinary Least Squares. For the number of lags, different selection information criteria found a varying number of lags (i.e., LR-5 lags; FPE-3 lags; AIC-3 lags; SIC-1 lag; HQ-2 lags)[13]. Therefore, I used the same intuition as Blanchard and Perotti (2002) to use four lags, providing that tax payment for a given period depends on the economic activity of the past three quarters. Additionally, some taxes such as the corporate taxes are usually paid with a prolonged delay relative to the transaction period (Blanchard & Perotti,2002). To test the robustness of the results to the number of lags, I used the different lags interchangeably in the benchmark model and found tiny variation in the results. Thus, I finally chose four number of lagged periods for the benchmark model.

The reduced form VAR itself contains very little economic significance because the reduced-form residuals are linear combinations of the underlying structural innovations. Since it is difficult to recover the structural innovations from the reduced form, we need to impose economic-theory based restrictions on the reduced-form VAR to focus the analysis on the structural shocks.

[13] Refer to Table 6 for results of the lag selection criteria.

6.2. Blanchard and Perotti method of identifying Fiscal policy shock

According to Blanchard and Perotti (2002), and Perotti (2005), the reduced form residuals of the Log_G_t and Log_T_t equations, u_t^g and u_t^t, are linear combination of three components: (a) the "automatic" response of the fiscal variables to innovations in other macroeconomic variables in the system; (b) "systematic discretionary" fiscal policy responses to shocks in those other variables; (c) "random discretionary" fiscal policy shocks, which are uncorrelated with the other shocks, unlike the reduced-from innovations. As such, the reduced-form residuals of spending and tax equations can be written as,

$$u_t^g = \alpha_{g,y}u_t^y + \alpha_{g,p}u_t^p + \alpha_{g,r}u_t^r + \alpha_{g,m}u_t^m + \beta_{g,t}e_t^t + e_t^g, \quad (14)$$

$$u_t^t = \alpha_{t,y}u_t^y + \alpha_{t,p}u_t^p + \alpha_{t,r}u_t^r + \alpha_{t,m}u_t^m + \beta_{t,g}e_t^g + e_t^t. \quad (15)$$

The structural shocks of spending and taxes are denoted by e_t^g and e_t^t, respectively. Similarly, the structural shocks derived from the reduced residuals of Log_Y_t, log_P_t, R_t and Log_M_t are e_t^y, e_t^p, e_t^r and e_t^m, respectively. We cannot estimate the equations (14) and (15) directly because the reduced-form residuals are correlated with the e_t^g and e_t^t. Therefore, we need to impose some economic theory-based assumptions to emphasize the main hypothesis that the fiscal policy variables cannot react to shocks of other variables in the same quarter (Ranvik & Žilić, 2011).

As such, the mission is to examine the effects of structural innovations in discretionary fiscal policy, e_t^g and e_t^t on rest of the variables in the system (de Costra & de Cos, 2006). Blanchard and Perotti (2002) first stated that using the quarterly data essentially eliminates the effects of systematic discretionary fiscal policy, because it takes virtually more than three quarters for the fiscal authority to eventually learn about the shock then react accordingly. This strong assumption now leaves us to estimate the coefficients $\alpha_{i,j}$'s, which captures the automatic response of spending and taxes to shocks in the cyclical change in output and rest of the variables. Likewise, we estimate the $\beta_{i,j}$'s parameters, which reflect the current effect of *i*-th structural shocks to the *j*-th variables (Ranvik and Žilić, 2011). In other words, we are to gauge the effects of automatic stabilizer and random discretionary fiscal reaction. Estimating the relevant coefficients of $\alpha_{i,j}$'s helps to generate the cyclically adjusted fiscal innovations as follows,

$$u_t^{g'} = u_t^g - \left(\alpha_{g,y}u_t^y + \alpha_{g,p}u_t^p + \alpha_{g,r}u_t^r + \alpha_{g,m}u_t^m\right) = \beta_{g,t}e_t^t + e_t^g, \quad (16)$$

$$u_t^{t'} = u_t^t - \left(\alpha_{t,y}u_t^y + \alpha_{t,p}u_t^p + \alpha_{t,r}u_t^r + \alpha_{g,m}u_t^m\right) = \beta_{t,g}e_t^g + e_t^t. \quad (17)$$

The next step is to determine the values for $\beta_{i,j}$'s, which unambiguously depend on one's assumption about the ordering of the fiscal variables to recover e_t^g and e_t^t. If we believe that spending decisions comes before tax decision, we can set $\beta_{g,t}$ to zero so that e_t^g can be recovered. In contrast, if tax is decided before spending then, $\beta_{t,g}$ is equal to zero so that we recover e_t^t. Perotti (2005) argued that there is no solid theoretical or empirical basis to substantiate which fiscal variable to be set orthogonal. As a result, I experimented the ordering by using the spending and tax interchangeably but there was a very, trivial change in the results. Therefore, as in most other papers (see for example: de Costra & de Cos, 2006; Mançellari, 2011; Ranvik & Žilić, 2011) I assumed that spending dictates tax decisions, hence $\beta_{g,t} = 0$ so that the final cyclically adjusted fiscal shocks are,

$$u_t^{g'} = e_t^g, \tag{18}$$

$$u_t^{t'} = \beta_{t,g} e_t^g + e_t^t. \tag{19}$$

In equation (19), the $\beta_{t,g}$ reflects "the effects of a structural spending shock on a discretionary tax decision" Mançellari (2011, p.18). According to Perotti (2005) and other papers that used his version of the Blanchard and Perotti (2002) approach, showed that once the e_t^g and e_t^t are recovered, they become instruments for u_t^g and u_t^t to estimate the structural shocks of the other variables in the system. The reduced-form residuals are expected to be contemporaneously correlated with the structural shocks so using the instrumental variables mitigates the issue. Perotti (2005) and de Costra and de Cos (2006) mentioned that ordering of the rest of the variables is immaterial to the results when we are interested in the effects of fiscal policy shock. Thus, the reduced-form innovations for the output, price, interest rate and import equations are written as follows,

$$u_t^y = a_{y,g} u_t^g + a_{y,t} u_t^t + e_t^y, \tag{20}$$

$$u_t^p = a_{p,g} u_t^g + a_{p,t} u_t^t + a_{p,y} u_t^y + e_t^p, \tag{21}$$

$$u_t^r = a_{r,g} u_t^g + a_{r,t} u_t^t + a_{r,y} u_t^y + a_{r,p} u_t^p + e_t^r, \tag{22}$$

$$u_t^m = a_{m,g} u_t^g + a_{m,t} u_t^t + a_{m,y} u_t^y + a_{m,p} u_t^p + a_{m,p} u_t^r + e_t^m. \tag{23}$$

As in (18) and (19), the equations (20) to (23) were estimated using the e_t^i (where $i = g, t, y, p \; and \; r$) as instruments. For example, to estimate equation (20), e_t^g and e_t^t were used as instruments for u_t^g and u_t^t. The rest of the equations followed the same precedence.

Following other studies, we can represent the relationship between the reduced-form residuals, U_{kt} and e_{kt} of k-variables in the AB model (Luke, 2005). The standard AB model takes the following form:

$$AU_{kt} = Be_{kt}, \tag{24}$$

such that the corresponding A and B matrices as in Mançellari (2011) and, Ranvik and Žilić (2011) are:

$$\begin{bmatrix} 1 & 0 & 0 & 0.24 & 0 & 0 \\ 0 & 1 & -0.73 & -0.19 & 0 & 0 \\ -a_{y,g} & -a_{y,t} & 1 & 0 & 0 & 0 \\ -a_{p,g} & -a_{p,t} & -a_{p,y} & 1 & 0 & 0 \\ -a_{r,g} & -a_{r,p} & -a_{r,t} & -a_{r,y} & 1 & 0 \\ -a_{m,g} & -a_{m,t} & -a_{m,y} & -a_{m,p} & -a_{m,r} & 1 \end{bmatrix} \begin{bmatrix} U_t^g \\ U_t^y \\ U_t^p \\ U_t^t \\ U_t^r \\ U_t^m \end{bmatrix} = \begin{bmatrix} \sigma_g & 0 & 0 & 0 & 0 & 0 \\ \beta_{t,g} & \sigma_y & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma_p & 0 & 0 & 0 \\ 0 & 0 & 0 & \sigma_t & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma_r & 0 \\ 0 & 0 & 0 & 0 & 0 & \sigma_m \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^t \\ e_t^y \\ e_t^p \\ e_t^r \\ e_t^m \end{bmatrix}. \tag{25}$$

To identify the variance-covariance matrix, we need to impose restrictions on the A and B matrices. The total number of restrictions required in this case is 51 according to the formula, $2k^2 - [(k^2 - k)/2 + k]$, where k is the number of endogenous variables. For the system to be utterly justified, the mission is to identify the appropriate economic theory-based restrictions.

The A matrix contains the coefficients of the contemporaneous relationship between the variables with the diagonal elements standardized to 1. That added six restrictions to the 29 coefficients of the B matrix that was zero. The standardization of the diagonal elements of matrix A "represented the relationship of reduced-form shocks to each other" Mançellari (2011, p.25). The elements in the diagonal of the B matrix are the standard deviations of the structural innovations. In de Castro and de Cos (2006), the diagonal elements of matrix B were unitary, which I applied but did not obtain sensible impulse responses of the structural shocks.

In the A matrix, all the coefficients of the reduced-form equations for government spending were set to zero, except the contemporaneous impact of inflation, which was estimated to be -0.240. The main argument for holding all the coefficients equal to zero is that the dynamic response of spending depends only on the government decision. For the impact of inflation, it was argued that wages for public servants and some expenditure goods and services such as nationalized hospitals and schools are not usually indexed to inflation within the same period. These arguments added five more restrictions. Moreover, the assumptions that interest rate and total imports do not contemporaneously affect the rest of the variables provided seven additional restrictions. Since the effect of government spending on tax is modeled in the B matrix, the relationship in matrix A was set to zero. This, combined with the coefficients of automatic elasticities of tax revenue to cyclical changes in the output and inflation in the economy, added three more restrictions. The last restriction for the system to be justified is provided by the assumption that the structural innovation in the output is not impacted by the shocks in inflation in the same period.

To account for the automatic response of government spending and tax to the cyclical changes in economic activity and inflation, I computed the output and price elasticities of those fiscal variables. The following subsections explain the procedures involved in estimating the relevant coefficients of tax and spending elasticities of output and price.

6.3. Estimating the elasticities of Government spending and tax revenue

Since spending and taxes are nets of interest cost, they are not interest rate sensitive. Thus, as in Perotti (2005), the contemporaneous response to innovations in the interest rate was set to zero (i.e. $\alpha_{g,r} = \alpha_{t,r} = 0$). De Costra and de Cos (2006) argued that this assumption may not be justifiable for net taxes if income from government investments in the form of dividends and interests are included. However, in my case the net tax excludes the non-tax component of the domestic revenue, which contained the interest income and dividends, so the restriction is valid.

Further, the government spending cannot automatically respond to cyclical changes in the economy (Blanchard & Perotti, 2002; Perotti, 2005; de Costra & de Cos, 2006). In PNG, the annual GDP data is usually published with some lag-periods, hence making it difficult for the fiscal authority to undertake contemporaneous decisions in response to cyclical changes in the output within the quarter. On that basis, the automatic response of government expenditure to cyclical changes in economic activity is zero (i.e. $\alpha_{g,y} u_t^y = 0$).

Since the government is not a producer in the economy, shocks in the imports will not contemporaneously alter fiscal decisions. In a small country like PNG that is heavily reliant on imports, government spending will affect the terms of trade, but any feedback of exchange rate developments bearing on government's revenue and spending can be captured through the price elasticity of tax and spending. Sampson et al. (2006) found the pass-through of changes in the exchange rate into inflation in PNG to be considerably high, which was the result of the developments in the Terms of trade. We captured this effect through the price elasticities of spending and taxes. Therefore, the contemporaneous response of the fiscal variables to changes in the total imports is set to zero (i.e., $\alpha_{g,m}u_t^m = \alpha_{y,m}u_t^m = 0$).

Now we are left with the contemporaneous response of tax revenue to business cycle shock $(\alpha_{t,y})$ including inflation $(\alpha_{t,p})$, and the contemporaneous response of spending to price shock, $(\alpha_{g,p})$. Most of the related literature used the Blanchard and Perotti (2002) method of calculating tax elasticity, which requires detailed institutional information about the tax system and transfer payments. However, due to data limitations and lack of supplementary institutional information, the paper adopts an alternate method from Kusi and Adjaye (1995) and Mançellari (2011) to derive certain estimates, which were then imputed into the final formula prescribed by Blanchard and Perotti to derive the overall tax elasticity.

6.3.1 Estimating the output and price elasticities of Tax

Figure 2 showed that the main tax components for PNG are the company income tax, personal income tax, international tax and, goods and services tax. Due to the absence of information on legitimate tax base for the country, I use proxy variables mentioned in Table 7, following Kusi and Adjaye (1995), Mançellari (2011) and, Ranvik and Žilić (2011). The known literature of which I am aware that calculated tax elasticity for PNG is Thac and Lim (1984) that used the 1965 to 1977 dataset and Kusi and Adjaye (1995) using the data for 1975-1992. Recently, Dudine and Jalles (2017) in a panel data analysis calculated the tax buoyancy[14] for PNG. We cannot use the tax buoyancy as a proxy for tax elasticity because it contains the effects

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[14] Tax buoyancy measures the overall efficiency and responsiveness of tax revenue to changes or growth in GDP. Thus, it contains the effects of both the automatic stabilizer and discretionary tax adjustments.

of both the automatic and discretionary fiscal measures on the change in revenue. What is of interest is the automatic response of tax to cyclical changes in economic activity, which is measured by the tax elasticity of output. To begin with, the tax elasticity formula used in Blanchard and Perotti (2005) is

$$\alpha_{t,y} = \sum_i \eta_{T_i,B_i} \eta_{,B_i,X} \frac{\bar{T}_i}{\bar{T}}, \quad (26)$$

where η_{T_i,B_i}denotes elasticity of each tax i to its respective base and $\eta_{,B_i,X}$ represents the elasticity of tax base to output or GDP. The $\bar{T}$ is net level of tax revenue, where $\bar{T} = \sum \bar{T}_i$ such that $\bar{T}_i > 0$ and $\bar{T}_i < 0$ correspond to taxes and transfers, respectively. Because of lack of appropriate data, I adopted the procedure used by Kusi and Adjaye (1995) to calculate the coefficients for η_{T_i,B_i} and $\eta_{,B_i,X}$. The details on the procedure used for calculation of the relevant coefficients are explained in Appendix C.

After estimating equations (C2) and (C4) from Appendix C, I obtained the results presented below.

Table 8. The coefficient of Output of elasticity Tax for 1977 - 2006

Tax type	Tax buoyancy	η_{T_i,B_i}	$\eta_{,B_i,X}$	$\frac{\bar{T}_i}{\bar{T}}$	Automatic elasticity
Personal Income tax	0.102	1.721	0.406	0.367	0.257
Company Income tax	0.668	0.638	1.500	0.332	0.317
Import duties	-0.858	-0.218	0.445	0.053	-0.005
Excise duties	-0.036	0.728	0.410	0.045	0.013
Export tax	0.390	0.977	0.664	0.050	0.033
GST/VAT	1.061	1.786	0.400	0.156	0.112
Overall Tax system	**1.328**				**0.726**

Source: Author's calculation

Despite some bizarre variations in the coefficients of the tax buoyancy and automatic elasticities for the individual tax type, the overall results for the tax system were plausible. The total quarterly tax elasticity was 0.726, less than the tax buoyancy over the years from 1977 to 2006. That implies that as the economy grew, the tax system automatically delivered a smaller portion of the national income to the government. The decreased share of the incremental in the GDP was transferred to the government through discretionary tax efforts. However, interpretation of the coefficients for each of the tax system requires detailed institutional information, which is beyond the scope of the paper. Notwithstanding this, I used the coefficients for the overall tax elasticity of the output for the tax elasticity restriction (i.e. $\alpha_{t,y} = 0.726$). The main justification is that the size of the coefficients for the overall tax buoyancy and elasticity of output did not deviate much from the related literature on PNG, as well as the estimates for other developing countries.

According to Kusi and Adjaye (1995), the total tax buoyancy and elasticity for PNG were 1.09 and 0.94, respectively. In Dudine and Jalles (2017), the long-run and short-run tax buoyancies for PNG were 1.12 and 1.09. Related studies for other developing nations found quite similar results. For example, Ranvik and Žilić (2011) computed the automatic tax elasticity of output for Croatia to be 0.95 and Mançellari (2011) estimate for that tax elasticity for Albania was 1.45.

Regarding the price elasticity of tax, I followed the similar approach but with some modifications because of the data limitation. I relied mostly on the assumptions used by Perotti (2005) and applied in other studies (for example Ranvik & Žilić, 2011; de Costra & de Cos, 2006). Perotti (2005) citing, Persson, Persson, and Svensson (1998), mentioned that it is impossible to credibly estimate the inflation elasticity of corporate income taxes because the effects could be both ways. Also, Perotti assumed the price elasticity of real-indirect taxes equals zero, claiming that elasticity of nominal revenue is unitary. Applying these assumptions, the price elasticities of all the indirect taxes, namely import duties, excise duties, export taxes and GST were zero, including the price elasticity of corporate or company profit taxes. Unlike Perotti (2005) and other papers, I could not calculate the price elasticity of social security taxes because of the nonexistence of the data.

After accounting for the price elasticities of indirect tax and company income tax, I calculated the price elasticity of personal income taxes in a standard linear model with the variables proposed by Perotti (2005). The regression was conducted on the personal income tax against the GDP deflator, while accounting for the real wage, GDP, and total employment index. Later the result was used together with other coefficients of the price elasticity of taxes to compute an overall weighted average of the price elasticity of taxes. Consequently, the overall parameter of price elasticity of net taxes amounted to -0.1924 (i.e. $\alpha_{t,p} = 0.1924$).

6.3.2 Estimating the price elasticity of Spending

To determine the price elasticity of spending, we need to decompose government spending components into wages, goods and services and capital investments (Mançellari, 2011). However, I could only divide total expenditure into current and capital investment spending given the nature of my dataset. Over the period under review, the average weights for the real current and capital investment spending as a share of total expenditure were 84 percent and 16 percent, respectively. Mançellari (2011) and Ranvik and Žilić (2011) citing Perotti (2005), stated that for non-wage spending on goods and services that might be indexed to prices within the quarter such as spending on drugs, nationalized hospitals, and schools, price elasticity will be 1.

The capital investments by the PNG Government are mainly contract based, where prices are determined in advance. Therefore, I followed Perotti's suggestion by setting the elasticity price of capital investment spending to zero.

In a simple linear process, I derived the prices elasticity of spending for the current spending, which included the wages[15] of public servants that was not indexed to inflation within the same quarter. Accordingly, the coefficient of the price elasticity of spending is -0.240 (i.e. $\alpha_{g,p} = 0.240$). The direction and size of the coefficient of the price elasticity of spending is within the range of estimates for other developing countries. For instance, Mançellari (2011) found the price elasticity of spending for Albania to be -0.34. Perotti (2005) recommended that the coefficient of price elasticity of real government spending below zero was legitimate. He suggested a coefficient value of -0.5, which was later applied in other studies (for example: Costra & de Cos, 2006; Caldara & Kamps, 2008; Ranvik & Žilić, 2011).

7. DISCUSSION OF RESULTS

This section discusses the main findings of my research based upon the impulse response functions (IRF) and the impact and cumulative fiscal multipliers obtained from the fiscal shocks. The structural shocks are usually interpreted as one standard deviation in the policy variables, and the impulse response explains the percent change of the responding variables (Mançellari, 2011). Given the absence of institutional information on the taxation policy, I prefer not to

[15] Perotti (2005) assumed that when wages are indexed to CPI with a considerable lag, the real government spending on wage will have elasticity of -1. This is because as inflation rises, real wage declines by the same magnitude.

discuss the effect of tax shock. The discussion entirely focuses on the effects of government expenditure shocks.

Table 9 presents the short-run coefficients of the benchmark model. However, as Ravnik and Žilić (2011) stated, the study is interested in the dynamics rather than estimating the parameters. Therefore, discussion of the short-run coefficients is excluded. Figure 8 presents the impulse responses of government spending, net tax, GDP, prices, interest rate and imports to one percent shock in government expenditure. Subsection 7.1 discusses the forecast error variance decomposition that explains the contributions to the variance decomposition of a variable by exogenous shocks to other variables. Subsection 7.2 presents the macroeconomic effects of shock in government expenditure, while subsections 7.3 and 7.4 discuss the impact of fiscal multipliers and robustness checks, respectively.

7.1. Forecast Error Variance Decomposition

Variance decomposition is a VAR tool that shows the composition of the variance in the next period that specific shocks have. That is, it breaks down the proportions of the forecasting error variance decomposition of a variable explained by exogenous shocks to other variables. Table 10 shows the quarterly variance decomposition generated by the benchmark model. The results show that in quarter one, more than 97.0 percent of the variation of the fluctuations in government spending, net tax, GDP, interest rate and imports are explained by their own shocks. In the same period, the shock to price accounts for 89.5 percent of the variation in the fluctuation of its own shocks. The shock in spending accounts for less than 1 percent of the forecasting error variances of the GDP after the first quarter, implying that spending shock less explains the short-run variations in the fluctuations of output.

7.2. Macroeconomic effects of government expenditure shock

In Figure 7, we find that a one standard deviation in shock expenditure in the first quarter led to an increase of 0.196 percent of government spending, which is about 1.4[16] percent as a share of real GDP. From the impulse responses generated, we notice that the increment in government spending was only temporary. Concurrently, the tax[17] revenue negatively responded to the economic shock in the first three quarters but rose to 0.02 percent after the fourth quarter, implying the automatic stabilizer effect. It is obvious that around the time of shocks, output declined affecting the tax revenue.

A one standard deviation expenditure shock on impact caused the price to decline by 0.001 percent and remained around the same level all throughout. Despite the conflicting direction of change in the price, the magnitude of change reflects the stickiness of price in the short run. Sampson et al. (2006) found that a huge portion of inflation in PNG was driven by external factors such as foreign inflation. The impact of government spending on prices in PNG occurs through the induced pass-through effects of depreciation in the kina exchange rate (Kannapiran, 1998).

As for the interest rate, a one standard deviation in expenditure caused the 6-month treasury bill rate to increase by 0.099 percent in the first quarter then peaked at 0.519 percent

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[16] As in Perotti (2004) and Mançellari (2011), I multiplied the impulse response of government spending with the average spending share of GDP (0.0707). This transforms the shock to 1 percentage point of GDP. Same logic is applied in interpreting the impulse response of imports to shock in government spending.

[17] Due to lack of institutional information about changes in the tax policy, it is difficult to substantiate the discussion on the effect of tax shock.

after the ninth quarter before returning to the trend. The positive response of interest rate to shock in government spending is consistent with our theoretical assumption.

With regards to imports, a one standard deviation in expenditure shock in the first quarter led to an increase of 0.009 percent or 0.3 percent as a share of real GDP in imports. The increment in imports peaked at 0.037 percent, which is about 1.3 percent as a share of real GDP in the second quarter, then returned to its long-run trend after the fourth quarter. The co-movement in the impulse responses of imports and government spending is as expected. Since nearly all the consumer and producer goods in PNG are sourced from abroad, I presume that considerable portion of government spending eventually translated into imports. For example, in 1997 the government directly imported 5500 tonnes of rice to nourish the population affected by the drought (Allen &Bourke, 2001).

For domestic output, a one standard deviation in expenditure shock caused the GDP to rise by 0.001 percent in the first quarter, then marginally improved over time. The results suggest that output is less influenced by shock in expenditure in the short-run, albeit the fact that response was positive. For the five-year periods, the increment in GDP is below 0.02 percent. I computed the impact and cumulative multipliers to provide more insight on the effectiveness of higher government spending on domestic output.

7.2. Fiscal multipliers

The direction and magnitude of the fiscal multiplier impact on the GDP are of great interest to economists and analysts. Following Garica, Lemus, and Mrkaic (2013), I calculated the fiscal multiplier impact using equations (D1) and (D2) provided in Appendix D. Table 11 presents the results on the impact and cumulative multipliers. I was unable to implement the bootstrapping procedures in E-views 10 unlike other papers (for example, Garica, Lemus & Mrkaic, 2013; Perotti 2005) to compute the standard errors for the fiscal multipliers. The standard errors for each of the IRF were derived from Monte Carlo simulation with 500 iterations.

The results show that the impact multiplier is 0.06 and the cumulative multiplier is 0.21 in a year after the shock. The cumulative multiplier indicates that it takes at least five years for the increment in GDP to exceed the cumulative expenditure shock. The low spending multipliers are explained by increases in imports and domestic interest rate. Further analysis to test the effect of increased government spending on private consumption and investment was constrained by the absence of the appropriate data. Nevertheless, the size of the spending multipliers is within the range of those for the developing countries (see; Ilzetzki, Mendonza & Vegh, 2012; Batini, Eyraud & Weber, 2014)[18].

7.4. Robustness checks

As briefly mentioned in section 5.2, I checked for the sensitivity of the results by investigating the impact of adjusting the trends in the benchmark model in three ways: a) include a deterministic trend, as in Blanchard and Perotti (2002) but specific to the fiscal and import variables that were trend stationary at levels; b) test the benchmark model in first difference; and c) conduct the analysis using the detrended series derived by the HP filter with a default smoothing lambda parameter of 1600. In this regard, I developed three separate models

[18] These literatures found that the spending multipliers for developing countries were between -0.3 to 0.8.

representing each of the cases (i.e., a, b & c)[19]. According to Yadav, Upadhyay & Sharm (2012, p.436), "If the series is not detrended, the estimated shock is a linear combination of the temporary and permanent shocks."

Thus, it is paramount to ensure that the detrend series are stationary to study the impact of the temporary shocks. Yadav, Upadhyay, and Sharm (2012) citing Baxter and King (1993) emphasized that the temporary and permanent shocks have different effects on the economy. Therefore, I conducted the unit root test in the detrended series. The unit root tests confirmed that all the detrended series were stationary after the first difference. Nevertheless, running the HP filter detrended series in first difference generated errors, so I conducted the test in level. The respective impulse responses of the three models A, B, and C are provided in Figure 8.

The model A results show that expenditure shocks caused government spending to increase by 0.189 percent or 1.3 percent as a share of real GDP but declines in the second quarter then increase to 0.038 percent after the fourth quarter. In the first quarter, a one percent increase in government spending drives the interest rate up by 0.125 percent. Simultaneously, imports rise by 0.009 percent or 0.3 percent as a share of real GDP. GDP responses positively with an increment of 0.0003 percent and then, gradually improves over time but at a lower rate.

Model B finds that government spending in quarter one increases by 0.196 percent or 1.4 percent as a share of real GDP in response to the expenditure shock. As such, a one percent increment in government spending causes the GDP, interest rate, and imports to increase by 0.0006 percent, 0.112 percent, and 0.004 percent, respectively in the first quarter. The price only increases in the second quarter by 0.0018 percent then falls to the trend.

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[19] Refer to Figure 9 for descriptions about each of the model (i.e. models A, B & C) used to check the robustness of the baseline analysis.

The results of model C find government spending rises by 0.0006 percent or 0.004 percent as share of real GDP. Although the spending tends to increase consecutively, the magnitude of the change is relatively below 0.05 percent. The GDP on impact responses negatively to a one percent increase in government spending then steadily increases over time but the increments are immaterial, remaining below 0.5 percent. A one percent increase in government spending triggers imports to increase by 0.001 percent or 0.03 percent as a share of real GDP.

In comparison with the benchmark model, we find that the impulse response results of the three alternate models are less robust. However, the directions of the impulse responses of government spending, net tax, GDP, price, interest rate and imports to the expenditure shocks agree with the results of the benchmark model. These findings reaffirm the results of the benchmark model.

8. CONCLUSION

The analysis shows that government spending responded positively to the expenditure shock but declined in the rest of the quarters, suggesting that fiscal reaction was only temporary. As a result, the impact on domestic output was low, indicated by the small size of the impact and cumulative spending multipliers. Based on the analysis, it can be inferred that increases in imports and interest rate absorbed a significant portion of the effect of increased government spending.

However, we do not know whether the effects of fixed exchange rate regime outweigh the flexible exchange rate regime due to data limitation. The theoretical analysis showed that higher government spending stimulates output under the flexible exchange rate regime and zero capital mobility in PNG. It may be possible that the supply side shock resulting from the unforeseen events masks the impact of spending on domestic output, which is an area of interest for future study.

Because of the numerous data issues, the paper acknowledges the following drawbacks for future research. Firstly, constrained by the lack of institutional data, I used the aggregate data in the analysis. Using the sectoral fiscal data and components of the GDP will deepen our understanding of the impact of fiscal shocks on economic activity. It will also assist us to obtain credible estimates for the short-run coefficients of the output and price elasticities of fiscal variables. Moreover, I excluded the discussion on tax shock due to insufficient institutional information to motivate the empirical analysis. Secondly, I did not separate the analysis for the two different exchange rate regimes because a small sample size would reduce the degree of freedom, affecting the robustness of the results (Ravnik & Žilić, 2011). However, it will be interesting to determine the fiscal multipliers under the flexible exchange rate in future when data is accumulating. Thirdly, the study did not account for other shocks that simultaneously occurred around the same time (Mountford & Uhlig, 2005). If government expenditure shock had not significantly influenced output, perhaps other shocks such as monetary policy and supply-side shocks might be dominant. Also, the SVAR approach adopted does not account for the effects of anticipated fiscal shocks.

Nonetheless, the empirical results drawn from this study suggest that government spending has not been highly effective in stabilizing output in the short run. With monetary policy independence and the flexible exchange rate regime, as capital mobility improves over time, it is likely that government spending will remain less potent in stabilizing output in the short-run. That points towards the importance of monetary policy as an effective short-run output stabilization tool, which can be examined in a future research. Addressing the data and technical issues highlighted in future research can improve our understanding of the effects of fiscal shocks on the PNG economy. Also, we could have a clear idea of whether fiscal policy or monetary policy is an effective short-run output stabilization policy tool for PNG. To this end, I hope that the findings of this paper will stimulating interests for further research on the topic of fiscal shock in PNG.

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APPENDIX A. FISCAL POLICY IMPACT UNDER FIXED EXCHANGE RATE REGIME AND ZERO CAPTAL MOBILITY

The equations (1) and (4) for the goods market, money market and BOP equilibrium conditions in the extended form are

$$Y_t - (1-\beta_n)E(Y_t - T_t + M_{t-1}, r_t) = (1-\beta_n^g)G_t + \bar{e}\bar{D}^*, \quad \text{(A1)}$$

$$M(Y_t - T_t + M_{t-1}, r_t) + \beta_n E(Y_t - T_t + M_{t-1}, r_t) = \bar{e}\bar{D}^* + M_{t-1}. \quad \text{(A2)}$$

That is a two-equation system with two endogenous variables, Y_t and r_t. To determine the impact of government spending that is debt-financed, we differentiate equations (A1) and (A2) with respect to Y, R and, G by total differentiation.

$$\left[1-(1-\beta_n)E_y\right]dY - (1-\beta_n)E_r dr = (1-\beta_n^g)dG, \quad \text{(A3)}$$

$$\left(M_y + \beta_n E_y\right)dY + (M_r + \beta_n E_r)dr = 0. \quad \text{(A4)}$$

Since I am interested in the impact of fiscal policy, I divide both equations by change in government spending, dG. Thus, we obtain the following equations.

$$\left[1-(1-\beta_n)E_y\right]\frac{dY}{dG} - (1-\beta_n)E_r\frac{dr}{dG} = 1-\beta_n^g, \quad \text{(A5)}$$

$$\left(M_y + \beta_n E_y\right)\frac{dY}{dG} + (M_r + \beta_n E_r)\frac{dr}{dG} = 0. \quad \text{(A6)}$$

Further, I rearrange the equations (A5) and (A6) in matrix form.

$$\begin{bmatrix} 1-(1-\beta_n)E_y & -(1-\beta_n)E_r \\ M_y+\beta_n E_y & M_r+\beta_n E_r \end{bmatrix}\begin{bmatrix} dY/dG \\ dr/dG \end{bmatrix} = \begin{bmatrix} 1-\beta_n^g \\ 0 \end{bmatrix}. \tag{A7}$$

Apply Cramer's Rule to solve for dY/dG.

$$\frac{dY}{dG} = \frac{\begin{bmatrix} 1-\beta_n^g & -(1-\beta_n)E_r \\ 0 & M_r+\beta_n E_r \end{bmatrix}}{\begin{bmatrix} 1-(1-\beta_n)E_y & -(1-\beta_n)E_r \\ M_y+\beta_n E_y & M_r+\beta_n E_r \end{bmatrix}}, \tag{A8}$$

$$\frac{dY}{dG} = \frac{(1-\beta_n^g)(M_r+\beta_n E_r)}{[1-(1-\beta_n)E_y](M_r+\beta_n E_r)+(M_y+\beta_n E_y)(1-\beta_n)E_r}. \tag{A9}$$

Following Frenkel and Razin (1978), I assume that $1-E_y = s$, denotes the marginal propensity to save and $\beta_n E_y = a$ is import from income or assets, respectively, and $\beta_n^g = a^g$. Hence, I obtain the short-run impact of change in government spending on domestic output as

$$\frac{dY}{dG} = \frac{\overbrace{(1-a^g)}^{+}(\overbrace{M_r}^{-}+\overbrace{\beta_n E_r}^{-})}{\underbrace{(s+a)}_{+}\left(\underbrace{M_r}_{-}+\underbrace{\beta_n E_r}_{-}\right)+\underbrace{(M_y}_{+}+a)\left(\underbrace{1-\beta_n}_{+}\right)\underbrace{E_r}_{-}}. \tag{A10}$$

The equation (A10) shows that multiplier impact of government spending on the economy depends on the magnitude of the marginal propensities to save and import, government's share of imports and the induced change in interest rate and money supply. For the condition $\frac{dY}{dG} > 0$ to hold, I assume that $M_y > 0$, $M_r < 0$ and $E_y < 0$.

APPENDIX B. FISCAL POLICY IMPACT UNDER FLEXIBLE EXCHANGE RATE REGIME AND ZERO CAPTAL MOBILITY

The equilibrium conditions of the goods market, money market, and BOP under no capital mobility are

$$Y_t = (1-\beta_n)E(Y_t - T_t + A_{t-1}, r_t) + (1-\beta_n^g)G + e_t\overline{D}^*, \tag{B1}$$

$$\overline{M} = M(Y_t - T_t + M_{t-1}, r_t), \tag{B2}$$

$$0 = e_t\overline{D}^* - \beta_n E(Y_t - T_t + A_{t-1}, r_t). \tag{B3}$$

Rearranging the equations (B1), (B2) and (B3), I obtain

$$Y_t - (1-\beta_n)E(Y_t - T_t + A_{t-1}, r_t) - e_t\overline{D}^* = (1-\beta_n^g)G, \tag{B4}$$

$$M(Y_t - T_t + A_{t-1}, r_t) = \overline{M}, \tag{B5}$$

$$e_t\overline{D}^* - \beta_n E(Y_t - T_t + A_{t-1}, r_t) = 0. \tag{B6}$$

Hence, the total differential of the two functions with respect to Y, r, e, and G are,

$$\left[1-(1-\beta_n)E_y dY\right] - (1-\beta_n)E_r dr - \overline{D}^* de = (1-\beta_n^g)dG, \tag{B7}$$

$$M_y dY + M_r dr = 0, \tag{B8}$$

$$-\beta_n E_y dY - \beta_n E_r dr + \overline{D}^* de = 0. \tag{B9}$$

Collecting the like terms and dividing the equation system by dG I get,

$$\left[1-(1-\beta_n)E_y\right]dY/dG-(1-\beta_n)E_r dr/dG-\bar{D}^* de/dG=(1-\beta_n^g), \tag{B10}$$

$$M_y dY/dG+M_r dr/dG=0, \tag{B11}$$

$$-\beta_n E_y dY/dG-\beta_n E_r dr/dG+\bar{D}^* de/dG=0. \tag{B12}$$

We then represent the system in the matrix form:

$$\begin{bmatrix} \left[1-(1-\beta_n)E_y\right] & -(1-\beta_n)E_r & -\bar{D}^* \\ M_y & M_r & 0 \\ -\beta_n E_y & -\beta_n E_r & \bar{D}^* \end{bmatrix} \begin{bmatrix} dY/dG \\ dr/dG \\ de/dG \end{bmatrix} = \begin{bmatrix} (1-\beta_n^g) \\ 0 \\ 0 \end{bmatrix}. \tag{B13}$$

Apply Cramer's Rule to solve for dY/dG.

$$\frac{dY}{dG}=\frac{\begin{bmatrix} -(1-\beta_n^g) & (1-\beta_n)E_r & -\bar{D}^* \\ 0 & M_r & 0 \\ 0 & -\beta_n E_r & \bar{D}^* \end{bmatrix}}{\left[(1-E_y)M_r+E_r M_r\right]\bar{D}^*}, \tag{B16}$$

$$\frac{dY}{dG}=\frac{-(1-\beta_n^g)M_r}{(1-E_y)M_r+E_r M_y}. \tag{B17}$$

Applying the assumptions that $a^g=\beta_n^g$ and $S=(1-E_y)$ following Frenkel and Razin the final solution is

$$\frac{dY}{dG}=\frac{(1-a^g)\overbrace{M_r}^{-}}{\underbrace{SM_r}_{-}+\underbrace{E_r M_y}_{-}}. \tag{B17}$$

Fiscal expansion impact on domestic output is positive, dY/dG>0, such that $M_r < 0, M_y > 0$ and $E_r < 0$. The analysis shows that impact of government spending under the flexible exchange rate and no capital mobility depends on the government's import share, marginal propensity to save and the crowding out effect. Unlike the fixed exchange rate case, the marginal propensity to import does not appear in equation (B17). This is because the domestic currency value of PNG's exports ($e_t\overline{D}^*$) must adjust exactly to compensate for the increase in imports to bring about the BOP equilibrium. As such, in the simplification process the variable cancelled out.

APPENDIX C. CALCULATING THE AUTOMATIC TAX ELASTICITY OF OUTPUT

The parameter η_{T_i,B_i} was calculated through the individual tax revenue equation represented as

$$\ln(T_i^*)_t = a_{i0} + a_{i1}\ln(X_i)_t + a_{i2}(\tau_i)_t + \epsilon_{it} , \tag{C1}$$

where, X_i is the potential tax base and τ_i denotes own tax system. In Kusi and Adjaye (1995), the proxies for the potential tax bases for personal income tax, import duties and excise duties were GDP per capita, and the total value of imports and private consumption, respectively. Mançellari (2011), used private consumption and total import values for value added tax and excise tax, and customs duties, respectively, but combined the personal and company income taxes as direct tax with base of GDP at factor prices. For this paper, I chose compensation of employees, gross operating surplus, total value of imports and exports as potential base proxies for the personal income tax, company income tax, import duties and export tax, respectively. Ranvik and Žilić (2011) also used the gross operating surplus as proxy for the profit tax. The potential base of the goods and services tax and excise duties was private consumption (refer to Table.7 for the summary). Unfortunately, the data series for the components of GDP were updated only to 2006. Therefore, the dataset[20] for elasticity calculation only covers periods 1977 to 2006 but, it captures more recent developments in the tax system than Kusi and Adjaye (1995), especially

[20] The dataset for elasticity calculations all came from the QEB publication accessed from https://www.bankpng.gov.pg/statistics/quarterly-economic-bulletin-statistical-tables/

with the inclusion of the goods and services tax. The same sample range applies to the calculation of spending elasticity. In conformity with the main analysis, I maintained the same definition of fiscal variables and seasonally adjusted the rest of the variables by the X-12 method, then expressed them in the natural logarithm of real terms.

Initially, Kusi and Adjaye augmented the equation (C1) with a partial adjustment mechanism to reflect the tax inspector's adjustment of the actual individual tax revenue by substituting the function $\Delta \ln(T_i)_t = \lambda_i[\ln(T_i^*)_t - \ln(T_i)_{t-1}]$ into it. The adjustment process explains that tax inspector adjusts the actual individual tax, $\ln(T_i)_t$ with a factor of the difference between the assessed tax revenue, $(T_i^*)_t$ and the actual from the previous period. However, constrained by the absence of information on assessed taxes, I assumed that the tax inspector simply uses the information on tax turnover for the past four quarters to analyse current tax performance. As such, I estimated the individual tax elasticity from the following equation,

$$\ln(T_i)_t = a_{i0} + a_{i1}\ln(X_i)_t + \sum_{j=1}^{4} a_{ij} \ln(T_i)_{t-j} + a_{i2}(\tau_i)_t + v_{it}, \qquad \text{(C2)}$$

where: a_{i1} denotes the elasticity of T_i in relation to taxbase X_i; a_{ij} represents a percent change in T_i resulting from a unit change of past taxes; a_{i2} is the long-run coefficient of a percentage change in T_i in relation to a unit change in τ_i; and the unexplained variations are captured in the error term denoted by v_{it}. While other series were observable, Kusi and Adjaye generated the time series for τ_i from

$$\tau_i = \left[(\tau_i)_t \frac{(1+g_i)_t}{(1+\theta_i g_i)_t}\right] \qquad \text{(C3)}$$

where $(\tau_i)_t = T_i/X_i$ is the average effective rate of tax and $g_{i,t} = \ln(X_i)_t - \ln(X_0)_t$ measures the endogenous change in the *i*th individual tax base over the period, beginning with the first year. As a result, the coefficient a_{i2} captures the direct response of each tax to its corresponding "discretionary tax measures" (DTM) and a_{i1} measures the response of the individual tax to the endogenous change in its base. The coefficient a_{i1} is what we are interested in to estimate η_{T_i,B_i}.

About the coefficient, $\eta_{,B_i,X}$ for the tax base, the elasticity calculation resembles the procedure of the individual tax elasticity described above. With X_i being the individual tax base, τ_m/τ_p (where m=import tax and p=personal income tax) is a variable that measures the DMT's impact related to each indirect tax on X_i, a generic form of the tax base elasticity equation:

$$\ln(X_i)_t = \beta_{i0} + \beta_{i1}\ln(GDP)_t + \beta_{i2}\left(\tau_m/\tau_p\right)_t + \beta_{i3}(\tau_i)_t + u_{it} \ . \quad \text{(C4)}$$

The coefficient, $\beta_{i1} = \eta_{,B_i,X}$ measures the elasticity of individual tax base to change in economic activity, while β_{i2} and β_{i3} capture the percent change in X_i in relation to a unit change in DTM and a percent change corresponding to a unit adjustment in the individual tax system.

APPENDIX D. ESTIMATING THE FISCAL MULTIPLIER

The study of the fiscal multiplier has been of great interest to economists since the era of John Maynard Keynes. Fiscal multipliers measure the extent to which a unit increase in government spending or tax measure affects output. There are several approaches to estimate fiscal multipliers (Ilzetzki, Mendonza & Vegh, 2012). Principally, the three broad methods to calculate fiscal multiplier are macroeconometric forecasting models, time series models and Dynamic Stochastic General Equilibrium model (Whalen & Reichling, 2015). This paper used the time series model consistent with the principal analysis. Accordingly, this paper adopted the methodology prescribed in Garica, Lemus, and Mrkaic (2013). The fiscal multiplier is usually examined in terms of the impact and cumulative effects.

Garica, Lemus, and Mrkaic (2013) defined the Impact multiplier (IM) as the contemporaneous effect of a unit change in fiscal variables on output at a time, t=1 (the period when the shock occurred). They calculated the IM directly from the impulse response function (IRF) then adjusted the contemporaneous multiplier with the weighted average ratio of the fiscal variable[21] share the total GDP. The correction was mainly to represent the values in the same unit as the variables used to estimate the IRF, which were initially in the natural logarithm form. Hence, the IM equation is

$$IM = \frac{\Delta Y_1}{\Delta G_1} = \frac{\Delta GDP_1}{\Delta G_1} \div \frac{\bar{G}}{\bar{Y}} \qquad \text{(D1)}$$

[21] Similar application can be used for tax multiplier.

where ΔY=change in output/ GDP, ΔG=change government spending and $\bar{G}/\bar{Y}$=weighted average of government spending share of GDP. If IM>1 then we know that government spending had a multiplier effect as output increase by more than the initial unit of spending. On the contrary, the IM<1 imply that portion of the spending effect has eroded and the apparent impact on output was lower than the initial rise in public expenditure.

In the same way, we can represent the function of the cumulative multiplier (CM). The CM measures the ratio of the cumulative effect of output to the cumulative change in government spending on the cumulative response of GDP over the post-shock periods. The CM fundamentally helps us to evaluate the fiscal policy effect over the longer forecast horizon (Ilzetzki, Mendonza & Vegh, 2012). As in the case of IM, we can correct the CM value with the weighted average of G share of Y. The final equation now takes the following form,

$$CM = \frac{\sum_{j=1}^{J} \Delta Y_j}{\sum_{j=1}^{J} \Delta G_j} = \frac{\sum_{j=1}^{J} \Delta GDP_j}{\sum_{j=1}^{J} \Delta G_j} \div \frac{\bar{G}}{\bar{Y}} \; . \qquad \text{(D2)}$$

The CM for J→∞ is defined as the long-run multiplier, however, in practice, one can use some finite number of periods expected for the multiplier to converge towards the long-run trend (Garica, Lemus & Mrkaic, 2013). Aligned with the time horizon for every Medium-Term Development Strategy[22] of the PNG Government, the paper used 24 quarters.

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[22] MTDS is an overarching development plan of the PNG Government that outlines the strategy to address the inherent economic issues over the five-year periods through the public expenditure program. A sample of the document can be accessed from,

http://aciar.gov.au/files/node/777/PNG%20medium%20term%20development%20strategy%202005-2010.pdf

Spilimbergo, Symansky, and Schindler (2009) comprehensively discussed some underlying reasons for the varying size and signs of the fiscal multipliers. The size of the fiscal multiplier depends on the marginal propensity to save, marginal propensity to imports, monetary conditions that include the exchange rate regime, the stability of the country's fiscal position after the stimulus, and degree of the development of the domestic financial market.

According to Ilzetzki, Mendonza and Vegh (2012) the impact and cumulative spending multiplier for high-income countries were 0.37 and 0.80, respectively. For the developing countries, the impact and cumulative multipliers were -0.21 and 0.18, respectively. The authors found that countries with closed economies or fixed exchange rate systems had high fiscal multipliers than those with flexible exchange rate regime and open trade economies. Moreover, Batini, Eyraud and Weber (2014) found that the short-run spending multipliers for developing countries were within the range of -0.3 and 2.8[23]. Based on these results, one would expect the spending multiplier for PNG to be within the range of the developing countries.

[23] Excluding China and Malaysia, the range is -0.3 to 0.8.

APPENDIX E: TABLES

Table 1. Percentage share of GDP by Sector

Sectors	1980	1985	1990	1995	2000	2005	2010	2014
Agriculture/forestry/fishing	33	33	29	34	34	33	25	22
Mining & quarring[1]	13	10	15	19	25	26	26	26
Manufacturing	10	11	9	8	7	6	3	3
Construction	4	4	5	4	5	8	12	10
Wholesale & retail trade	8	10	10	8	3	6	14	13
Finance, insurance, real estate & buss. Serv	6	4	1	3	4	3	12	9
others	27	28	32	24	21	18	9	16

Source: QEB publication and Author's calculations

Table 2. Selected macroeconomic variables as percentage share of nominal GDP

Variables	***1976***	***1977***	***1978***	***1979***	***1980***	***1981***	***1982***	***1983***
Gov't Expenditure	34.2	16.6	33.5	32.2	35.0	39.2	38.2	32.4
Imports	29.4	34.5	34.6	34.4	40.0	43.9	43.0	38.0
Gross savings	22.7	29.7	27.5	29.1	19.9	10.9	11.0	14.3
Tax Revenue	14.9	7.6	10.1	8.0	9.3	11.7	13.0	12.0
	1984	***1985***	***1986***	***1987***	***1988***	***1989***	***1990***	***1991***
Gov't Expenditure	32.5	31.5	32.5	30.5	28.8	33.9	35.4	33.0
Imports	37.4	36.0	35.1	34.9	37.8	37.8	34.4	37.1
Gross savings	17.9	12.3	15.4	13.5	18.3	11.0	17.1	21.1
Tax Revenue	18.0	17.2	17.2	17.5	17.9	22.6	19.5	17.3
	1992	***1993***	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***
Gov't Expenditure	32.1	32.7	28.4	28.3	27.4	28.0	27.3	31.7
Imports	30.2	22.8	24.2	26.2	29.4	29.8	28.6	31.3
Gross savings	20.7	25.5	28.1	35.1	26.2	14.8	18.4	18.9
Tax Revenue	18.0	20.1	20.4	19.5	22.5	23.7	20.5	21.8
	2000	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***
Gov't Expenditure	32.9	31.0	31.6	28.3	32.8	34.9	34.8	34.9
Imports	28.5	30.4	36.0	33.7	37.2	31.4	36.0	41.5
Gross savings	32.5	28.3	17.5	30.5	30.4	…..	…..	…..
Tax Revenue	23.8	20.9	20.4	21.3	25.7	25.0	29.3	31.1
	2008	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	
Gov't Expenditure	35.0	29.9	30.6	30.7	34.1	36.1	34.8	
Imports	39.3	35.4	36.3	32.9	31.0	35.2	23.7	
Gross savings	…..	…..	…..	…..	…..	…..	…..	
Tax Revenue	26.6	22.3	24.4	25.9	25.4	24.8	23.0	

Source: Author's calculations using various QEB tables and World bank database for Gross savings

Table 3. Description of the variables

Variable	Description	Source[24]
Endogenous		
Log_G_t	Log of net real spending (excl. interest costs). Transfer payment could not be subtracted because it also contained other spending related to unforeseen events, which this paper referred to as spending shocks.	QEB, Table 7.1. *"Fiscal Operations of the Government."* The pre-1991 fiscal series were annual, so I interpolated them by the quadratic method. I also used the quarterly series computed by Kannapiran (1998). In the analysis, I use Kannapiran's dataset for pre-1991 because it turned out to produce better results than the interpolated series.
Log_T_t	Log of net real taxes (excl. interest costs). The reasoning for not subtracting transfer payments is same above.	
Log_Y_t	Log of real GDP (interpolated series).	World Bank's online database, https://data.worldbank.org/country/papua-new-guinea Interpolation of the series was done through linear method.
Log_P_t	Log of GDP deflator, as a measure of the overall price level (interpolated series).	
R_t	Nominal interest rate	QEB, Table 6.3. *"Other Domestic Interest Rates"*
Log_M_t	Total Imports	QEB, Tables 8.1 A & B: *"Balance of payments."*
Exogenous		
Y_t^*	Total GDP of OECD nations in annual growth rates (current quarter relative to the corresponding time of the previous year).	OECD's online database, https://data.oecd.org/gdp/quarterly-gdp.htm#indicator-chart
Exdum	A dummy denotes the change in the exchange rate regime. The fixed exchange rate era has zero (1976Q1-1994Q3), while rest is set to unitary for the period of the flexible exchange rate.	
Deterministic components	Based on data visualization and interpolation method, both constant and trend are tested.	

Source: Author's own choice of variables primarily based on Perotti (2005)

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[24]The data from the Quarterly Economics Bulletin (QEB) publications of the Bank of Papua New Guinea are found on, https://www.bankpng.gov.pg/statistics/quarterly-economic-bulletin-statistical-tables/

Table 4. Unit Root Tests

Variable	Augmented Dicky Fuller Test P-values				Philip Perron Test P-values			
	Level	First Diff	Constant	Trend	Level	First Diff	Constant	Trend
Log_Y_t		0.0000	√			0.0000	√	
Log_P_t		0.0115	√			0.0000	√	
Log_G_t	0.0290		√	√	0.0000		√	√
Log_T_t	0.0005		√	√	0.0004		√	√
R_t	0.0106		√		0.0637		√	
Log_M_t	0.0270		√		0.0016		√	
Y_t^*	0.0019		√		0.0151		√	

The null hypothesis for both tests is that variable has unit roots. Reject the null for p-values less than 5%. All the variables are in natural logarithm form except the interest rate.

Variable	Kwiatkowski-Philip-Smith-Shin LM Statistics			
	Level	First Diff	Constant	Trend
Log_Y_t		0.234545***	√	
Log_P_t	0.172235*		√	√
Log_G_t	0.210223*		√	√
Log_T_t	0.101038***		√	√
R_t	0.455352***		√	
Log_M_t	0.063479***		√	√
Y_t^*	0.052984***		√	√

Ho: variable is stationary.
The symbols *, ** and *** denote the 1%, 5% and 10% level of significance, respectively, for failing to reject the null.

Source: Author's calculation. Table format was adopted from Mançellari (2011)

Table 5. Johansen Cointegration Test

Sample: 1976Q1 2014Q4
Included observations: 151
Series: LOG_GT LOG_TT LOG_YT LOG_PT RT_SA LOG_MT
Exogenous series: YTF EXDUM
Warning: Rank Test critical values derived assuming no exogenous series
Lags interval: 1 to 4

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	5	3	2	3	2
Max-Eig	2	1	1	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Source: E-views 10 output of Author's calculation

Table 6. VAR Lag Order Selection Criteria

Endogenous variables: LOG_Gt LOG_Tt LOG_Yt LOG_Pt Rt LOG_Mt
Exogenous variables: C Yt* EXDUM
Sample: 1976Q1 2014Q4
Included observations: 148

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-337.4197	NA	4.91e-06	4.802969	5.167495	4.951075
1	753.0495	2048.314	3.18e-12	-9.446614	-8.353037*	-9.002296
2	839.5928	155.5442	1.61e-12	-10.12963	-8.307004	-9.389103*
3	878.2648	66.36955	1.57e-12*	-10.16574	-7.614060	-9.128999
4	906.9163	46.84894	1.75e-12	-10.06644	-6.785704	-8.733482
5	952.4755	70.80150*	1.57e-12	-10.19561*	-6.185831	-8.566449
6	978.9729	39.02991	1.85e-12	-10.06720	-5.328365	-8.141823
7	994.8759	22.13529	2.53e-12	-9.795620	-4.327733	-7.574030
8	1026.307	41.20066	2.85e-12	-9.733883	-3.536944	-7.216081

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: E-views 10 output of Author's calculation

Table 7. Major components of the Tax system and their potential Bases

Tax type	Proxy Tax Base
Personal Income tax	Compensation of employees
Company Income tax	Gross operating Surplus
Import duties	Total value of imports
Excise duties	Private consumption
Export tax	Total value of exports
GST/VAT	Private consumption

Source: Author's selection from Kusi and Adjaye (1995), Mançellari (2011), and Ranvik & Žilić (2011).

Table 9. Estimated coefficients of the A and B matrices of the Benchmark model

$$A=\begin{bmatrix} 1 & 0 & 0 & 0.24 & 0 & 0 \\ 0 & 1 & -0.73 & -0.19 & 0 & 0 \\ -0.003 & 0.009 & 1 & 0 & 0 & 0 \\ 0.006 & 0.016 & 0.441 & 1 & 0 & 0 \\ -0.587 & -0.467 & 13.184 & 0.147 & 1 & 0 \\ -0.051 & -0.02 & 0.924 & -0.16 & -0.003 & 1 \end{bmatrix} \text{ and } B=\begin{bmatrix} 0.195 & 0 & 0 & 0 & 0 & 0 \\ -0.011 & 0.15 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.01 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.015 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1.65 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.108 \end{bmatrix}$$

Source: Author's calculation obtained from V-Views 10 output

Table 10. Variance decomposition of the benchmark model

Period	S.E.	Log_Gt	Log_Tt	Log_Yt	Log_Pt	Log_Rt	Log_Mt
Variance Decomposition of LOG_Gt:							
1	0.195223	99.96335	0.000467	0.003100	0.033087	0.000000	0.000000
4	0.261221	78.21032	7.049242	7.366445	4.404860	2.688254	0.280878
8	0.303079	71.60667	7.262450	8.692480	9.451075	2.455217	0.532107
12	0.333692	67.52528	7.119531	9.616762	12.52844	2.559425	0.650565
16	0.359498	64.66713	6.916707	11.71529	13.76023	2.348888	0.591757
20	0.383841	61.48694	6.846615	14.67787	14.31992	2.134955	0.533695
Variance Decomposition of LOG_Tt:							
Period	S.E.	Log_Gt	Log_Tt	Log_Yt	Log_Pt	Log_Rt	Log_Mt
1	0.148827	0.534210	99.24258	0.188211	0.034998	0.000000	0.000000
4	0.205199	2.446077	74.39705	0.295356	16.22623	0.440953	6.194336
8	0.219728	2.476877	67.84281	0.987265	16.64868	0.462057	11.58230
12	0.223853	2.497292	65.40130	0.982947	16.69275	0.556008	13.86970
16	0.227727	2.872228	63.33922	1.084356	17.36502	0.824103	14.51507
20	0.231604	3.500963	61.44258	1.513446	18.45528	0.874020	14.21371
Variance Decomposition of LOG_Yt:							
Period	S.E.	Log_Gt	Log_Tt	Log_Yt	Log_Pt	Log_Rt	Log_Mt
1	0.010139	0.579643	1.684487	97.73454	0.001333	0.000000	0.000000
4	0.035156	0.824532	2.589703	95.78127	0.333097	0.191926	0.279477
8	0.060716	1.146720	4.190224	90.35472	2.511283	0.244836	1.552216
12	0.081905	1.826232	5.356947	84.55298	5.660816	0.330711	2.272310
16	0.101090	2.392275	5.947956	80.00439	8.447237	0.424755	2.783392
20	0.118360	2.924456	6.299352	75.50694	11.62982	0.372347	3.267081
Variance Decomposition of LOG_Pt:							
Period	S.E.	Log_Gt	Log_Tt	Log_Yt	Log_Pt	Log_Rt	Log_Mt
1	0.015639	0.836942	1.262696	8.387925	89.51244	0.000000	0.000000
4	0.049452	0.588053	2.443162	5.005481	91.64515	0.250763	0.067390
8	0.072502	0.611118	1.828371	3.093712	92.28450	1.145535	1.036763
12	0.084220	0.655177	1.674013	2.322225	92.43340	1.036436	1.878746
16	0.094010	0.699122	1.692273	1.896820	92.62609	0.854711	2.230983
20	0.102017	0.710467	1.757200	1.624328	92.49976	0.832557	2.575691
Variance Decomposition of Rt:							
Period	S.E.	Log_Gt	Log_Tt	Log_Yt	Log_Pt	Log_Rt	Log_Mt
1	1.661394	0.355615	0.279943	0.651947	0.000218	98.71228	0.000000
4	3.055623	1.345583	0.556987	11.35612	0.611121	84.20584	1.924343

8	3.656661	7.117854	0.966020	23.18037	1.247856	64.54907	2.938833
12	4.001095	10.91672	1.275629	20.74324	5.363538	54.48427	7.216607
16	4.140168	11.41086	1.225831	19.72157	8.232842	51.61899	7.789912
20	4.187069	11.54324	1.198742	19.54151	9.166183	50.78390	7.766429

Variance Decomposition of LOG_Mt:

Period	S.E.	Log_Gt	Log_Tt	Log_Yt	Log_Pt	Log_Rt	Log_Mt
1	0.108584	0.718451	0.136195	0.720863	0.032384	0.117520	98.27459
4	0.175843	10.57040	0.355852	5.766172	1.128837	1.268924	80.90982
8	0.206644	8.287362	1.116009	12.30013	1.200180	1.069640	76.02668
12	0.216249	8.237965	1.404043	13.75627	1.826093	0.983097	73.79253
16	0.219592	9.423809	1.485490	13.44375	2.097329	0.964657	72.58496
20	0.222118	10.63513	1.538612	13.37143	2.397426	0.981980	71.07542

Factorization: Structural

Table 11. Fiscal Multiplier

Spending Multiplier						
Quarter	Q1	Q4	Q8	Q12	Q16	Q20
Impact	**0.06**					
Cumulative		**0.21**	**0.39**	**0.60**	**0.80**	**1.00**

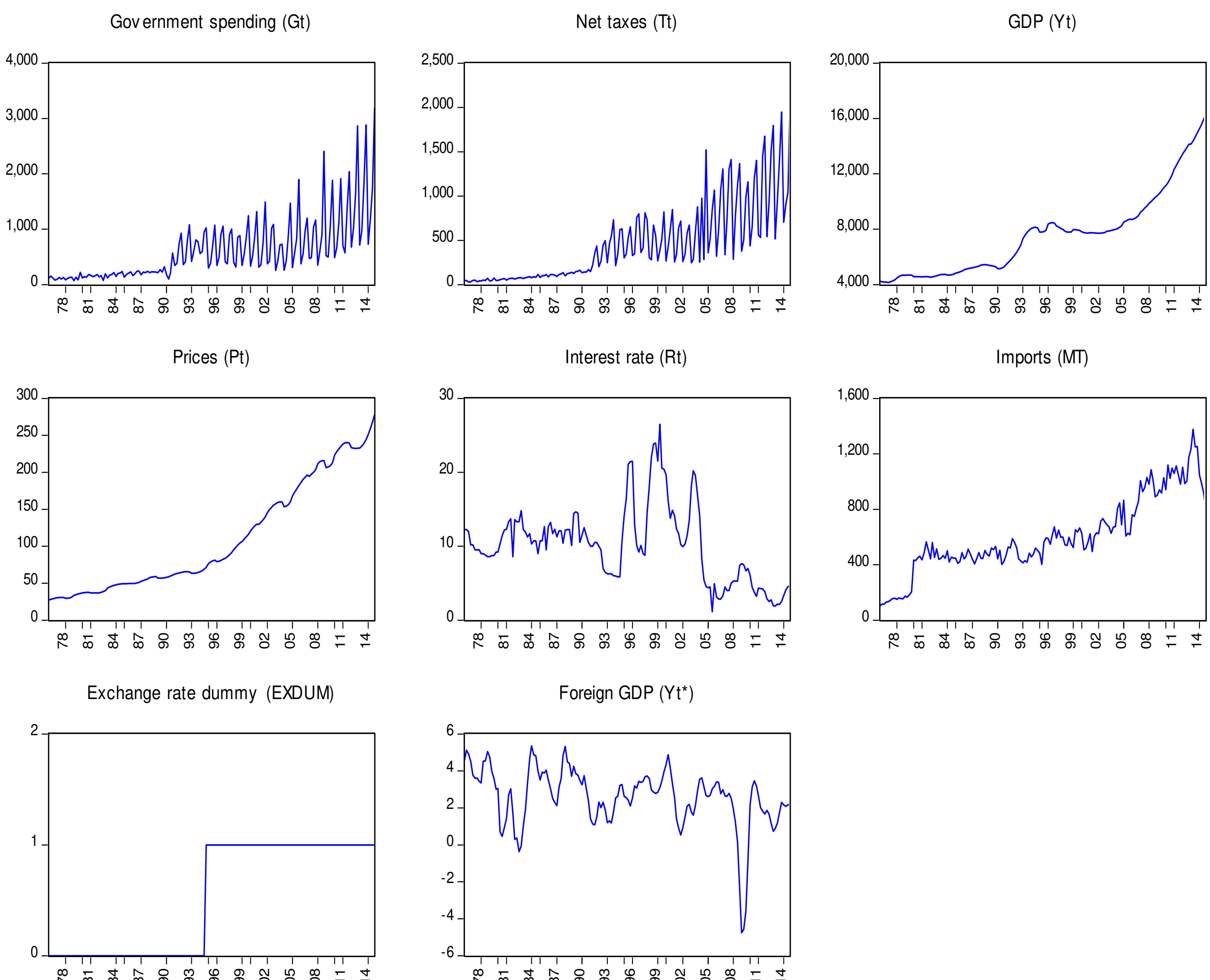
Source: Author's calculations using the impulse responses

APPENDIX F: FIGURES

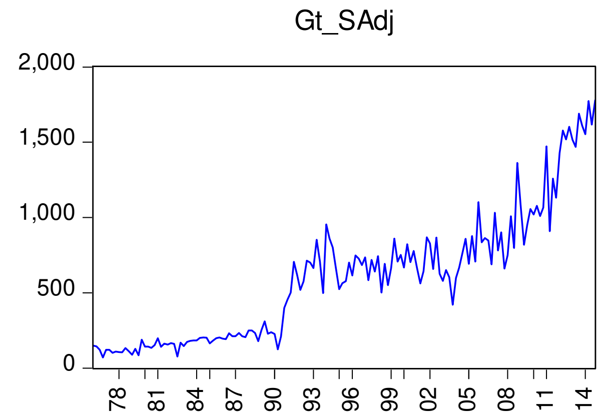
Figure 6. Visualization of the data

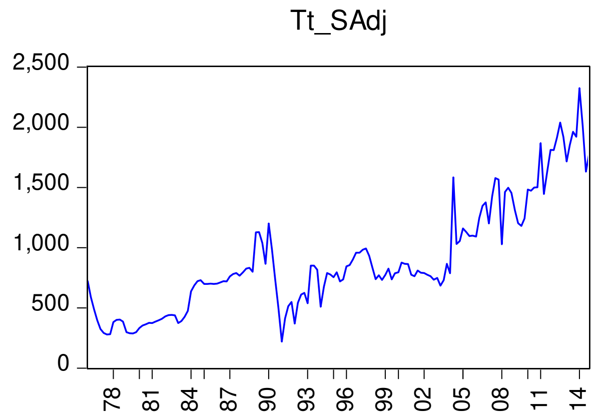
The horizontal axis denotes the period in years recorded with the interval of 3 years. The vertical axis depicts the units, where Gt, Tt, Yt, and Mt are in K'million while the Rt and Yt are in percentage. The exchange rate dummy takes the usual form of one and zeroes reflecting the varying exchange rate regimes. The seasonally adjusted series expressed in the natural log form later entered the SVAR model.*

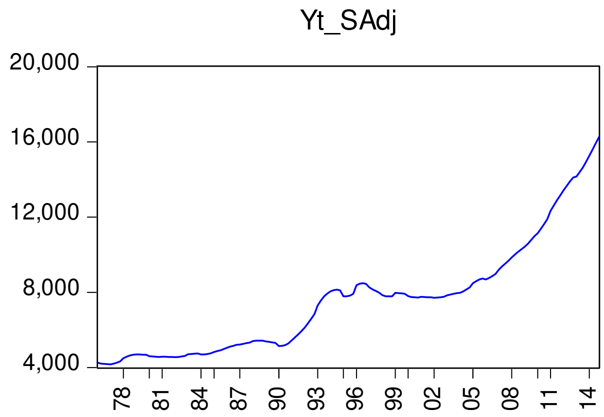
6A. Original set of the variables

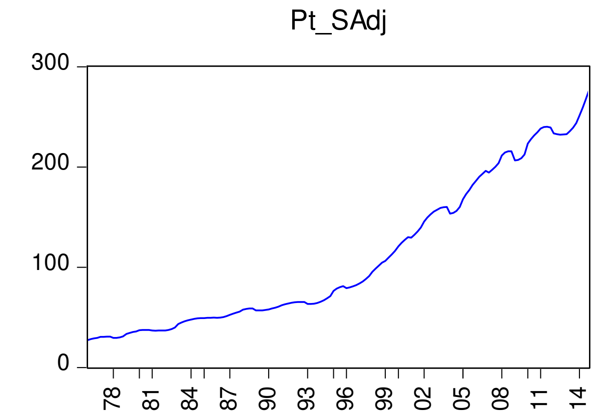


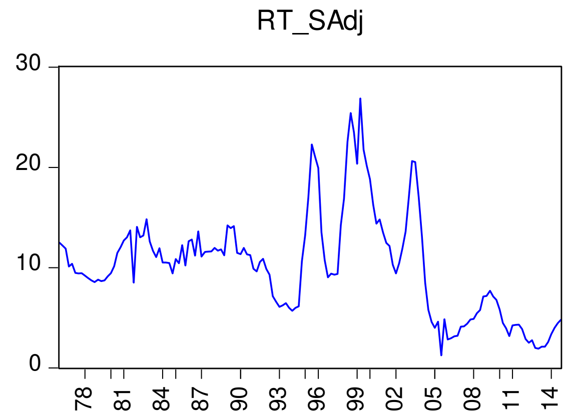
7B. Seasonally adjusted series using the X-12 method











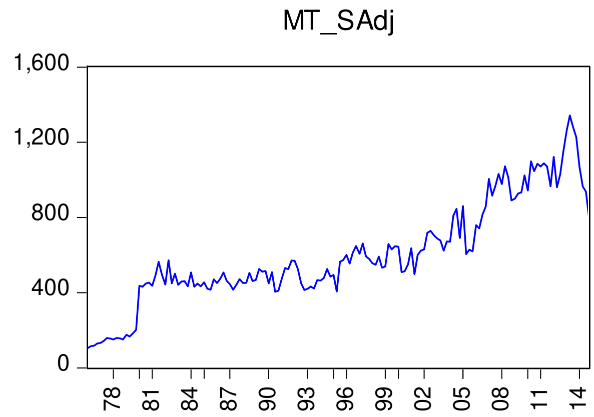


Figure 7. Response to 1 standard deviation in expenditure shocks– Benchmark Model

The impulse response function (IRF) for the fiscal structural innovations in the VAR system. The two red lines indicate the two Standard deviations. Monte Carlo simulation computed the standard errors of the IRF with 500 iterations.

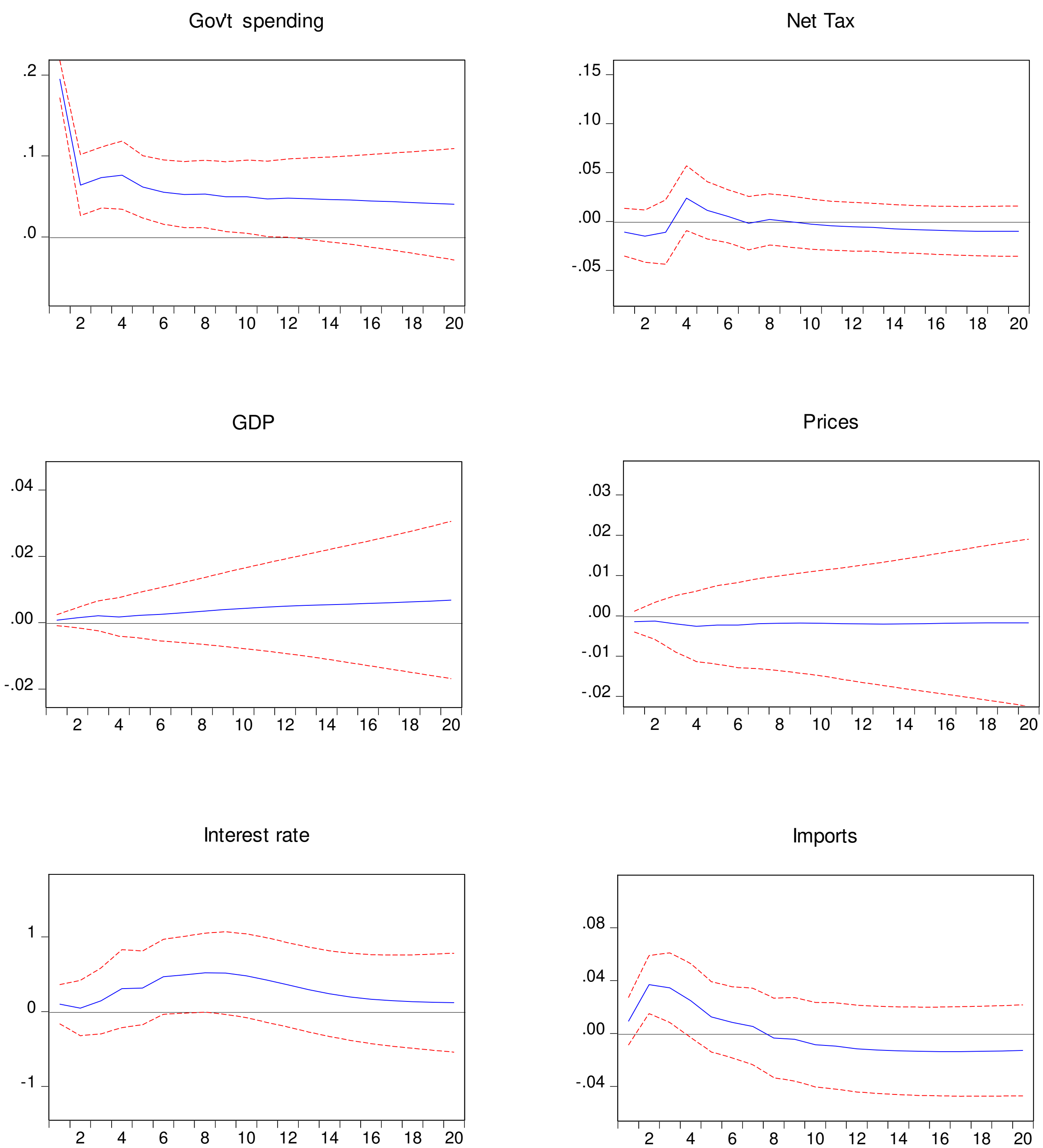
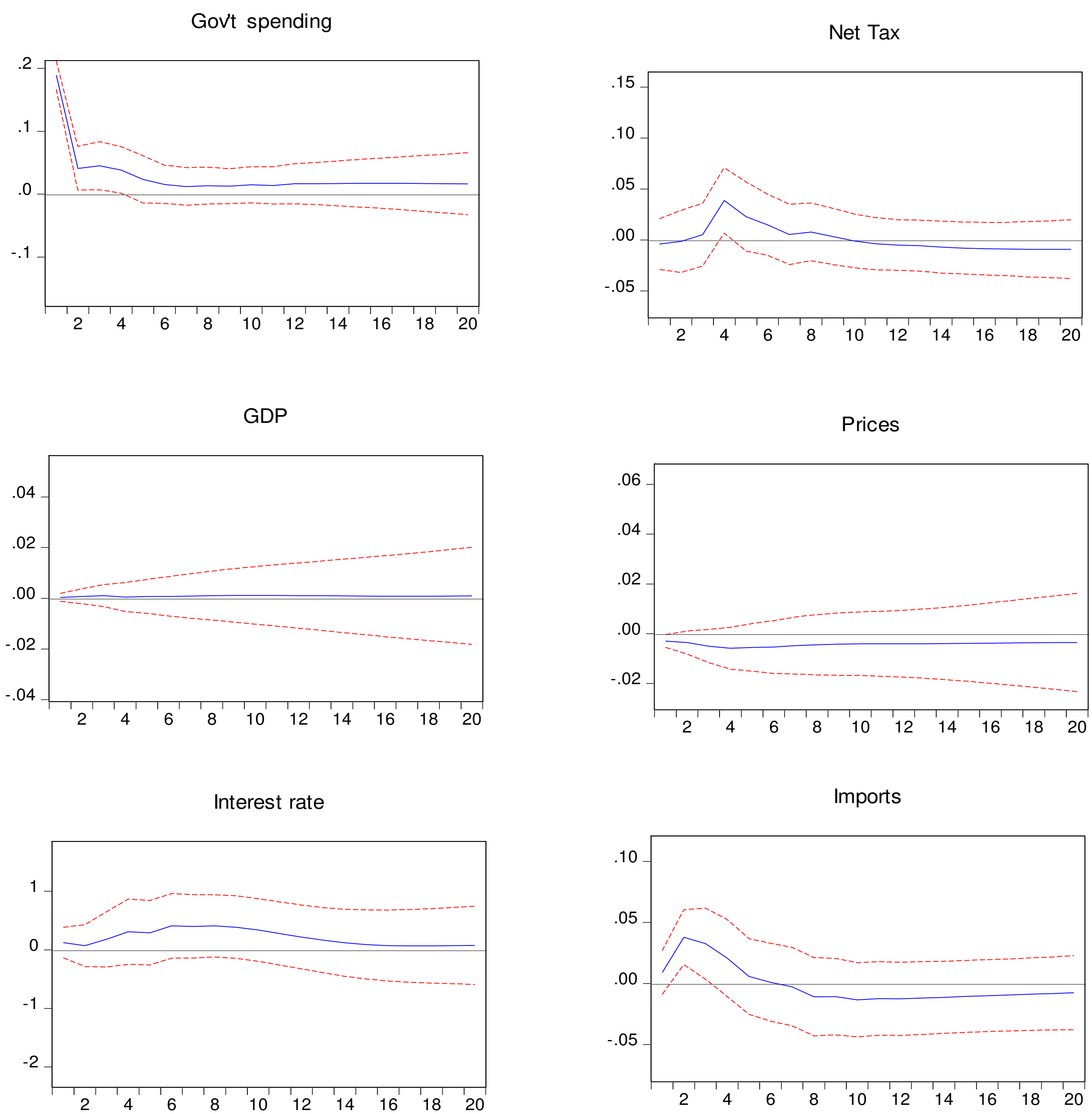


Figure 8. Response to 1 standard deviation in expenditure shocks - Robustness check

The impulse definition of the IRF for all the models is from the structural decomposition. The standard errors were derived following the benchmark case.

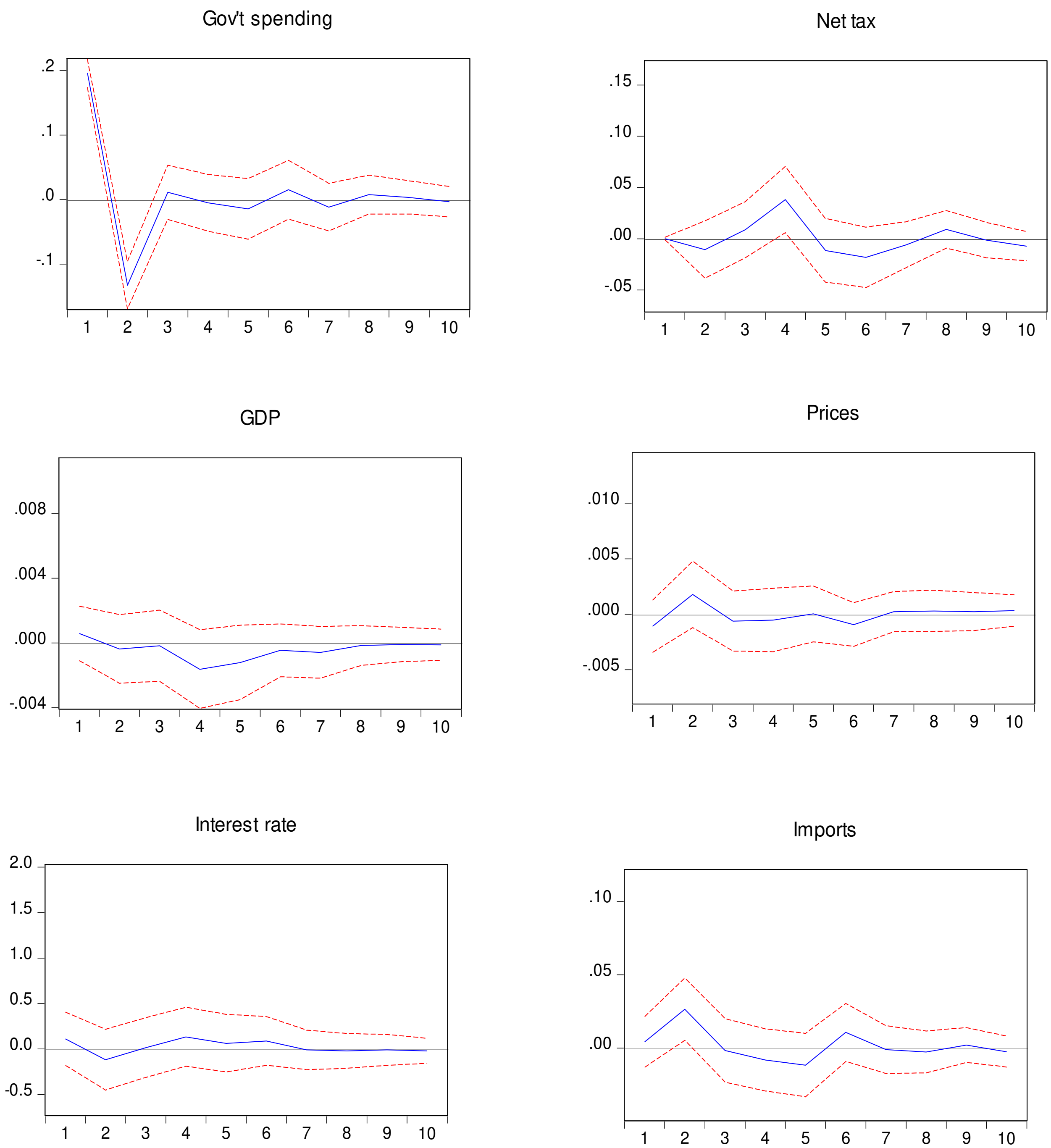
8.1. Model A

Model A follows Blanchard and Perotti (2002) by augmenting the benchmark model with inclusion of a determinist trend, provided that fiscal variables were trend stationary.



8.2. Model B

Model B tests the benchmark model in first difference, given the fact that Pt and Yt were stationary after first difference. All the variables in the VAR system are in first difference.



8.3. Model C

Model C tests the benchmark model with the detrended series derived by the HP filter. The exogenous variables exdum and Yt were not detrended.*