Regime-Dependent Fiscal Multipliers and Structural Adjustment in a Small Open Developing Economy

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Abstract

Understanding regime-dependent fiscal effects is important for effective fiscal policy design, but empirical work in this area has been sparse for small open developing economies. This paper uses Jamaica as a case study, given its economic characteristics and history of structural adjustment programs, to estimate regime-dependent fiscal effects on output. Results indicate that tax multipliers on GDP are higher than expenditure multipliers in both states of the economy, while both increase sharply during recessions. This asymmetric and time-varying characteristic of the fiscal effects, as well as the magnitude of the multipliers, are largely in line with the results found in the literature on developing economies. Government expenditure multipliers are markedly low, which is also in line with the literature but presents opportunities for further investigation using disaggregated data. Regarding growth, the significantly higher taxation multiplier in conjunction with a heavier burden placed on taxation measures to meet fiscal targets are particularly restrictive in facilitating growth but paradoxically an important tool for stabilisation during episodes of current account crises.

JEL Classification: C24, E62, H30, O40

Key words: Markov Regime-Switching, Fiscal Policy, Structural Adjustment, Economic Growth.

[Δ] I would like to thank Dorla Humes, Ian Durant and Amos Peters for their excellent comments. Author's E-mail: mcleodr@caribank.org, mcleodroger1@gmail.com. This version: January 2019

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1. Introduction

In small open developing economies, particularly in the Latin-American and Caribbean (LAC) region, there is a lack of economies of scale and a narrow financial resource base for investments which exacerbates credit constraints. Theoretically, this suggest Keynesian effects or high multipliers of fiscal policy. This is particularly the case during recessions, which can be prolonged in small open developing economies due to under-utilisation of capacity, borrowing constraints, growing wealth inequality and a high debt-to-GDP ratio. At the same time, it is often noted in the literature (see David (2017) that small open economies may have lower multipliers because of "leakages" in demand through higher imports. Further, countries with flexible exchange rate regimes may have smaller multipliers as real exchange rate movements can offset the impact of fiscal policy. While this is a standard conundrum for policy practitioners, there is limited empirical evidence of the value of fiscal multipliers in small open developing economies to enable evidence-based decision making and policy design. Further, there has been a recent emergence in the literature of the need to re-examine the estimation of fiscal multipliers and apply an approach that is cognizant of the asymmetric and time-varying characteristic of fiscal effects.

Many Caribbean countries have recently endured recessions and macroeconomic crises, which have been followed by aggressive fiscal retrenchment and structural adjustment reforms. During such programs, it is easier to achieve the targeted fiscal balance in the short term with heavy burden placed on revenue based measures rather than expenditure based controls, which tend to take a longer time to formulate and implement. If it is the case, however, that the value of tax multipliers are higher than expenditure multipliers, then revenue based fiscal consolidation efforts may be inefficient and more costly to GDP growth. This begs the question as to whether tax and expenditure multipliers differ and if so, what are the implications on how fiscal consolidation should be designed for an optimal approach? On the flip side, do deficits incurred today from an expansionary fiscal policy using government expenditure as the instrument, compensate for a future increase in taxes by way of a higher expenditure multiplier relative to the tax multiplier, thereby leading to a net positive effect on GDP?

Further, should these questions be answered using standard linear models? Results in Blanchard and Leigh (2013) suggests that fiscal retrenchment during a recession has been associated with lower than expected growth in European Union (EU) countries, due to a higher than expected fiscal multiplier effect. This suggests that fiscal multipliers are regime dependent or time-varying; a result which has induced research in re-estimating fiscal multipliers using regime dependent or non-linear methods.[1] Studies on advanced economies such as Arin *et al* (2015), Ricci-Risquete *et al* (2016) and Dufrenot et al. (2016) have shown that fiscal multipliers have both asymmetric and

[1] See Literature Review for details of these papers.

time-varying effects[2]. As such, it is important to account for how fiscal multipliers evolve in recessions relative to normal periods. It is also important to account for asymmetric effects by estimating taxation and expenditure multipliers separately, so as to determine whether a country's fiscal policy can be modified to increase its effectiveness. There has been no research on small open developing economies such as those in the Caribbean that have incorporated time-varying and asymmetric fiscal multiplier effects to determine the extent to which the results are similar to that which has been garnered in the literature.

Against this background, the purpose of this paper is to bridge this gap by estimating regime-dependent fiscal multipliers in a Markov Switching Time Varying Transition Probabilities (MS-TVTP) model using Jamaica as a case study. Jamaica is an excellent case study given its economic characteristics of a small open developing economy that is highly indebted, has a narrow financial base for investments, and more importantly, has a rich history of structural adjustment programmes or fiscal stimulation and consolidation efforts. Since its independence Jamaica has attempted or conducted fiscal reform programs under various conditions with mixed results. Significant fiscal reforms started in the 1980s, which had improved the fiscal accounts and maintained relative fiscal stability until heavy fiscal deterioration occurred in the mid-1990s as a result of the financial crisis and high interest rates on debt. Fiscal deterioration was then exacerbated by the US financial crisis that prompted attempts in 2009 to commence structural adjustment and fiscal reforms with the International Monetary Fund. This was eventually executed from 2013 to 2017, which introduced a host of fiscal reforms and enforced a 7.5 per cent primary balance rule.

It is useful to use this case study to assess how these characteristics impact on fiscal multipliers in small open developing states relative to other economies in the literature. By incorporating both time varying and asymmetric effects in our model, this ensures the accuracy of the estimated fiscal multipliers. In this context, the paper contributes to the on-going literature on the impact of fiscal policy using Markov-switching models. The econometric framework in this paper also incorporates the control function approach to account for possible endogeneity when estimating fiscal effects. The chosen instruments reflect the model derived in Shen et al (2015), given the incorporation of monetary policy, the real effective exchange rate and the external demand channels.

Some key findings have emerged from this paper. Tax multipliers are significantly higher than expenditure multipliers in both states of the economy. Second, both tax and expenditure multipliers on real GDP increase significantly during the recession/macroeconomic crisis regime, reaching an average value of 0.21 and 0.61, respectively. This asymmetric and time-varying characteristic of the values, as well as the magnitude of the multipliers are in line with the results found in the literature, but some important distinctions are seen. Unlike the results found for the

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[2] Asymmetric effects refer to the case of significantly different values for tax and spending multipliers. Time-varying effects refer to multiplier values that change in response to current economic conditions.

United States in Dufrenot et al. (2016) and others based advanced economies, taxation was the more potent instrument for fiscal policy in this paper. In Emerging market economies and low in come countries, however, it has increasingly been found that taxation multipliers are higher (see Batini et al. 2014 for details). Higher taxation multipliers also suggest that the heavy burden placed on the taxation instrument in meeting the primary balance rule was particularly restrictive, albeit, this also means a faster rate of stabilization when confronting current account deterioration. Nonetheless, a higher taxation multiplier imply that fiscal consolidation can be maintained while improving the facilitation of growth. Reduced tax rates, financed by proportionately reduced government expenditure, could facilitate growth to a greater extent with minimal impact on the fiscal balance. This adjustment could be facilitated by a policy oriented more towards private sector-led growth and efficiency gains in public sector spending.

For the remainder of the paper, I review the literature on fiscal multiplier estimation, along with further outlining of how this paper contributes to the evolution of the literature. The econometric methodology and the data is then presented. At this point, I discuss the results for all equations in the Model, after which important implications of the findings and how it relates to fiscal policy, structural adjustment and economic growth are presented. A summary of the paper and other concluding statements then follows.

2. Literature Review

The impact of fiscal policy on the economy has been debated by economists for quite some time. The historical debate has been driven by the differing theorised mechanisms that govern the way in which fiscal policy impacts the economy. The choice of theory relies on an implicit assumption of how the underlying macroeconomic conditions evolve over time. Classical economic theory suggests that free markets lead to an efficient outcome where the long-run aggregate supply curve is inelastic. As such, deviations away from full employment will only be temporary and hence, fiscal multipliers will generally be equal to one. Keynesians, on the other hand, argue that the economy may be operating at less than full capacity for an extended period of time due to imperfect markets. Because of this critical divergence, Keynesian Theory places importance on the role of expansionary fiscal policy in combating recessions given that fiscal multipliers will be greater than one, The seminal Real Business Cycle Model of Baxter and King (1993) has been further developed in the literature to show the varied effects of fiscal policy with either neo-classical or Keynesian assumptions (and respective fiscal effects).

In terms of empirical evidence, there has been extensive research detailing the extent to which macroeconomic conditions determine the level of fiscal multipliers. The literature has primarily focused on advanced economies and illustrating the extent to which fiscal multipliers vary given differing country characteristics or macroeconomic conditions. One of the seminal papers on this issue is Blanchard and Leigh (2013) which showed that fiscal consolidation in EU countries was generally associated with a lower than expected growth outcome. The Paper suggested that fiscal multipliers have been largely underestimated. Some of the reasons they gave for this underestimation included: (a) the lower bound of interest rates reduced the Central Bank's ability to combat the contractionary impact of tax hikes (or budget cuts); (b) a poor functioning financial system, coupled with depressed consumption and income, resulted in consumption levels depending more on present, rather than future, income; and (c) a considerably higher amount of slack in the economy increased fiscal multipliers. The results propelled growing interest in estimating fiscal multipliers and the extent to which macroeconomic conditions influence their size and sign. Gechert *et al* (2016) has since shown similar results for EU consolidation, using meta-regression on multipliers for various fiscal measures under different business cycle regimes.

Wee Chain (2017) uses a dataset of 120 countries to show that fiscal multipliers are larger in advanced economies. The author also shows that fiscal multipliers are larger: when public debt is low; financial development is high; and during a recession or financial crisis. Minea and Mustea (2015) shows that fiscal multiplier estimates display important heterogeneities across groups of Mediterranean countries depending on the economic characteristics, the geographical characteristics, the multiplier for the time span of the review area and the fiscal stimulus provided by the government. Leeper *et al* (2017), on the other hand, uses Bayesian modeling to show that short-run output multipliers are comparable across regimes, but are much larger after 10 years under passive money/active fiscal policy than under active money/passive fiscal policy.

In addition to looking at the way in which fiscal multipliers vary across countries, the literature has also focused on the extent to which the fiscal multipliers have varied within countries depending on the macroeconomic conditions. Studies such as Bilbao-Ubillos *et al* (2014) and Corsetti *et al* (2012) have shown that fiscal multipliers increase during recessions. These recessions would be characterised by adverse financial and economic conditions with an increased number of credit-constrained agents, thereby resulting in a higher impact on government expenditure. Government expenditure has also been shown to be more effective when countries are operating at less than full capacity in studies such as: Rendahl (2016); Fazzari *et al* (2015); Michaillat (2014); and Auerbach and Gorodnichenko (2012). Kempa and Khan (2015), Mertens and Ravn (2014), Cogan *et al* (2010) and other studies have shown that fiscal multipliers are higher at lower interest rates or with more accommodative monetary stances. Brinca *et al* (2015) also shows that negative wealth effects increase the number of liquidity-constrained agents, thereby putting upward pressure on the fiscal multiplier. It is also shown in Dufrenot *et al* (2016) that the level of the debt ratio can influence the speed of transitioning out of a recession.

While the literature has focused on providing empirical evidence to show the state-contingent result of higher fiscal multipliers during recessions, there has been theoretical research such as Canzoneri *et al* (2016) which has built upon previous stuides. Here the authors employed a model of costly financial intermediation based on the Curdia-Woodford Model to derive state-dependent fiscal multipliers. It is shown that fiscal multipliers expand to greater than one during recessions (and decrease to almost one otherwise), as a result of the interest rate spread being more sensitive to fiscal policy during recessions than during expansions. The Model is underpinned by financial friction costs measured by the interest rate spread, which are considerably higher during recessions.

Recent empirical literature has also begun to employ non-linear modeling, which is ideally suited for regime-switching effects and to explore state-contingent effects of fiscal policy. Auerbach and Gorodnichenko (2013) is one of the seminal papers in this regard. The authors used a non-linear Vector Autoregressive (VAR) using the Organisation of Economic Cooperation and Development data to show that fiscal policy is effective in combating the effects of a recession, with fiscal multipliers significantly higher than those during normal times. Hernandez de Cos and Moral-Benito (2016) uses the model developed in Auerbach and Gorodnichenko (2013) on data in Spain, to show that fiscal multipliers are larger during recessions and banking stress periods. These results were only partially corroborated by Caggiano *et al* ((2015), where non-linear VAR were employed to assess fiscal expenditure multipliers in the United States (US). Results suggest that fiscal expenditure multipliers in recessions are not statistically larger than those in expansions. The authors, however, noted that non-linearities arise when focusing on deep recessions versus strong expansionary periods. Other studies, such as Owyang *et al* (2014), do not find statistically significant difference between fiscal multipliers in normal and turbulent periods.

Other non-linear models have been used to study state-contingent fiscal multipliers such as the Markov switching models. Dufrenot *et al* (2016) employs a MS-TVTP Markov switching model on the US to explore state-contingent fiscal multipliers on GDP and its components. Fiscal policy is shown to be effective (Keynesian effects) during downturns, while anti-Keynesian effects were shown during normal periods. The study was done using expenditure and tax multipliers. A similar framework will be applied here, which is also in line with earlier studies such as Arin *et al* (2015) and Ricci-Risquete *et al* (2016), using data on the US and Spain, respectively. Arin *et al* (2015) and Ricci-Risquete *et al* (2016), however, had assumed fixed transition probabilities to govern the regime switching behaviour inherent in the business cycle. The key difference in Dufrenot *et al* (2016) is the assumption that transition probabilities vary over time and may be a function of transition type variables that significantly impact the probability of being in calm or turbulent periods.

As it relates to literature on developing economies, studies that have focused exclusively on developing or underdeveloped countries are quite limited. This is particularly as a result of data unavailability. Nonetheless, there are some studies available such as Kraay (2014) and Shen *et al* (2015). Kraay (2014) uses a novel data set on a large sample of developing countries to show that government expenditure multipliers are in the vicinity of 0.4. There is also some evidence of heterogeneity in estimated multipliers that is consistent with the theory, however, these were largely not shown to be statistically significant. Shen *et al* (2015) focuses on low-income countries (LICs) using a theoretical framework of a new-Keynesian small, open economy model. The authors show analytically and through simulations that some of the features of LICs play a key role in determining the effects of fiscal policy. External financing mitigates the private sector crowding out effects of government expenditure, however, this is countered, to some extent, by external financing causing an appreciation of the real exchange rate which reduces the fiscal multiplier.

As it relates to Caribbean countries in particular, research work has been sparse. Guy and Belgrave (2012) use data on Caribbean countries (some of which were interpolated data) in a panel VAR and a structural vector autoregressive (SVAR) model, to show that fiscal multipliers among the sample countries are low and that the contemporaneous fiscal stance seems to be pro-cyclical. Other results, however, showed unexpected impacts of tax shocks against economic theory. Gonzalez-Garcia *et al* (2013) uses data on the member countries of the Eastern Caribbean Currency Union (some of which were interpolated data) to show that the long-run multipliers of taxes and consumption expenditure are not statistically significant, while public investment has a long-run multiplier of 0.6.

3. Data and Methodology

The MS-TVTP Model is an extension of the Markov-Switching Fixed Transition Probability (MS-FTP) Model first proposed by Hamilton (1989). This model will be used to estimate the business cycle using a two-state model of 'good' and 'bad' economic conditions, which translates to a normal conditions regime and a recession/macroeconomic crisis regime, respectively. The econometric framework aims at using the data itself without restrictions to determine statistically-significant and distinct, regime-dependent means and variances for GDP growth over the sample period. The model then estimates the impact of the respective fiscal variables on output in both states of the economy. Following Diebold *et al* (1994) and Filardo (1994, 1998), the MS-TVTP is used to allow for the estimation of the impact of transition variable(s) on the probability of switching from one regime to the other. In this paper, the chosen transition variables are moving average measures of business cycle indicators following studies such as Dufrenot *et al.* (2016) and Auerbach and Gorodnichenko (2013). The issue of endogeneity of the fiscal variables will be addressed using the control function approach.

This empirical approach adequately captures: asymmetric and regime dependent fiscal effects on output while accounting for endogeneity; effects on output from the economic fundamentals; and the dynamic feedback from fiscal policy to the different states of the economy through the inclusion of transition variables. In terms of diagnostics, the assumptions of time varying probabilities are tested by checking whether the TVTP approach outperforms the FTP specification in terms of model fit, and whether other diagnostic results are satisfactory.

3.1 MS-TVTP Model

Consider the following Markov regime switching equation:

$$y_t = \mu(s_t) + X_t'\alpha(s_t) + Q_t'\beta + \varepsilon_t \quad (1)$$

where, y_t is a measure of output; μ is the regime-dependent intercept (conditional mean); X_t' is a vector of variables that has a regime-dependent effect (non-linear effect) on output; Q_t' is a vector of variables that has the standard linear impact on output; s represents the state or regime; and $\varepsilon_t \big| s_t \sim N\big(0, \sigma^2(s_t)\big)$. The sample path follows a first-order, two-state Markov process such that $s_t \in$ 1,2. While in the MS-FTP case, the transition probabilities governing switching between regimes is assumed to be time-invariant (and stochastic), the MS-TVTP relaxes the assumption of time-invariant transition probabilities and allows them to evolve as a cumulative density function, $\Phi(\quad)$, of chosen transition variables, denoted as η_t. The results will later show that this is crucial for model performance. Switching between regimes is governed by a time-varying transition probability matrix as follows:

$$P_t = \begin{bmatrix} p_t^{11} & p_t^{12} \\ p_t^{21} & p_t^{22} \end{bmatrix} \quad (2)$$

where,

$$p_t^{11} = P(s_t = 1|s_{t-1} = 1, a_1 + b_1\eta_t) = \Phi(a_1 + b_1\eta_t) \quad (3)$$

$$p_t^{12} = 1 - p_t^{11} = P(s_t = 2|s_{t-1} = 1, a_1 + b_1\eta_t) = 1 - \Phi(a_1 + b_1\eta_t) \quad (4)$$

$$p_t^{22} = 1 - p_t^{22} = P(s_t = 1|s_{t-1} = 2, a_2 + b_2\eta_t) = \Phi(a_2 + b_2\eta_t) \quad (5)$$

$$p_t^{21} = P(s_t = 2|s_{t-1} = 2, a_2 + b_2\eta_t) = 1 - \Phi(a_2 + b_2\eta_t) \quad (6)$$

Where, the normal conditions regime is denoted as 1 and the recession/macroeconomic crisis regime is denoted as regime 2. Note that probabilities are written in the following format: p_t^{ij}. Also, the probabilities are summed along rows, therefore i represents t-1 and j represents time t in all notations. The time varying transition probabilities in equations (3) to (6) are conditional on the regime of the previous data point, as well as on functions of $(a_1 + b_1\eta_t)$ and $(a_2 + b_2\eta_t)$. The parameters a_i and b_i for i=1,2 are the respective intercept and coefficient for the transition variable's impact on the probability of staying in each regime. For ease of comparison across previous studies, as shown in equation (3) and (5), the model is designed to estimate the impact of the transition variables on p_t^{11} and p_t^{22}, using b_1 and b_2, respectively. So, b_1 represents the impact of the transition variables on p_t^{11} – the probability of staying in the normal conditions regime (State 1) if already in the normal conditions regime. Correspondingly, b_2 represents the impact of the transition variable on p_t^{22} – the probability of staying in the recession regime, if already in the recession regime.

3.2 Maximum Likelihood Estimation

The MS-TVTP model will be estimated using maximum likelihood with the assumption that the conditional density of being in a particular regime is Gaussian (normal). The estimation procedure is as follows:

Let $\Omega_t = (X_t', X_{t-1}', \dots, X_1', \eta_t, \eta_{t-1}, \dots, \eta_1)'$ and $\Psi_t = (y_t, y_{t-1}, \dots, y_1)'$ be vectors containing information up to data point t. In addition, let θ be a vector containing all model parameters. As such, the conditional regime-dependent density functions will be as follows:

$$f(y_t|s_t = 1, s_{t-1} = \text{j}, \Omega_t, \Psi_{t-1}, \theta) = \Gamma\left(\frac{y_t - X_t'\alpha(s_t = 1)_1 - Q_t'\beta}{\sigma_1}\right)\Phi(a_j + b_j\eta_t)/\sigma_1 p_t^{1j} \qquad 7$$

$$f(y_t|s_t = 2, s_{t-1} = \text{j}, \Omega_t, \Psi_{t-1}, \theta) = \Gamma\left(\frac{y_t - X_t'\alpha(s_t = 2) - Q_t'\beta}{\sigma_2}\right)\Phi(a_j + b_j\eta_t)/\sigma_2 p_t^{2j} \qquad 8$$

where, Γ and Φ are the standard normal density and cumulative density functions, respectively.

The likelihood function for output takes the form:

$$L(\theta) = \prod_{t=1}^{T} f(y_t|\Omega_t, \Psi_{t-1}, \theta) \qquad 9$$

From equation (9), it can be seen that the density, $f(y_t|\Omega_t, \Psi_{t-1}, \theta)$, conditional on $s_t = \text{i}, s_{t-1} = \text{j}$ can be written as the sum of the probability weighted regime densities as follows:

$$L(\theta) = \prod_{t=1}^{T} \sum_i \sum_j f(y_t|s_t = \text{i}, s_{t-1} = \text{j}, \Omega_t, \Psi_{t-1}, \theta) Pr(s_t = \text{i}, s_{t-1} = \text{j}|\Omega_t, \Psi_{t-1}, \theta) \qquad 10$$

Now, by Bayes rule, for $k \in 1{,}2$, the conditional probabilities from equation (10) can be written as:

$$Pr(s_t = \text{i}, s_{t-1} = \text{j}|\Omega_t, \Psi_{t-1}, \theta) = p_t^{ij} Pr(s_{t-1} = \text{j}|\Omega_{t-1}, \Psi_{t-1}, \theta) \qquad 11$$

$$= p_t^{ij} \frac{\sum_k f(y_t|s_t = \text{j}, s_{t-1} = \text{k}|\Omega_t, \Psi_{t-1}, \theta_t) Pr(s_t = \text{j}, s_{t-1} = \text{k}|\Omega_t, \Psi_{t-1}, \theta)}{f(y_t|\Omega_t, \Psi_{t-1}, \theta)}$$

The estimates of the parameters will be derived by direct optimisation of the log likelihood function. The model equations are iterated recursively until the Maximum Likelihood Estimator stabilises. This derives the conditional probabilities and estimated parameters of the Model. For the case when the variables are stationary (which is consistent with the data to be used here), then one can directly calculate the unconditional probability of being in State 1 at time 1, $Pr(s_t = 1)$ and use this quantity as the initial values for the estimation. For the non-stationary case, the probability would be an additional parameter to be estimated in line with the procedure in Diebold et al (1994).

3.2.1 Endogeneity and the Control Function Approach

Filardo (1998) shows that it is possible and relevant to estimate a MS-TVTP model with a maximum likelihood procedure once explanatory variables are not driven by the explained variables to avoid any simultaneity bias. Given that fiscal variables respond to output contemporaneously leading to a potential simultaneity bias or endogeneity issue, the fiscal multiplier estimations will be derived using the control function approach. This is usually applied to Markov-switching models with endogeneity problems (see Kim and Kim (2011) for further details). Using this approach, fiscal effects will be estimated in a two-step approach.

The first step of the control function approach involves regressing each fiscal variable on the control variables and saving the standardized residuals. The second step involves regressing output on: (i) the lagged observations of the fiscal variables, (ii) the control variables acting as instruments and (iii) the saves residuals from the first step. Using this method, potential issues of simultaneity bias will be avoided (see Kim and Kim (2011)). To simplify the model and minimize the amount of parameters to be estimated, all control variables will enter the model linearly. The selected instrumental variables will be the usual economic fundamentals that explain output in a small open economy, such as the real interest rate, the real exchange rate and foreign demand, as well as lagged observations of output.

3.3 Model Equations

The model estimates two multipliers, namely an expenditure multiplier and a taxation multiplier. The control function approach is applied to each fiscal variable to account for the possible endogeneity issues. As a result, this leads to separate equations for estimating the expenditure and taxation multipliers, given that the first stage of the control function approach involves regressing each fiscal variable on chosen control variables and saving each set of residuals for insertion in the second stage. This essentially results in separate equations for the expenditure variable and the taxation variable. To get an accurate specification of the multiplier effect, the real GDP series to be used as the dependent variable in these equations will be transformed into a real 'private GDP' measure[3] as done in Dufrenot et al. (2016). In addition, control variables acting as instruments are given a linear specification to reduce the amount of parameters to be estimated.

3.3.1 Expenditure and Taxation Equations

For the expenditure equation, first differenced log real private GDP is explained by: the regime-dependent intercept (conditional mean of first differenced real private GDP); a regime-dependent

[3] This is measured as GDP minus government consumption.

lagged dependent variable; regime-dependent fiscal variables; control variables specified with linear effects; and the saved residuals from the first stage of the control function approach. As such, the expenditure equation is as follows:

$$\Delta y_t = \mu(s_t) + \alpha_1(s_t)\Delta y_{t-1} + \alpha_2(s_t)\Delta\omega_{t-1}^{e} + \alpha_3\Delta\nu_{t-j} + \alpha_4\Delta r_{t-k} + \alpha_5\Delta y_{t-l}^{*} + \alpha_6\forall_t(s_t) + \sigma_y(s_t)\varepsilon_t \quad 12$$

Where, Δ is the difference operator; y_t is real private GDP; $\mu(s_t)$ is the intercept and conditional mean of real private GDP; ω^e is government expenditure; ν is the real effective exchange rate; *r* is the real short-term interest rate; y_t^* is foreign real GDP; $\forall_t$ is a time series of the saved residuals from the first step of the control function approach outlined in section 3.2.1; and $\sigma_y(s_t)$ is the regime-dependent variance with:

$$E\left(\varepsilon_t | \Delta y_{t-1}, \Delta\omega_{t-1}^{e}, \Delta\nu_{t-j}, \Delta r_{t-k}, \Delta y_{t-l}^{*}\right) = 0 \quad 13$$

Correspondingly, the taxation equation is as follows:

$$\Delta y_t = \mu(s_t) + \beta_1(s_t)\Delta y_{t-1} + \beta_2(s_t)\Delta\omega_{t-1}^{r} + \beta_3\Delta\nu_{t-j} + \beta_4\Delta r_{t-k} + \beta_5\Delta y_{t-l}^{*} + \beta_6\emptyset_t(s_t) + \sigma_y(s_t)\epsilon_t \quad 14$$

Where, ω^r is the tax revenue ratio; and $\emptyset$ is a time series of the saved residuals from the first step of the control function approach outlined in section 3.2.1; and $\sigma_y(s_t)$ is the regime-dependent variance with:

$$E\left(\epsilon_t | \Delta y_{t-1}, \Delta\omega_{t-1}^{e}, \Delta\nu_{t-j}, \Delta r_{t-k}, \Delta y_{t-l}^{*}\right) = 0 \quad 15$$

Real private GDP is measured as: nominal GDP minus public consumption after which the result is deflated (see the Appendix for the construction of all variables). The fiscal variables are ω^e and ω^r, which are real government expenditure and real tax revenue (tax revenue deflated) in differenced form, respectively. The control variables acts as instrumental variables in the first stage of the control function approach. The control variables are chosen based on the usual economic fundamentals responsible for determining output in a small open developing economy such as, the real effective exchange rate, the short-term monetary policy interest rate in real terms, and a measure of external demand (real GDP in the United States), all in first differenced form. These variables account for: the competitiveness effect through relative prices; the monetary policy impact through interest rates; and external demand effects through US real GDP, all of which are specified to have a linear effect on real private GDP.

There is no standard or theoretical basis for choice of transition variable, however, Auerbach and Gorodnichenko (2012) show that it is important to take into account the dynamic feedback in the model and uses a seven-quarter moving average of output growth. Dufrenot *et al* (2016) also incorporates this approach, but uses public debt and output gap as transition variables. Existing literature suggests any business cycle indicator could be used. For simplicity, a one year moving average of output growth, denoted as η_t, was used as the transition variable for both the expenditure and taxation equations. Statistical significance of the transition variable in this case, would then suggest that the impact of expansionary fiscal policy, for example, on the probability of staying in normal conditions or switching from a recession to normal conditions, depends on whether this expansionary fiscal policy was financed by past GDP growth.

3.3.3 Data

The starting point of the sample period under consideration was motivated entirely by data availability. Data was collected at the quarterly frequency covering the period 1995 Q1 to 2018 Q1. Equations for the different components of GDP such as private consumption and investment could not be estimated due to unavailable data at the quarterly frequency. All data were seasonally adjusted before being transformed by taking logs and converting to first differenced form. All nominal variables were converted into real terms using the GDP deflator. Interest rates were converted to real terms using the Consumer Price Index (CPI).

For accurate estimation of fiscal effects, real GDP was converted to real private GDP by subtracting public consumption[4] from GDP and deflating the result. The fiscal variables used in the equations are defined as tax revenue and total government expenditure in real terms. The fiscal variables were constructed both in real terms and as a share of GDP as a robustness check with results being very similar for both cases. This was also done to ensure an increase in the respective variables directly translates to a direct increase in tax rate or a direct increase in government expenditure. The construction of each variable is further elaborated on in the Appendix. The lag specification for each equation is determined by setting a lag operator to 4 as a general specification, after which statistical tests are used to determine specific lags. All data are sourced from the Bank of Jamaica (BOJ).

3.3.4 Converting Estimated Parameters to Multipliers

Given that the econometric approach specifies a log-log model, the coefficients are essentially elasticities, which will need to be transformed into multipliers. The value of the multiplier can be more simply interpreted as the per cent increase in GDP (or investment) brought about by a one per cent increase in an explanatory variable. Consider the following model:

$$\Delta y_t = \lambda_0(s_t) + \lambda_1(s_t)\Delta y_{t-1} + \lambda_2(s_t)\Delta\omega_{t-1} + \varepsilon_t(s_t) \qquad 16$$

where, y is GDP and ω is the fiscal variable, for example, government expenditure. If all variables here are defined in logs, the coefficients are then elasticities. To convert the elasticities, they are

[4] Public consumption is defined as government expenditure on employee compensation and government programmes only.

then all multiplied by the average of the GDP-to-government expenditure ratio in the sample period. This then produces the respective multiplier. In the literature, however, the conversion of elasticities to multipliers, takes two important illustrative considerations in mind. First, the coverage or period for which the multiplier is calculated should be appropriately designed in the context of the research question. Second, the multiplier should be illustrated within a range to account for outliers. Based on the existing literature, researchers have used either an impact multiplier, peak multiplier, long-run multiplier, or a combination of all. The impact multiplier uses the elasticity of output at the impact period. The peak multiplier uses the elasticity of output at its peak response. The long-run multiplier uses the cumulative changes in output over time.

Given that fiscal variables appear with a lag in the equations, peak multipliers should be used for this paper to ensure accuracy. If output is said to be at its 'peak' following increased government expenditure, then it should be the case that $\Delta y_t = \Delta y_{t-1}$, and the elasticity would need to be correspondingly adjusted. As such, to calculate peak multipliers, it follows that the elasticity to be used becomes $\lambda_2(s_t)/\big(1-\lambda_1(s_t)\big)$, instead of $\lambda_2(s_t)$. This adjusted elasticity is then multiplied by the average of the GDP to government expenditure ratio to get the multiplier. Note, however, that the GDP to government expenditure ratio is not constant over the sample period and, as such, computing the multiplier with the average ratio only may not be appropriately thorough[5]. To account for this, the time-varying nature of the ratio is addressed by using a minimum and maximum value for the ratio, in addition to using the usual average value of the ratio. These three estimates of the ratio are then used to derive three respective estimates of the peak fiscal multiplier – a minimum, maximum and average fiscal multiplier, which is displayed in the results. This procedure must be done for each state as the model produces state-dependent fiscal elasticities which determine state-dependent multipliers. Hence, the respective minimum, maximum and average GDP to government expenditure ratios are calculated for each state of the economy. The same procedure is applied to get the government tax multiplier in a separate equation using the ratio of GDP to the tax variable.

4. Results

In this section, the estimated parameters will be shown followed by the calculated multipliers for each state for the two equations: the expenditure equation and the taxation equation. The posterior probabilities are estimated and shown, followed by the parameter estimates. The posterior probabilities are the conditional probabilities of being in regime 1 at period t, taking into account the information available in the entire sample period. In order to separate regime

[5] This has to do with our second consideration above of ensuring completeness in calculating and displaying multipliers.

1 from regime 2 data points, the posterior probability value of 0.5 will be used as the separation value. If the posterior probability of being in State 1 at a particular data point is higher than 0.5, then the data point is classified as State 1 – the normal conditions regime. Correspondingly, a data point is classified as State 2 if the posterior probability (value of being in State 1) is less than 0.5. For the estimated parameters tables, Column 1 will display variable names rather than symbols, with the exception of the transitions variable impact. Recall that b_1 in the results table represents the impact of the transition variables on p_t^{11} – the probability of staying in the normal conditions regime if already in the normal conditions regime. Correspondingly, b_2 represents the impact of the transition variable on p_t^{22} – the probability of staying in the recession regime. The symbols, a_1 and a_2, are the intercepts in each transition variable equation. The MS-TVTP Model separates normal conditions from recessions/macroeconomic crises by incorporating shifts in output. This approach considers the locations of these shifts in output as the point where one regime changes to another.

4.1 Estimation of Regimes

Figure 4.1 shows the posterior probability of being in the normal conditions regime (regime 1), as well as real GDP and real private GDP. From figure 4.1, the model depicts that regime 1 periods coincide with the growth spurt starting in 2000, following the financial crisis and subsequent recession in the late 1990s, which is inundated with regime 2 periods as indicated by the posterior probabilities. The posterior probabilities then depict that regime 1 periods continue until late 2003, which was characterised by sharp exchange rate depreciation and the brief economic downturn which followed. Regime 1 periods then return almost immediately until the US financial in 2008 and the subsequent sharp and sustained economic downturn that followed. The model then depicts that regime 1 periods return and are maintained, with the exception of the brief downturn in 2014 following the approval of the most recent structural adjustment program. The probability switches coincide with changes in economic conditions as characterised by real GDP and real private GDP. This bodes well for the relative accuracy of the model in its ability to replicate normal conditions and recessions/macroeconomic crisis conditions.

The results in Table 4.1 and Table 4.2 are derived using real government expenditure and the tax revenue ratio, respectively. The conditional means for regime 1 and regime 2 in both Table 4.1 and 4.2 clearly depict an upturn regime and a downturn regime. Regime 1 is the normal conditions regime with a low but positive average growth per quarter. Regime 2 is the recession regime and has an average decline per quarter of roughly 0.029 per cent. The conditional variances are relatively the same for both regimes. The business cycle with both regimes are therefore well established by the model with the average changes reflecting recessions and boom periods over the sample. The estimates are also broadly consistent across Table 4.1 and 4.2.

FIGURE 4.1: POSTERIOR PROBABILITIES FOR EXPENDITURE EQUATION

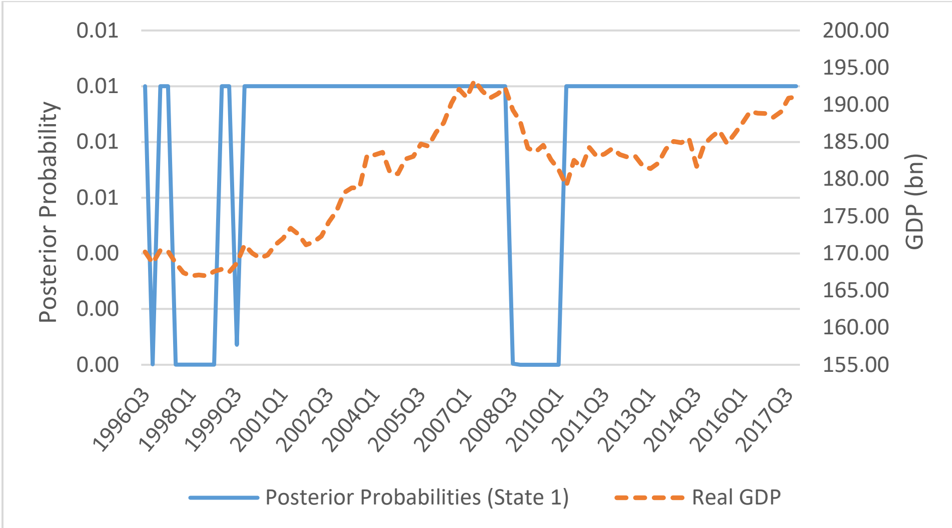

TABLE 4.1: MS-TVTP ESTIMATED PARAMETERS FOR EXPENDITURE EQUATION

Variable	Value	Standard Error^
$\mu(1)$	0.0003	0.001
$\mu(2)$	-0.029	0.001***
$\sigma_y(1)$	0.0001	0.00001***
$\sigma_y(2)$	0.0002	0.0001*
$\Delta y_{t-1}(1)$	-0.154	0.091*
$\Delta y_{t-1}(2)$	0.587	0.018***
$\Delta\omega_{t-2}^{e}(1)$	0.014	0.015
$\Delta\omega_{t-2}^{e}(2)$	0.123	0.001***
Δv_{t-5}	0.079	0.044*
Δr_{t-2}	-0.001	0.055
Δy_{t-2}^{*}	0.404	0.012***
$\forall_t(1)$	-0.037	0.016**
$\forall_t(2)$	-0.079	0.013***
a_1	1.747	0.292***
b_1	118.831	53.394**
a_2	0.245	0.689
b_2	-46.122	116.023
Log-Lik.	288.594	
AIC (TVTP Model)	-543.189	
AIC (FTP Model)	-5.616	

^: *,**,*** refers to statistical significance at the 10, 5 and 1% levels.
Numbers in parenthesis refer to the state or regime.

FIGURE 4.2: POSTERIOR PROBABILITIES FOR TAXATION EQUATION

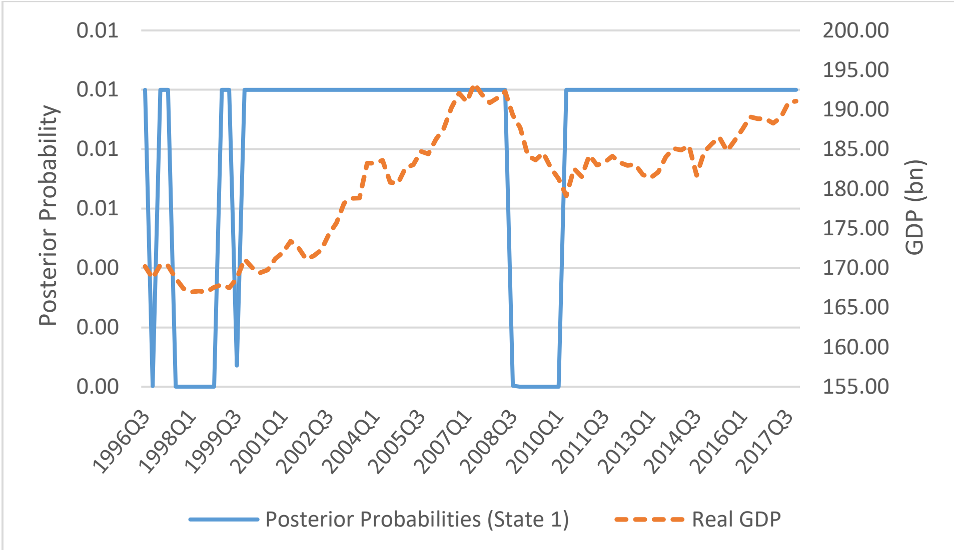

TABLE 4.2: MS-TVTP ESTIMATED PARAMETERS FOR TAXATION EQUATION

Variable	Value	Standard Error^
$\mu(1)$	*0.0008*	*0.001*
$\mu(2)$	*-0.033*	*0.007****
$\sigma_y(1)$	*0.0001*	*0.00001****
$\sigma_y(2)$	*0.0001*	*0.0001**
$\Delta y_{t-1}(1)$	*-0.173*	*0.102**
$\Delta y_{t-1}(2)$	*-0.423*	*0.330*
$\Delta\omega^r_{t-2}(1)$	*-0.058*	*0.029***
$\Delta\omega^r_{t-2}(2)$	*-0.178*	*0.094***
Δv_{t-5}	*0.045*	*0.044*
Δr_{t-2}	*-0.072*	*0.054*
Δy^*_{t-2}	*0.359*	*0.197***
$\emptyset_t(1)$	*0.002*	*0.028*
$\emptyset_t(2)$	*-0.179*	*0.163*
a_1	*2.396*	*0.579****
b_1	*184.383*	*98.887***
a_2	*-1.919*	*1.335*
b_2	*-229.279*	*201.092*
Log-Lik.	*262.406*	
AIC (TVTP Model)	*-490.811*	
AIC (FTP Model)	*-5.616*	

^: *,**,*** refers to statistical significance at the 10, 5 and 1% level.
Numbers in parenthesis refer to the state or regime.

4.2 Fiscal Multipliers

The estimated parameters (elasticities) from Tables 4.1 and 4.2 are converted to multipliers shown in Table 4.3. The details of the conversion methodology is shown in section 3.3.4. As the calculations illustrate, there are some important Keynesian effects and variations seen across regimes in line with the recent literature. The fiscal effects are significantly asymmetric and time-varying. The government expenditure multiplier is very low and suggestive of Ricardian effects with values close to zero during normal conditions. The expenditure multiplier, however, shows stronger, albeit low effects, in the recession/macroeconomic crisis regime with a value of 0.167. The same variation is seen for the tax multiplier. However, tax multipliers show significantly stronger effects in both regimes. The average tax multiplier is 0.213 in normal conditions, but increases significantly to 0.605 in the recession/macroeconomic crisis regime. This suggests that fiscal policy may be an effective tool in combating a recession, particular if taxes as the fiscal instrument. The results on the transition variables, however, will shed more light on this. Of note, the variables with the largest impact on private GDP are external demand (real GDP in the US) and domestic taxes. In normal economic conditions, it is found that external demand is the most important determinant of real private GDP.

With respect to results found for advanced economies using similar methods, the results for taxation multipliers are consistent with the results found for expenditure multipliers for the United States in Dufrenot et al (2016). Taxation multipliers, however, remain low in both regimes in Dufrenot et al (2016). Both the results in this paper and Dufrenot et al. (2016) for the United States point to the inability of expenditure to stimulate growth during normal conditions, which is in line with economic theory of crowding out effects. Expenditure multipliers are negative in the normal conditions regime in Dufrenot et al. (2016), while there are close to zero, albeit positive, in this paper. Overall, the taxation instrument was more potent in the case of Jamaica, while the spending instrument was more effective in the case of the United States in Dufrenot et al (2016). Also the multipliers in this paper increase to as high as 0.7, which is exactly in line with the results in Dufrenot et al. (2016).

TABLE 4.3: ESTIMATED MULTIPLIERS

	Minimum	Average	Maximum
Government Expenditure			
Regime 1	0.029	0.040	0.055
Regime 2	0.133	0.167	0.239
Government Taxes			
Regime 1	-0.164	-0.213	-0.254
Regime 2	-0.461	-0.605	-0.670

Regarding the results found for the transition equation, the statistical significance and positive sign of b_1 in Tables 4.1 and 4.2, suggests that if the initial regime is the normal conditions regime, then fiscal expansionary policies increases the probability that the economy will continue in the normal conditions regime if this is financed by past GDP growth. This occurs only in the cases when fiscal policy actions are financed by increased output growth or deceleration in the rate of decline of growth. The higher value of b_1 in Table 4.2, however, suggests that this is more potent in the case of taxation. With respect to when the economy is in a recession/macroeconomic crisis regime, the insignificance of b_2, albeit with the correct sign, suggest that past output growth is uninformative about the future state of the economy. This suggests that the extent to which fiscal policy can be used to combat recessions does not depend on whether the fiscal stimuli is financed by past GDP growth. This is contrary to the result found for regime 1, where the impact of fiscal stimuli on the probability to stay in normal conditions depends on whether this was financed by past GDP growth. In terms of diagnostics, the specification of time-varying transition probabilities was not rejected by the data and has a better performance over the FTP assumption (see AIC in Tables 4.1 and 4.2). All issues of endogeneity were corrected with statistically significant bias correction terms from the control function approach.

5. Implications for Fiscal Policy

In this Section, important implications from the results are discussed using the sample period as the span of focus. From Figures 4.1 and 4.2, when reviewing actual real GDP, the recession periods seen are roughly 1996 Q1 to 1999 Q2 and 2008 Q2 to 2010 Q2, which largely coincide with the estimations posterior probabilities using real private GDP. The findings of the model indicate that tax multipliers are significantly more potent than government expenditure multipliers. This could be attributed to the channels by which fiscal policy impact the real economy. This is outside of the scope of this paper, however, growth impetus provided from from government expenditure during recession conditions could be more prone to leakage possibly through its impact on consumption of imported products. This is an important point of investigation for future research. Notwithstanding, what does the results from section 4 imply for fiscal policy?

Regarding the cyclical behaviour of fiscal policy over the sample period, it is shown that fiscal policy has largely been counter-cyclical. This is displayed in Table 4.3 where the budget balance was calculated as a percentage of GDP. This counter-cyclical behaviour was prevalent throughout the sample period but increased during period 4, which could be attributed to the structural adjustment programme from May 2013 to June 2017. The fiscal balance in period 4 was three times as high (in absolute terms) than the second highest counter-cyclical span in period 1. During this period, an array of fiscal and growth-enhancing reforms were introduced while maintaining a primary balance of roughly 7.5% of GDP. Using the fiscal multipliers in this paper, one can assess both fiscal instruments during this period to estimate the relative impact of fiscal consolidation. An important question to answer is: does it matter how the primary balance is achieved and maintained in the context of facilitating growth? The results indicate that it does. This is so primarily because fiscal multipliers are asymmetric and time-varying.

Since the start of the structural adjustment programme in 2013 Q2, real private GDP growth has averaged 0.187% per quarter, and has had a cumulative change of roughly 3.5% to end-2017. This translates to annual average growth of roughly 0.8%. Since 2013 Q2, using the constructed variables as they appeared in the model, tax revenue as a share of GDP has increased by 13.58%. Using the normal conditions regime fiscal multiplier for taxes of -0.21, the respective downward pressure put on real private GDP since 2013 Q2 is 2.9%. Correspondingly, government expenditure has decreased by 4.1%. Consequently, the downward pressure on real private GDP incurred from this reduction in government spending (with a multiplier of 0.040) is marginal at 0.16%. Based on these estimations, since the start of the programme, fiscal policy has collectively exerted downward pressure on real private GDP of approximately 3% cumulatively. The cumulative 3% percent downward pressure translates to an average annual cost to real private GDP of 0.7% – almost as high as the actual annual average growth in real private GDP over the sample period. Also, given that fiscal multipliers increase significantly during recessions/macroeconomic crises, if the economy goes into a recession, then the current fiscal policy would have an even larger constraint than -0.7% annually.

FIGURE 4.3: <u>REAL PRIVATE GDP AND FISCAL TRENDS</u>

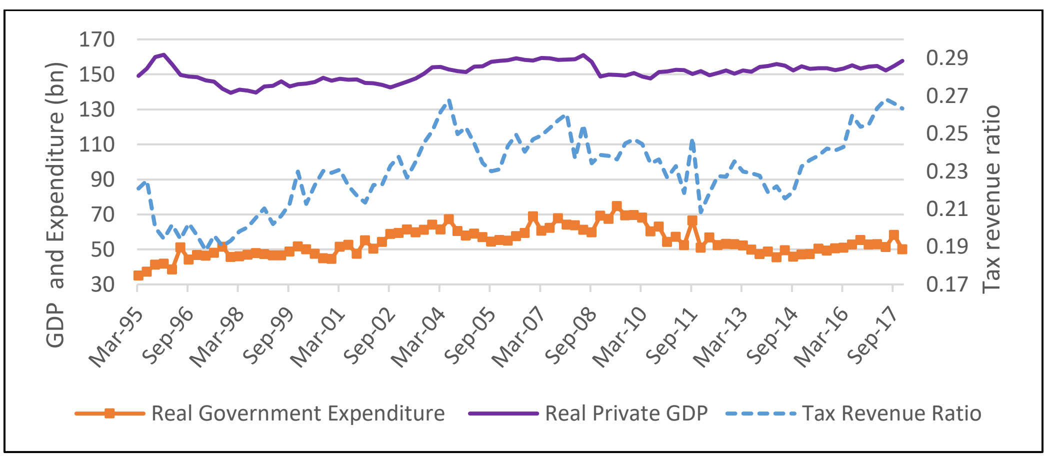

TABLE 4.3 FISCAL POLICY DURING ECONOMIC CYCLES

	Real Private GDP	Real Govt. Expenditure	Tax Revenue Ratio	Balance (% of GDP)^
Period 1: 1996 Q1 to 1999 Q4				
Cumulative change	-10.962	21.257	16.796	-2.323
Average change	-0.690	1.329	1.050	-0.145
Period 2: 2000 Q1 to 2008 Q1				
Cumulative change	9.330	20.890	3.007	2.282
Average change	0.283	0.633	0.091	0.069
Period 3: 2008 Q2 to 2010 Q2				
Cumulative change	-7.188	-5.466	-1.177	-1.392
Average change	-0.799	-0.607	-0.131	-0.155
Period 4: 2010 Q3 to 2018 Q4				
Cumulative change	6.620	-18.614	11.777	6.764
Average change	0.221	-0.620	0.393	0.226

^Refers to the quarterly budget balance (as a percentage of GDP) derived by subtracting government expenditure from total tax revenue. All variables were in log differenced form so all figures reported in the table are in percentage terms. 'Real Govt. Expen.' refers to Real Government Expenditure.

In order to minimise contractionary effects so as to better facilitate economic growth while keeping the same level of fiscal consolidation, policy practitioners could modify fiscal policy going forward by taking advantage of the differentiating values of the tax and expenditure multipliers. Reduced taxes could be financed by proportionately reduced government expenditure, if continued consolidation (primary balance level) is desired or required, leading to reduced contractionary effects. This adjustment could be facilitated by a policy oriented more towards private sector-led growth and efficiency gains in public sector spending.

An important caveat to note, however, is that higher tax multipliers may have also led to a faster rate of stabilization when taxes were more than proportionately raised relative to government expenditure during adjustment programmes. This speed of stabilization may be particularly important in cases where in addition to fiscal pressures, there is also current account deterioration with insufficient international reserves to support import consumption at its present rate. In such cases, the speed of stabilisation may be more important than growth facilitation, albeit, such situations would be avoided with a more proactive fiscal policy.

Notwithstanding, growth facilitation can be enhanced at the same fiscal balance with lower tax rates compensated by reduced expenditure. Structural adjustment programs in many cases facilitate the reduction of inefficient expenditure. A recent study, Izquierdo and Pessino (2018), suggests that inefficiencies in government spending in LAC countries could be as large as $220 billion a year, or 4.4% of the LAC Region's GDP. As such, this may present opportunities to sustainably reduce inefficiency in areas such as: energy efficiency across the public sector;

digitisation of public administrative processes to reduce transaction costs and enhance agency coordination; enhanced resilience and preparedness to natural disasters to minimise recovery costs; improved targeting of SSN spending; and an enhanced public financial management framework. Some of these initiatives may require an initial outlay of expenditure that may be significant, while others require only a marginal increase or even result in a decline in expenditure. It is envisioned that the latter initiatives can be immediately pursued for quick wins, with efficiency gains expected to be achieved over the short term. Initiatives which require significant expenditure, on the other hand, could be repaid over the short-to-medium term through efficiency gains that allow governments to achieve more with less resources. This, thereby, enables lower taxation in a sustainable manner to help achieve and sustain robust growth outcomes.

6. Conclusion

In this paper, regime-dependent fiscal multipliers were estimated for Jamaica over the period 1996 Q1 to 2017 Q4, using a MS-TVTP approach. The empirical framework estimated both tax and expenditure multipliers on GDP. The paper outlines the process by which fiscal policy and economic growth evolve in a small developing economy, which is particularly important to policy practitioners in the LAC Region. By incorporating the TVTP approach, which governs switching between states, the paper ensures the complete characterisation of the transmission of fiscal policy to the real economy.

The model does well to replicate the business cycles over the sample period with normal economic conditions and macroeconomic crisis/recession periods well established. In line with expectations, the variances of the regime are not significantly different, while the differentiating means are well defined. Endogeneity of the fiscal variables is addressed using the two-step control function approach and the inclusion of control variables as instruments. The paper shows that fiscal effects and calculated multipliers are significantly asymmetric and time-varying. Tax multipliers on GDP are significantly higher than expenditure multipliers in both states of the economy, while both increase significantly during recessions. These results are largely in line with the literature on regime dependent fiscal multipliers, but some important distinctions were discussed. Overall, the taxation instrument was more potent in this paper, while the spending instrument was more effective in the case of the United States in Dufrenot et al (2016). Also the multipliers in this paper increase to as high as 0.7, which is exactly in line with the results in Dufrenot et al. (2016).

By using the derived multipliers, the paper shows that fiscal contractions during the recent structural adjustment program exerted downward pressure on real GDP of roughly 3% cumulatively. Notwithstanding, a higher tax multiplier in conjunction with the design of the program implied a faster rate of stabilization. This speed of stabilization may be particularly important in cases where in addition to fiscal pressures, there is also current account deterioration with insufficient international reserves to support import consumption at its present rate. Going forward, however, substantially higher tax multipliers relative to expenditure multipliers suggest that fiscal policy could be modified to markedly lower contractionary effects on GDP. Reduced taxes, financed by proportionately reduced government expenditure, could lead to better growth facilitation with minimal impact on the fiscal balance. This outcome could be facilitated by a policy oriented more towards private sector led growth and achieving public sector efficiency gains.

The data span of this paper is sufficient for standard models, however, it is still limited and as such the estimates should be taken with caution. Future research could focus on extending the current data set to increase the precision of estimates, while addressing data limitations such as the absence of quarterly consumption and investment. This is needed to more formally assess import leakages through consumption and the crowding effect of government expenditure on investments. Further research could also disaggregate government spending to estimate heterogeneous multipliers for each category of spending.

Data and Variable Construction

All variables were collected in the quarterly frequency, seasonally adjusted, and then converted to log form. The variables, however, enter the model in differenced form and are all I(1). Taxes enter the GDP equation as revenue scaled by GDP, while government expenditure is scaled by the GDP deflator in keeping with the literature. Data was unavailable to apply market interest rates as the short-term interest rate in the equations because short-term Government Treasury Bills were discontinued in 2017. As such, the Central Bank 30-day CD rate (monetary policy instrument up to end 2017) was used to represent the short-term interest rate. An overnight interest rate was established for the first time as the new central policy rate in the third quarter of 2017, taking over from the 30-day CD rate for the final two data points of the sample used in this paper. This 30-day CD rate has continued to be adjusted in line with monetary policy actions.

TABLE A.1: <u>VARIABLES FOR ESTIMATED EQUATIONS^</u>

Variable	Description
Real Private GDP	$log\left(\frac{GDP_t - government\ consumption_t}{GDP\ deflator_t}\right)$
Tax revenue	$log\left(\frac{total\ tax\ revenue_t}{GDP\ deflator_t}\right)$
Government expenditure	$log\left(\frac{total\ government\ expenditure_t}{GDP\ deflator_t}\right)$
Real effective exchange rate	$log(trade\ weighted\ real\ exchange\ rate)$
Short term real interest rate	$log\left(1 + interest\ rate_t \frac{\Delta\ CPI_t}{CPI_{t-1}}\right)$
External demand	$log(USA\ real\ GDP_t)$

^Government consumption is defined as government expenditure on employee compensation and programmes. Interest rate is defined as the 30-day BOJ CD policy rate. CPI is the Consumer Price Index. Source: BOJ.

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