Elasticity and Buoyancy Of the Jamaican Tax System

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Abstract

This paper aims to determine the relationship between GDP growth and the growth in tax revenue as well as the responsiveness of taxes to fiscal policy in Jamaica. This will be done by estimating the buoyancy and elasticity of tax revenues spanning the period March 1998 to December 2010, using the Divisia Index (DI) approach. The DI approach seeks to separate the effect on total revenue of (i) the discretionary measures and (ii) the built-in response of tax revenues to the growth in GDP. An understanding of the level of responsiveness of tax revenue to discretionary measures and GDP are essential to the formulation of fiscal policy. This is of importance in the context of analysing and discussing the effectiveness of the Government's policy actions over time in its effort to garner additional revenue. Further, the ability of the Government to finance expenditure through revenue growth reduces the required level of debt raising as well as pressure on domestic interest rates. At the same time, the results of the model can inform tax policy as they indicate that overall discretionary measures have led to increased revenues over the review period. It was also found that the tax system was inelastic to the growth in the tax base.

JEL Classification: C32, H20, H21, H60, O540

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[1] The views expressed in this paper are those of the author and do not necessarily reflect those of the Bank of Jamaica.

1.0 Introduction

The most recent Green Paper on Tax Reform tabled in Jamaica's Parliament in April 2011 highlights several tax reform measures which the Government would wish to implement over the medium term commencing January 2012.[2] The objectives of the reform measures are simplicity, equity, broadening the tax base, improved compliance as well as growth and competitiveness arising from policy certainty and confidence in the economy. More importantly, the measures must meet 'the revenue demands of the budget while maintaining macro-economic and social stability'. While the planned reforms are on a scale that is unprecedented, efforts in the past have broadly been aimed at boosting revenue growth in order to finance expenditure and reduce the fiscal deficit. The question arises as to how effective measures implemented in the past have been in improving the revenue potential of the country over time. This is important as the underperformance of revenue increases the need for additional debt raising and limits the ability of the Government to spend on projects that can boost economic growth and development. It also increases the borrowing requirement of the Government which crowds out private investment through higher interest rates.[3]

In order to assess the responsiveness of tax revenues to fiscal policy measures, it is necessary to determine its responsiveness to growth in the tax base. Taxes are levied on several bases which are dynamic and tend to move in tandem with the economic activity within a country. Numerous literature have utilised a proxy base such as GDP due to the complexity of the specific tax bases in an attempt to determine how revenues respond to changes in the base. Such an analysis is twofold as it becomes necessary to assess revenue growth with and without the discretionary measures.[4] This refers to the concepts of elasticity and buoyancy. Elasticity is defined as the automatic response of revenue to changes in income net of discretionary changes while buoyancy is the total response of tax revenue to changes in incomes and therefore includes any changes due to discretionary measures (Bilquees, 2004).

[2] Green Paper on Tax Reform, Ministry of Finance, Jamaica.
[3] See Selected Indicators for Jamaica in Appendix A.1
[4] For a summary of discretionary measures over the period, see Appendix A.2

This paper seeks to determine whether tax revenue responds more to the discretionary measures than to the built-in response due to changes in the tax base. To accomplish this, the effects of discretionary tax measures and increases in the proxy tax base, GDP, are separated from tax revenue to determine the responsiveness of tax revenues to changes in the base. In theory tax revenues are said to increase with economic growth based on the assumption that tax bases grow as GDP increases. To determine this relationship it must be identified whether the growth in tax revenue over the years have been the result of discretionary tax measures or if they were due to the automatic increase in tax revenues that is expected when GDP increases. This paper builds on Thompson (1999) and uses quarterly data spanning the period March 1998 to December 2010. It will explore to what extent new discretionary measures affect the results of elasticity and buoyancy from the previous paper. It will also attempt to determine whether or not other measures for the tax base can be incorporated apart from GDP.

The remainder of the paper is structured as follows. Section 2 presents a review of the relevant literature while Section 3 provides the data and methodological approach. Section 4 provides the results from the study and Section 5 concludes.

2.0 Literature Review

The elasticity and buoyancy of tax systems are concepts that have been widely studied in the public finance literature. By definition, elasticity is the change in tax revenue directly arising from a one unit change in income. In other words, it is the proportionate change in tax to the proportionate change in income (Indraratna, 2003). It is also defined as the automatic response of revenue to changes in income net of discretionary changes (Bilquees, 2004). Buoyancy speaks to the total response of tax revenue to changes in incomes and therefore includes any increases due to discretionary measures (Bilquees, 2004). It measures the responsiveness of revenue to a changed tax system whether the change is due to discretionary measures, built-in responsiveness or both (Indraratna, 2003). These concepts are equally important as they indicate the rate at which revenues are increasing or decreasing.

Most studies focus on the elasticity of a tax system as they are concerned with how well the system responds to changing tax bases net of discretionary measures. Indraratna (2003) notes that a system is elastic if tax revenues rise proportionally faster than income as income increases and that the benefits of such a system is the provision of resources for Government consumption and financing capital formation. He therefore defines tax elasticity as the built-in response of revenues to changes in income once the effect of discretionary changes made by authorities to maintain short-term revenue objectives are excluded[5]. It is common practice to also determine the buoyancy of the system and compare it to the elasticity of the tax system. A comparison of both coefficients provides insight into the impact of discretionary measures. If the buoyancy exceeds elasticity, discretionary tax measures are assumed to be contributing more to the growth in tax revenues than the built-in response to the base. However, if the elasticity exceeds the buoyancy, then discretionary tax measures will lead to a decrease in revenue. If there is a case where both coefficients are equal, then discretionary measures are said to have little to no impact on tax revenue.

Several methods have been utilised in the literature to measure both the elasticity and buoyancy of tax revenues. Generally, the estimation of elasticity involves adjusting the revenue series to remove the discretionary tax measures. Common methods that adjust the revenue series include the Proportional Adjustment Method, Constant Rate Structure Method, Dummy Variable Approach and Divisia Index Approach. The Proportional Adjustment Method adjusts a historical revenue series according to a particular year's tax structure assuming that the particular tax structure is maintained throughout the period under review (Indraratna, 2003). This method has been used by Indraratna (2003) who studied the responsiveness of Sri Lanka's tax structure over the period 1960 to 1994. His results showed low responsiveness of all taxes to income growth with total revenue, in particular, being 0.80. The results remained relatively unchanged even after dividing the tax structure into *post-reform* and *pre-reform* periods, implying that the economic reforms did not improve the elasticity of the system. He also estimated the buoyancy

[5] If the elasticity coefficient exceeds unity, revenue growth is exceeding GDP growth. On the other hand, if the elasticity coefficient is less than unity, this would indicate lagged revenue growth compared to GDP growth.

where it was found that these coefficients were higher than the elasticity for all taxes indicating the importance of discretionary measures in maintaining a steady source of revenue throughout the period. Indraratna (2003) noted the inelastic tax structure could be explained by factors such as exemptions, tax incentives, duty waivers and low compliance as well as the sectors in the economy that were not subject to taxation.

The second measure is the Constant Rate Structure method which involves generating a simulated tax revenue series for a reference year as well as estimates of the tax base for subsequent years. Although this is said to be the most accurate approach, it is not used frequently due to the heavy reliance on the availability of disaggregated data on the effective tax rates and on the changing composition of the bases (Choudhry, 1979; Bilquees, 2004; Rasheed, 2006). Thirdly, the Dummy Variable (DV) approach utilised by Rasheed (2006), uses dummies to capture discretionary tax changes in tax rates and tax structures. He estimates the buoyancy for Pakistan over the period 1980 to 2004 and utilised not only GDP, but also high powered money (M_0), narrow money supply (M_1), broad money supply (M_2), CPI, gross investment, volume of trade, tax evasion and public debt to identify the responsiveness of tax revenue. Using a Vector Error Correction Model (VECM), it was found that only the buoyancy coefficients for GDP, M_0 and volume of trade were significant. The coefficient on GDP was the largest at 0.174 while that on M_0 and volume of trade was very low at 0.061 and 0.089, respectively. It is important to note that it becomes difficult to provide an accurate estimate using the dummy variable approach when discretionary changes have been frequent in the past since it leads to excessive reduction in the degrees of freedom which affects the efficiency of the estimators (Choudhry, 1979; Bilquees, 2004; Rasheed, 2006).

Authors utilising the Divisia Index (DI) Approach include Choudhry (1979), Thompson (1999) and Bilquees (2004). Choudhry (1979) estimates the elasticity using the DI approach for United States of America (USA) between 1955 and 1975, United Kingdom (UK) between 1955 and 1974, Malaysia between 1961 and 1973 and Kenya between 1962 and 1974. His results indicated that both the buoyancy and elasticity estimates for the USA and UK were smaller than those for Malaysia and Kenya due to the differing tax structures for the developed and developing countries. It was also found that discretionary measures had little impact on the system in the USA while the UK system was more elastic than buoyant. On the other hand, both Malaysia and Kenya showed higher buoyancy rates relative to elasticity indicating that discretionary measures in these countries had greater revenue generating ability. Choudhry (1979) also compared his results from the DI approach to that of the proportional adjustment and constant rate structure approaches. He found that the proportional adjustment estimates were close to that of the DI approach but the constant rate structure approach gave the lowest estimates and failed to detect the effects of discretionary measures in the UK.

Both Thompson (1999) and Bilquees (2004) followed the theoretical methodology laid out by Choudhry (1979). Thompson (1999) estimated the elasticity and buoyancy of tax revenues for Jamaica over the period 1991/92 to 1998/99 and found that the tax system was more elastic than it was buoyant implying that more revenues could be raised in the absence of discretionary measures. Bilquees (2004) focused on measuring buoyancy and elasticity of the tax system in Pakistan over the period 1974/75 to 2002/03 and also analysed the factors responsible for the size of the elasticity coefficients. He utilised total GDP and non-agricultural GDP as the tax base and used a VECM to determine both the short-run and long-run elasticity. Bilquees (2004) found the buoyancy coefficient to be less than unity indicating that tax changes did not significantly improve revenue, although the buoyancy coefficient was greater than the elasticity coefficient. The coefficient of elasticity was found to be less than unity showing that continued exemptions, allowances and loopholes for evasions contributed to the distortions in the tax system, preventing the tax base to broaden as the economy expands. This finding of buoyancy being less than unity for Pakistan is confirmed by both Bilquees (2004) and Rasheed (2006) although the estimate using the DI approach was larger.

Given that several tax measures have been implemented in Jamaica, the dummy variable approach is not appropriate for the Jamaican tax system. Data on the tax bases and the effective tax rates is difficult to attain given the complexity of the domestic tax system thus the constant rate structure method will not be used in this analysis. Additionally, the proportional adjustment method is not suitable given that the estimated yields from the tax measures presented in Jamaica often times differ from the actual yields. With that in mind, this paper will use the DI approach to estimate the buoyancy and elasticity since the adjustment of the series is based on the derivation of the index. It also has the added advantage of using only historical data and not relying on the specific information on revenue effects of discretionary changes or the frequency of the tax changes.

Other issues in the literature relate to the regression equation used to estimate the elasticity and buoyancy. In all the methods presented above a regression equation is estimated. In some cases both the short-run and long-run elasticities have been estimated with the short-run elasticity measuring cyclical variability or stability and the long-run elasticity measuring the growth potential of the various tax bases. This paper focuses on the long-run elasticity since it is concerned with the overall growth potential of the tax base. Studies that have estimated short-run and long-run elasticity have utilised the standard VECM and ordinary least squares (OLS) methodologies. However, the challenge with the standard long-run estimation was found to be the non-stationarity of the tax revenue and the proxy tax base, GDP. This is particularly important as the standard OLS regression of the log of the tax base regressed on the log of the tax yield usually leads to asymptotically biased coefficient estimates and inconsistent standard errors. Sobel and Holcombe (1996) corrected for these problems by using the Stock-Watson (1993) dynamic ordinary least squares (DOLS) model to correct for the coefficient bias and the Newey-West (1987) correction to eliminate the inconsistency in the standard errors. By the DOLS method, leads and lags of the change in the independent variable are added to the regression equation. They argue that with this combination, more accurate long-run estimates of elasticity can be obtained than have been obtained in the past from the standard levels regression. Their study measured the growth and variability of tax bases over the business cycle for the USA from the period 1951 to 1991. The DOLS and Newey-West correction will be applied to this paper for the buoyancy equation in addition to the OLS and VECM equations for robustness.

3.0 Data and Methodology

This paper uses quarterly data from March 1998 to December 2010 for GDP, consumption, total tax revenue, PAYE, customs duty, corporate income tax (CIT), general consumption tax (GCT) and special consumption tax (SCT). Data on GDP and taxes were acquired from the Statistical Institute of Jamaica and Ministry of Finance of Jamaica, respectively.[6] The paper incorporates the standard OLS estimation procedure as used by Choudhry (1979) and Thompson (1999) and also incorporates the vector error correction model (VECM) used by Bilquees (2004) and the Dynamic OLS (DOLS) model proposed by Sobel and Holcombe (1996) which both correct for the shortfalls of the OLS model.[7],[8] The shortfall of the OLS coefficient estimates relate to asymptotically biased coefficient estimates and the inconsistency of the standard errors in the presence of nonstationary variables.

The DI approach will be used to estimate the buoyancy and elasticity of tax revenues. This method seeks to separate the effect on total revenue of the (i) discretionary measures and (ii) the built-in response of tax revenues to the growth in GDP. First, the effects of discretionary tax measures are removed from total revenue growth using an index that isolates the automatic growth in revenue. Next, the buoyancy is estimated with respect to GDP by a standard regression technique. Finally, the estimated buoyancy is adjusted by a transformation of the index to determine the elasticity of the tax yield. In the literature, the more popular methods of separating discretionary measures from the built-in responsiveness of tax revenue to growth include the proportional adjustment method, the constant rate structure method and the dummy variable method. Criticisms of these methods are their dependence on the complete adjustment of historical revenue series which can be cumbersome in light of the distortions between projected and actual revenue yields, data availability issues as well as the frequency with which tax measures are used by Governments.

[6] See Appendix A.3 for descriptive statistics.
[7] Unit root and cointegration tests can be found in Appendix A.4.
[8] The Schwarz Bayesian Criteria was used to select the lead and lag lengths for both the VECM and DOLS. See Appendix A.5 for further details.

The DI approach alleviates these problems as it uses only historical data, it does not require specific information on the revenue effects of tax changes and it does not require information on how frequent tax measures have been in the past. Drawbacks to this method include the likelihood of underestimation (overestimation) of positive (negative) revenue effects of tax measures as well as unsatisfactory results in the case of large revenue effects (Choudhry, 1979). Given the unavailability of data on tax arrears over the period being examined, it was therefore not possible to remove the effect that this may have on the outcome. Despite this limitation, it was assumed that tax arrears within the tax categories were constant overtime.

3.1 Theoretical Framework of the Divisia Index[9]

The conceptual framework for the DI for tax yields is analogous to the theory of total factor productivity. There is assumed to be a stable relationship between factor inputs and total output such that increases in factor inputs result in output growth representing an upward movement along the production curve. This movement relative to factor inputs is referred to as total productivity. Similarly, there exists a relationship between the growth in revenue and the tax yield curve whereby increases in the tax bases cause growth in revenue resulting in the movement along the tax yield curve. Tax elasticity is the term used to represent the movement along the tax yield curve since it is an aggregate measure of the automatic growth in revenue. Technical change is assumed to cause changes in factor productivity over and above those caused by changes in factor inputs. As such, it would be expected that there would be a shift in the aggregate production function. Similarly, a discretionary tax change causes the aggregate tax function to shift also since it alters the given tax system. The presence of a discretionary tax change (a technical change) results in a change in the tax yield (output) due to the combined effect of growths in the tax bases (factor inputs) and a shift in the curve caused by such a change. If there is no technical change or discretionary measure the given structure remains unaltered.

To elaborate, assume there is an aggregate tax function where the tax yield is a function of k bases. This is similar to the aggregate production function where aggregate output is

[9] Based on Choudhry (1979).

a function of *n* factor inputs. If there is no discretionary tax measure (or technical change), there is no change in the tax yield (output) for a given tax structure and a given configuration of bases (factor inputs). However, different revenues are obtained once there are discretionary tax measures that alter tax rates and/or exemption levels for a given set of bases. These revenues differ from those that would have been obtained without the measures. This difference in revenue is due to an induced shift in the aggregate tax function caused by a discretionary tax measure similar to how the production function shifts due to technical change.

The DI is similar to the index of technical change which is the ratio of an index of total productivity to an index of factor productivity. It can be interpreted that the percentage change in total productivity caused by technical change equals the percentage change in output divided by the percentage change in factor inputs. It follows that the DI for discretionary change is the percentage change in total tax yield divided by the percentage change in total tax yield due to the built-in response to an increase in the bases. The appropriateness of the index is due to the invariance property. If no technical change occurs, there will be no change in the index and the growth in total factor productivity is due entirely to increases in inputs. Similarly, if there is no discretionary tax change, the growth in revenue is entirely due to the growth in tax bases. Thus, a change in the index should reflect the overall revenue effects of discretionary measures.

The application of this index is dependent on two very significant conditions: it must be derived from an aggregate tax function and it must possess the invariance property. The necessary and sufficient conditions for the invariance property of the DI are as follows:

a) There exists a well-defined continuously differentiable aggregate function, $f(x_1(t),.....x_k(t))$.
b) The function f is linear homogeneous (constant returns to scale).

Condition a) is crucial to the existence of a relationship between tax yields and the tax bases and essentially elasticity and buoyancy since if no underlying aggregate function existed, there would be no way to determine these relationships. The “continuously differentiable" character of an aggregate function ensures the regularity of such a function which would otherwise lead to erratic behaviour of the tax yield. The second condition of linear homogeneity is somewhat restrictive as it implies that tax revenues and tax bases have a one-to-one relation. However, this may not be the case as in several countries revenues rise at a faster rate than the increase in their bases thereby possessing some form or the other of progressivity in their tax structures. The progressivity in tax systems implies that increases in income will lead to a more than proportional increase in revenues. To correct for this restriction, Hulten (1973) transformed the original DI to eliminate the linear homogeneity using a function characterized by non-constant returns to scale without violating the invariance property. Notwithstanding, the homogeneity condition, though not necessarily linear, is paramount to the invariance property. For the purpose of this study, it is assumed that f is homogenous – though not linear – in keeping with the a priori expectations. This is similar to the theoretical notions of consumption and production functions.

Authors have justified the homogeneity condition by purporting that tax ratios for several countries, including developing countries, have been increasing over time and these have done so without erratic movements.[10] Based on this assumption, aggregate revenue T as a homogenous function of GDP (x) is as follows:

$$T = Ax(t)^{\mu} \text{ ………………. (1)}$$

Where T is tax revenue, x is the tax base (GDP) and μ is the coefficient of buoyancy. As x rises over time, the tax ratio (T/x) remains constant or rises through time as the value of μ equals or exceeds unity. An alternative representation is as follows:

$$\log T = C + \mu \log x \text{ ……………….. (2)}$$

The derivation of the index results in Equation (3) after several transformations (see Appendix A.6).

$$D(n) = \frac{T(n)}{T(0)} \Bigg/ \prod_{i=1}^{k} \left[\frac{x_i(n)}{x_i(0)} \right]^{\tilde{\beta}_i} \text{ ……………………………. (3)}$$

[10] Tax ratios can be defined as the tax revenue divided by GDP.

This presents the DI as the index of total growth of tax revenues divided by the index of automatic growth of tax revenues measured by the denominator. An alternative representation of Equation (3) in logarithmic form is:

$$\log D(n) = \log\left(\frac{T(n)}{T(0)}\right) - \sum_{1}^{k} \tilde{\beta}_i \log\left(\frac{x_i(n)}{x_i(0)}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (4)$$

Equation (4) expresses the growth rate of the discretionary tax revenues as the difference between the growth rates of total revenues and automatic tax revenues. The growth rate of automatic tax revenues is a weighted sum of the growth rate of the (proxy) bases, $\tilde{\beta}_i$ (see Appendix A.6). One of the major advantages of the DI over other techniques is that no adjustment of the historical series is necessary. This is because the index in and of itself provides the automatic growth of revenue without "cleansing" the data of discretionary tax changes. Of note also is the fact that the index is an exact index of discretionary measures of the underlying equation since it is the integral of all discretionary changes along the tax yield curve.

An important practical issue for the DI relates to the fact that $\beta_i(t)$ is discrete and as such it will contain some discretionary effects. In the discrete version it is likely that $\beta_i(t)$ will be biased thereby affecting the estimate of the automatic growth of tax revenue expressed as $\prod_{i=1}^{k}\left[\frac{x_i(n)}{x_i(0)}\right]^{\tilde{\beta}_i}$.[11] The bias will be upward (downward) when the discretionary changes produce positive (negative) revenue effects. In other words, when discretionary measures produce positive (negative) revenue, the automatic growth of tax revenue will be overestimated (underestimated).

Once the DI is derived, the buoyancy coefficient can be estimated. Given that the degree of homogeneity of the aggregate tax function f is assumed to be $r > 0$, it can be shown

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[11] The discrete version is presented as: $\tilde{\beta}_i = \frac{1}{n}\sum_{t=1}^{n} \beta_i \frac{\rho_i(t)}{\rho_i}$ where $\rho_i(t) = \frac{x_i(t) - x_i(t-1)}{x_i(t-1)}$ and $n\bar{\rho}_i = \log\left(\frac{x_i(n)}{x_i(0)}\right)$.

Also, $\beta_i(t) = \frac{T_i(t) - T_i(t-1)}{x_i(t) - x_i(t-1)} * \frac{x_i(t)}{T(t)}$.

that if the growth rates of all bases are equal to that of GDP, then the tax function can be written as:

$$T = Ax(t)^{r} D^{*}(t) = Ax(t)^{\mu} \text{ ………………………. (5)}$$

Where x is GDP, D* is an index for revenue growth due to discretionary changes in the time interval [0, t], and μ is the buoyancy of the tax yield. The index D* is a special case of the index D and has the same form for the time interval [0, n]. It may be written as follows:

$$D^{*}(n) = \frac{T(n)}{T(0)} \Bigg/ \left[\frac{x(n)}{x(0)}\right]^{\tilde{\beta}^{*}} \text{ …………………… (6)}$$

Where $\tilde{\beta}^{*} = \frac{1}{n}\int_{0}^{n} \beta(t)\frac{\rho(t)}{\rho}dt$, ρ being the growth rate of GDP only. From (5), D* for the time interval [0, n] can be written as:

$$D^{*}(n) = \left[\frac{x(n)}{x(0)}\right]^{\mu - r} \text{ …………………………. (7)}$$

If there is no discretionary change in the time interval [0, n], both the elasticity and buoyancy coefficients will be equal implying that in such a case D*(n) =1. Similarly, the estimate for the general DI can be represented as:

$$D(n) = \left[\frac{x(n)}{x(0)}\right]^{\mu - \hat{r}} \text{ ……………………….. (8)}$$

The elasticity coefficient can be derived from Equation (8) as:

$$\hat{r} = \mu - \frac{\log D(n)}{\log[x(n)/x(0)]} \text{ ………………………. (9)}$$

Using the alternative estimate for the DI, D*(n), the elasticity of tax revenue can be derived as follows:

$$\hat{r}^{*} = \mu - \frac{\log D^{*}(n)}{\log[x(n)/x(0)]} \text{ ………………… (10)}$$

It is important to note that $\hat{r}$ and $\hat{r}^{*}$ are equal if the bases grow at the same rate as GDP or at a rate proportional to the growth rate of GDP. The estimate for $\hat{r}$ is based on the disaggregate DI method since it takes into account more than one tax base while $\hat{r}*$ is based on the aggregative DI method as it only considers GDP as the base. For the purpose of this paper, the aggregative DI method will be used.

4.0 Results

4.1 Divisia Index

Based on the index, it was found that over the period March 1998 to December 2010, the overall growth in tax revenue was 3.39 per cent. The discretionary measures increased total tax revenues by 1.20 per cent. This implies that the total growth over the period was mainly as a result of the built-in response of revenues to the growth in the tax base. Similar to total tax revenue, GCT growth was due mainly to the automatic growth in revenue with tax measures contributing a mere 0.96 per cent. For the remaining tax types, only SCT showed increases due mainly to discretionary measures over the period with 8.17 per cent of total growth being attributed to discretionary measures. Total growth in PAYE and customs duty was mainly due to a combination of tax measures and the built-in response to the base with discretionary measures increasing revenue by 1.42 per cent and 1.94 per cent, respectively.

Table 1: Discretionary Growth, Automatic and Total Growth of Tax Revenues

	Total Tax	PAYE	GCT	SCT	Customs Duty
Discretionary Growth	1.20	1.42	0.96	8.17	1.94
Automatic Growth	2.19	1.97	2.22	0.30	2.22
Total Growth	3.39	3.39	3.18	8.47	4.16

4.2 Buoyancy and Elasticity

The main categories of taxes along with their relevant bases are presented in Table 2. With the exception of GCT and SCT, all other taxes were levied on GDP. Consumption was used as the base for GCT as it provides a more accurate estimation of the bases for these tax types. This differs from Thompson (1999) who used GDP as the base for all taxes. With regards to SCT, consumption was not found to be an appropriate base since it produced results that were not in line with expectations. However, there were challenges in finding data for a more suitable base.

Table 2: Tax Types and Corresponding Categories	
Tax Categories	Relevant Bases
Total	GDP
PAYE	GDP
CIT	GDP
GCT	Consumption
Customs Duty	GDP

The results from the OLS estimation, Table 3, indicate that although the overall tax system is inelastic, as seen with the elasticity coefficient of 0.97, and discretionary measures have positively impacted revenues with a coefficient of 1.11. Similar to Choudhry (1979), Thompson (1999) and Bilquees (2004), the contributions of the components of tax revenue to the buoyancy and elasticity were also analysed. This breakdown of specific tax types indicate that customs duty was positively impacted by discretionary measures with buoyancy estimate of 0.91. On the other hand, the elasticity coefficient was lower implying that the built-in response to an increase in the tax base had little effect on customs duty revenues. Estimates for GCT suggest a lower revenue impact of discretionary measures and is weak with a coefficient of 1.03 when compared to the elasticity coefficient of 1.06.

Table 3: Estimates of Buoyancy and Elasticity

	OLS		VECM		DOLS	
	Buoyancy	Elasticity	Buoyancy	Elasticity	Buoyancy	Elasticity
Total Tax	1.11	0.97	1.09	0.95	1.09	0.95
GCT	1.03	1.06	1.05	1.08	1.07	1.09
Customs Duty	0.91	0.42	2.80	2.31	2.40	1.91

However, given that the variables were found to be non-stationary, the results from the OLS estimation may be misleading. This is because in the presence of non-stationary variables, the coefficient estimates are asymptotically biased and the standard errors are inconsistent resulting in spurious regressions. To overcome these shortfalls of the OLS technique, both the VECM and the DOLS procedures were utilised in an effort to arrive at more accurate estimates (see Table 3). Results from the VECM were captured by taking the coefficient of the long run relationship captured in the error correcting term. The buoyancy coefficient of 1.09 for total revenue was found to be greater than the elasticity coefficient of 0.95. Similar to the OLS results, the overall system was found to be inelastic. The estimate for customs duty suggests that discretionary measures significantly impact the respective revenues with a buoyancy estimate of 2.80 and an elasticity estimate of 2.31. GCT estimates remained relatively in line with those of the OLS estimation indicating that discretionary measures have not been as effective in increasing GCT revenue.

Finally, DOLS estimates were in line with those from the VECM model reiterating the point that discretionary measures have increased tax revenues over the period under review. The buoyancy coefficient of 1.09 was found to be greater than the elasticity coefficient of 0.95. Customs duty recorded a lower buoyancy coefficient of 2.40 relative to an elasticity coefficient of 1.91. Notably, these coefficients are significantly larger than those estimated by the OLS model, although marginally smaller than the VECM estimates, the latter difference possibly due to the inclusion of both lead and lagged values of the differenced explanatory variable involved in the DOLS estimation procedure. On the other hand, the GCT buoyancy and elasticity estimates were in line with those estimated in the VECM.

The results from all three tests indicate that in the case of total revenue and customs duty, discretionary tax measures have led to an increase in revenues over the period which would not have otherwise taken place in the absence of these measures. It is important to note, however, that the revenue figures may reflect arrears collection which has implications for revenues since they would include amounts relating to a previous year's discretionary measures, GDP, or a combination of the two. For example, the collections from the recent tax amnesty which lasted for the period April to October 2009 would be classified as arrears as they reflect amount owed in previous periods. Therefore, revenues collected in fiscal year 2009/10 would include these arrears and show improvement in the buoyancy which may not be the case. Although the presence of arrears may skew the results, total tax arrears was on average $20 billion per year which suggests that the overall impact of these arrears may not be significant.

Total revenue estimates differed from Thompson (1999) which indicates that discretionary measures have improved revenue performance in the period following that paper. Thompson (1999) had found that the tax system was more elastic than it was buoyant. The results also appear to be contrary to the index whereby contribution of discretionary measures to total growth is less than that of the built-in or automatic response. One possible reason for this difference is that the index possibly overestimated the automatic response to changes in the tax base due to the bias in the discrete version of $\beta_i(t)$. On the other hand, the results for customs duty imply that the revenue gains over the period were due to the various discretionary measures.

The estimates also reveal that GCT measures, which to a large extent have been revenue raising in nature and involved the expansion of the tax base, an increase in the base and the simplification of the structure, resulted in lower revenues. This finding is similar to Thompson (1999) who stated that this phenomenon implied that more revenue could have been raised in the absence of discretionary measures. It should be noted that given the collection challenges relating to the PAYE and CIT, such as non-compliance and tax evasion, the estimates of the buoyancy and elasticity could not be used in this analysis. However, given the table above, it can be seen that the discretionary changes to the PAYE have contributed to the growth in overall PAYE revenue.

5.0 Conclusion

By using quarterly data from March 1998 to December 2010, this paper estimated the buoyancy and elasticity of the Jamaican tax system. The Divisia Index approach was utilised to separate the discretionary tax measures from the automatic response of revenues to changes in the base. It was found that discretionary tax measures have had an overall impact on growth in total revenue over the period. However, the automatic response of revenue to changes in the tax base was found to be less than unity. This implies that the ability of the economy to increase revenue on its own remains fairly

weak requiring discretionary measures coupled with increased borrowing to make up for the shortfalls in revenue. The low elasticity could be a result of the various exemptions, tax incentive and waivers that existed over the period.
Further breakdown into the components of tax revenue indicated that discretionary measures had resulted in an increase in custom duty revenue. On the other hand, discretionary measures have had little impact on GCT revenues as the elasticity coefficient was found to be greater than the buoyancy coefficient. This has implications for the Green Paper on tax reform as part of its focus is to shift away from direct forms of taxation and towards indirect forms of taxation.

The results have shown that the Government's actions through the use of discretionary measures over the period under review have increased revenues. However, the presence of arrears collections, although relatively flat to date, may affect tax revenues in the future. Assuming that arrears collections continue along its current path, the Government stands to gain additional revenues from discretionary measures which would reduce the need for additional debt raising or the curtailing of key Government expenditure. However, there may come a point at which discretionary measures become less effective and places pressure on the Government to fund the budget by other means. The extent to which these needs are reduced is also impacted by system inefficiencies and complexities, some of which the Green Paper seeks to address. Additionally, timing factors associated with the collection of tax revenues as well as the lag effect of the discretionary measures reduces the fiscal space available to the Government.

It should be noted that the choice of lag and lead length used is likely to affect the results from the model. Secondly, the use of quarterly data makes it difficult to use other methods such as proportional adjustment method to compare the results since it removes the estimated yield from discretionary measures which are usually calculated annually and a straight line method would not be appropriate. Additionally, the use of a single estimate for both elasticity and buoyancy varies depending on the time period under study. This may result in time-varying coefficients which can be analysed to determine the period to period change in the revenue potential of taxes. Future work is possible in this area as such an assessment can be used to determine the impact of discretionary measure per period.

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Appendix

Appendix A.1 Selected Indicators

Fiscal Year	Nominal GDP Growth (%)	Primary Balance to GDP (%)	Tax Revenue to GDP (%)	Fiscal Balance to GDP (%)	Total Debt to GDP (%)	Inflation	Average Interest Rates (6 month T-bill rate)
FY1997/98	9.03	1.52	19.54	-6.59	72.18	8.82	22.66
FY1998/99	7.07	4.75	20.64	-5.91	80.79	5.97	23.95
FY1999/00	9.93	8.19	21.30	-3.53	86.55	8.33	20.36
FY2000/01	10.05	12.02	22.19	1.08	96.99	6.23	17.78
FY2001/02	9.52	8.55	21.07	-3.32	115.65	7.67	16.10
FY2002/03	12.56	6.52	21.26	-6.32	124.24	6.08	17.46
FY2003/04	17.20	10.73	23.11	-4.81	122.34	16.58	23.52
FY2004/05	12.28	10.38	23.63	-4.19	119.30	13.15	14.68
FY2005/06	11.97	9.43	22.80	-2.95	116.55	11.20	13.21
FY2006/07	13.82	7.53	23.20	-4.52	113.75	8.04	12.44
FY2007/08	12.96	6.50	23.95	-4.60	109.16	19.94	13.07
FY2008/09	12.12	4.86	23.96	-7.33	116.79	12.43	18.17
FY2009/10	7.97	6.08	23.96	-10.93	129.30	13.33	17.02
FY2010/11	7.70	4.53	23.42	-6.21	131.40	7.84	8.15

Sources: The Statistical Institute of Jamaica, Bank of Jamaica, The Ministry of Finance, Jamaica

Appendix A.2
Summary of Discretionary Measures 1999/00 to 2010/11

SCT	Increase in SCT on cigarettes, removal of ad valorem SCT on cigarettes, reduction in ad-valorem SCT on motor vehicles, restructuring and increase in SCT on alcoholic beverages, Increase on petrol, Imposition of ad valorem rate on fuel
GCT	Increases in GCT rate and expansion of GCT base to include electricity, telephone services and instruments
Income tax	Increases in the tax threshold for employees, self-employed and pensioners, removal of personal income tax preferences
Stamp Duty and Transfer Tax	Reduction in stamp duty and transfer tax rates
Environmental Levy	Imposition of environmental levy on imported containers and lottery games
Assets Tax	Increase in the assets tax rates
Travel Tax	Increase in flat tax for non-cruise passengers
Withholding Tax	Elimination of withholding tax on dividends

Source: Ministry Papers, The Ministry of Finance, Jamaica.

Appendix A.3 Descriptive Statistics

	CIT	CONS	CUSTOMS	GCT	GDP	PAYE	SCT	TREV
Mean	3485.5	156331.5	3397.9	11022.2	167985.1	8223.6	3569.4	38466.1
Median	2160.2	132411.2	3292.5	10167.5	153259.4	8080.7	2815.4	36690.6
Maximum	15567.7	304266.5	6261.2	21450.8	307426.6	16452.5	10409.4	79984.7
Minimum	1041.0	62090.3	1362.7	4499.6	78402.8	3195.2	966.4	15481.9
Std. Dev.	2778.2	74670.4	1320.3	5363.2	71464.9	3926.8	2263.1	18014.3
Skewness	2.2	0.5	0.2	0.4	0.4	0.3	1.8	0.4
Kurtosis	9.0	1.9	1.9	1.7	1.8	1.8	5.2	1.9
Sum	181243.8	8129238.0	176690.1	573151.7	8735226.0	427626.1	185607.8	2000236.0
Observations	52	52	52	52	52	52	52	52

Appendix A.4 Unit Root and Cointegration Test Results

A.4.1 Results from Unit Root Tests

Variables	ADF - Levels	ADF - 1st Difference	ADF - 2nd Difference	Results	α
LGDP	-0.825243	-2.905398		I(1)	0.1
LCONS	-0.663367	-9.575366		I(1)	all
LTREV	-0.949059	-3.20479		I(1)	0.05
LPAYE	-1.295935	-2.452212	-14.58651	I(2)	all
LCIT	0.881083	-17.79257		I(1)	all
LGCT	-0.072321	-7.889593		I(1)	all
LSCT	-0.722913	-15.98841		I(1)	all
LCUSTOMS	-1.167198	-12.06065		I(1)	all

A.4.2 Results from Cointegration Tests

	Trace Test No. of C.E's	Maximum Eigenvalue Test No. of C.E.'s	Trace Test No. of C.E's	Maximum Eigenvalue Test No. of C.E.'s
	LGDP		***LCONS***	
LTREV	1	1		
LPAYE	na	na	na	na
LCIT	1	1		
LGCT			0	1
LSCT			0	1
LCUSTOMS	1	1		

Notes: Both tests were carried out at the 0.05 level.

Appendix A.5 Lag and Lead Length Selection

Lag and Lead Length based on Schwarz Bayesian Criteria

	VECM		DOLS	
	Lag	**Lead**	**Lag**	**Lead**
Total Tax	5		6	1
GCT	1		4	0
Customs Duty	3		2	1

Appendix A.6 Derivation of the Divisia Index

To derive the index the continuously differentiable function at each point in time is:

$T(t) = f(x_i(t),.....,x_k(t);t)$ ………………. (1)

Where T is tax revenue, x is the tax base (GDP) and t is the time variable is a proxy for discretionary tax measures. By taking the logarithm of the tax function, differentiating with respect to time and re-arranging gives equation (2) as:

$$\frac{f_t(t)}{f(t)} = \frac{\dot{T}(t)}{T(t)} - \sum_{1}^{k} \frac{f_i(t)x_i(t)}{f(t)} \frac{\dot{x}(t)}{x_i(t)} \text{ …………………..(2)}$$

Setting $\frac{f_i(t)x_i(t)}{f(t)} = \beta_i(t)$ and $\frac{f_t(t)}{f(t)} = \frac{\dot{D}(t)}{D(t)}$ where D(t) is the DI of discretionary change and a shift in the ratio $\frac{\dot{D}(t)}{D(t)}$ indicates the growth of tax revenues as a result of discretionary tax measures. Equation (2) can be rewritten as:

$$\frac{\dot{D}(t)}{D(t)} = \frac{\dot{T}(t)}{T(t)} - \sum_{1}^{k} \beta_i(t) \frac{\dot{x}(t)}{x_i(t)} \text{ ……………….. (3)}$$

The index can also be obtained over the interval [0, n] by integrating Equation (3) as:

$$\frac{D(n)}{D(0)} = \left[\frac{T(n)}{T(0)}\right] \exp\left(- \sum_{1}^{k} \int_{0}^{n} \beta_i(t) \frac{\dot{x}(t)}{x_i(t)} \right) \text{ …………………. (4)}$$

By way of normalizing we set D(0) =1 and D(n) represents the index of revenue growth strictly as a result of discretionary tax measures at time n.

Although Equation (4) provides an estimate for the DI, $\beta_i(t)$ is time-varying and as such the computation of the DI is difficult. This problem has been overcome by Star and Hall (1976) who transformed the time-varying $\beta_i(t)$ into a constant $\tilde{\beta}_i$ which is a weighted average of $\beta_i(t)$. This gives the following equation:

$$\int_{0}^{n} \tilde{\beta}_i \frac{\dot{x}(t)}{x_i(t)} dt = \int_{0}^{n} \beta_i(t) \frac{\dot{x}_i(t)}{x_i(t)} dt \text{ ……………………………….. (5)}$$

Equation (5) can be transformed as follows: $\tilde{\beta}_i = \frac{1}{n}\int_0^n \beta_i(t)\frac{\rho_i(t)}{\bar{\rho}_i}$ where $\rho_i(t) = \frac{\dot{x}_i(t)}{x_i(t)}$ and $n\bar{\rho}_i = \int_0^n \frac{\dot{x}_i(t)}{x_i(t)}dt = \log\left(\frac{x_i(n)}{x_i(0)}\right)$.

The constant $\tilde{\beta}_i$'s are the weighted average of the fluctuating $\beta_i(t)$ and the weights are the ratios of the instantaneous rates of growth of the bases to their average rates of growth in the time interval [0, *n*].

Integrating the left hand side of Equation (5) gives:

$$\tilde{\beta}_i \log\left(\frac{x_i(n)}{x_i(0)}\right) = \int_0^n \beta_i(t)\frac{\dot{x}_i(t)}{x_i(t)}dt \quad \text{………………………………} (6)$$

Placing the left-hand side of Equation (6) into Equation (5) yields

$$D(n) = \frac{T(n)}{T(0)} \Bigg/ \prod_{i=1}^{k}\left[\frac{x_t(n)}{x_t(0)}\right]^{\tilde{\beta}_i} \quad \text{…………………………….} (4)$$