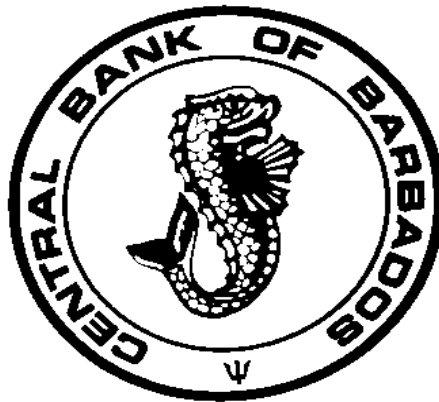


**MEASURING TAX EFFORT FOR A SMALL OPEN ECONOMY:
THE CASE OF BARBADOS**

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Abstract

This paper attempts to calculate the tax effort for a small emerging economy during the period 1987 to 2009. The study adopts an econometric technique that gives more ‘unbiased’ results in measuring tax effort. Evidence from Kim (2007) found that the Kalman filter estimator is more accurate than other methods employed in the past. The results from this study are useful as it provides an indication of how a country is doing in terms of tax collection relative to what could be reasonably expected given its economic potential.

JEL Classification:

Keywords: Tax effort, Kalman filter, Barbados

Introduction

Governments all over the world are faced with the challenge of generating sufficient revenue to meet rising expenditure levels. Given that some of these economies lack physical resources in which to derive revenue, statistics have shown that the majority of these countries have relied significantly on taxes as a means of reducing the fiscal deficit gap. Today, the world economy is undergoing various economic shocks, which are further threatening the sustainability of the fiscal position of economies, particularly small nations that are dependent on economic powerhouses such as the United States and the United Kingdom. As such, there has been greater pressure on governments to implement fiscal measures that would help contain this growing deficit.

In Barbados, the fiscal deficit to GDP at the end of fiscal year 2009/10 was 7.9%, which is considered high when compared to internationally accepted standards or as recommended by the IMF. The government has therefore indicated a commitment, through a Medium Term Fiscal Strategy (MTFS), to reduce this deficit so that a fiscal surplus is achieved by 2015-16. The government has been able to cut its current expenditure, particularly transfers and subsidies, by 7.2% for the first five months of 2010 when compared to a similar period in 2009. Despite this improvement, revenue has been declining at an alarming rate (by 9.1% for first five months in 2010 over 2009).¹ As such, an in-depth analysis is necessary to determine how well Government has been able to collect tax revenues relative to the amount of tax that should be collected given the structural characteristics of the economy.

Therefore, it is necessary at this time to derive a tax effort index for Barbados to help Government determine if it has yet achieved its full tax potential. Calculating tax effort is also important for comparative purposes, as it is considered superior to tax shares (Piancastelli, 2001). A tax effort ratio above one indicates that the country has surpassed its predicted capacity given its structural characteristics while a ratio below one suggests that the country is collecting less than anticipated and should seek to implement some measure to improve tax revenue collection. A tax effort of one, given structural characteristics, suggests that tax collection is as expected. Piancastelli (2001) goes further to classify the index as follows: high index (> 1.00), medium index ($1.00 > x > 0.84$), and low index (< 0.84).

¹ See <http://www.centralbank.org.bb> for economic review of Barbados economy for first half of 2010

This paper differs from previous studies as most recent available data and econometric technique are utilized. The results from this study will be useful to countries when making fiscal decisions in the event of budgetary imbalance, as it determines whether Government has fiscal room to adjust taxes.

The structure of this paper is as follows: section 2 discusses the literature; section 3 gives the data employed in the study; section 4 examines the methodology; and section 5 gives the results while section 6 suggests policy recommendations and concludes.

Literature Review

In earlier studies on measuring tax effort, authors fancied two approaches: the average tax ratio method and the potential tax revenue method. For the average tax ratio method, tax effort is defined as the ratio of tax revenue to gross domestic product while the potential tax method calculates tax effort by first estimating a regression equation of tax share to GDP. This estimated tax share is then used to find tax effort by calculating the difference between the actual and the estimated tax share. Kim (2007) provided evidence, through a Monte Carlo simulation, that the average tax ratio method and the potential tax revenue method estimations for tax effort are biased.

The average tax ratio method estimates an observable proxy variable for tax effort and considered this variable as tax effort. (For example, the ratio of tax revenue to GDP is taken to be a good proxy for tax effort). According to Kim (2007), the problem with the average tax ratio method is that other factors affecting the proxy variable are not controlled for. The inability to control for other factors affecting the proxy variable might not reflect the level of tax effort accurately. Furthermore, choosing a proxy variable is likely to cause problems when other proxies are available in which case the magnitude of tax effort is not dependent on the true tax effort but on the proxy chosen. Some studies utilizing this methodology are Tait and Eichengreen (1978), Tanzi (1981) and Luo and Douglas (1996).

For the potential tax ratio method, the estimated tax revenue variable does not take into account the unobservable variable tax effort in the regression equation, which also affects tax revenue. Thus, the use of the estimated tax revenue to calculate tax effort is also biased given that the actual tax revenue collections capture this variable. More recent studies adopted this

approach. Some of the empirical studies used to investigate tax effort via the potential tax effort method are discussed below.

Piancastelli (2001) estimated possible changes in the tax system performance of a sample of developing countries from 1985 to 1995 using both panel and cross section data. The author noted that high income countries showed sound performance in terms of tax efforts as most countries were found to have a tax effort index above one. Eltony (2002) examined the determinants of tax revenue shares and constructed an index of tax effort for sixteen Arab countries using pooled time-series and cross-sectional country data from 1994 to 2000. The author concluded that the Arab countries with low indices of tax effort should focus on increasing tax revenues rather than rationing tax ratios by undertaking tax reform.

In investigating the tax capacity and tax effort of Central and Eastern Europe (CEE) countries from 1992 to 2000, Mertens et al (2003) found that CEE countries have experienced declining tax effort. Moreover, the authors found that for CEE countries the level of economic development and sectoral shares of GDP are both significant determinants of tax capacity. The paper further highlighted that several countries, especially Poland, Romania, and the Slovak Republic may be able to significantly improve their tax effort.

Gupta (2007) examined the principal determinants of tax revenue performance across developing countries. In his study he noted that per capita GDP, agriculture share in GDP, trade openness and foreign aid, corruption, political stability and the share of direct and indirect taxes are significant in determining revenue performance. The paper stated that revenue collections are low in countries, which heavily depend upon taxing goods and services, while countries that levy taxes on income, profits and capital gains outturn of revenue is much higher. Furthermore, Gupta developed a revenue performance index that compared actual and predicted revenue performance. The author noted that several African countries, including a number of countries from Sub-Saharan Africa, perform significantly better than predicted. However, several countries from Latin America and Eastern Europe perform below their predicted revenue performance.

Bird et al (2008) used a panel study to investigate the impact of both supply and demand factors on tax effort in Latin America and other developing and transition countries between 1990 and 1999. The authors found that the demand factors namely corruption, voice and accountability have a significant and negative impact on tax effort, whereas the supply factors inclusive of the non-agricultural sector, as well as GDP per capital had a positive and significant

effect on a country's ability to collect taxes. In conclusion the authors noted that good governance is a key aspect in determining a societies' willingness to be taxed.

To account for these biasnesses, Kim (2007) proposed the use of the Kalman filter estimator which estimates the unobservable tax effort. Our paper adopts this methodology in estimating tax effort.

Data

This paper seeks to calculate tax effort in Barbados using a state space approach through the Kalman filter. Prior studies have identified the general level of economic development, openness to trade, and the relative importance of industries in domestic production as key factors explaining a country's ability to collect taxes. In Barbados, per capita income (PY), openness (OP), and the contributions of the manufacturing industry (MANU), the tourism industry (TOUR), the wholesale and retail industry (WHOLE), and the construction industry (CONS) are considered as major areas or sectors in which the government can derive income through taxes. Openness is calculated by the sum of exports and imports expressed as a share of GDP. The dependent variable, tax revenue (TAXR), comprises of both direct and indirect taxes.² A total of 92 observations are considered, as quarterly data from 1987 to 2009 are used. The data for all variables are obtained from the Central Bank of Barbados and are expressed in real terms as a ratio of real gross domestic product. Descriptive statistics for all the variables are provided in Table 1.

²² The major direct taxes are personal, corporate, and property while the major indirect taxes are VAT, excise, and import.

Table 1: Descriptive Statistics

	TAXR	CONS	MANU	OP	PY	TOUR	WHOLE
Mean	1.679	0.071	0.079	2.311	0.003	0.148	0.199
Median	1.639	0.071	0.077	2.403	0.003	0.142	0.197
Maximum	2.351	0.114	0.111	3.782	0.004	0.205	0.252
Minimum	1.154	0.035	0.047	1.190	0.002	0.105	0.155
Std. Dev.	0.259	0.016	0.019	0.628	0.001	0.022	0.019
Skewness	0.335	0.448	-0.023	0.086	0.264	0.414	0.286
Kurtosis	2.607	3.038	1.469	2.082	2.079	2.291	2.911
Jarque-Bera	2.313	3.089	8.990	3.344	4.319	4.558	1.289
Probability	0.314	0.213	0.011	0.187	0.115	0.102	0.524
Sum	154.5	6.618	7.276	212.6	0.340	13.67	18.38
Sum Sq. Dev.	6.119	0.024	0.034	35.96	1.83E-05	0.047	0.033

The level of economic development should increase tax revenue for Barbados, as personal and corporate tax revenues are very sensitive to them. Real per capita income is used as a proxy for the stage of development. Higher incomes paid to residents should automatically result in greater tax revenues, as it pushes individuals in a higher tax bracket. Moreover, consumption taxes should rise since expenditure by residents are expected to be stimulated, which in turn can enhanced firms' profitability; thus resulting in more tax income. Findings from previous studies (Stotsky and WoldeMariam, 1997; and Eltony, 2002) show that increased industrial shares of manufacture, construction, tourism, and wholesale and retail influence tax revenue of governments positively as corporate taxes are impacted significantly. Therefore, we anticipate positive coefficients on these variables. With regard to openness, the more open a country is the more taxes is expected to be collected through excises and import duties.

Methodology

To investigate tax effort for Barbados, we first test for unit roots using two standard tests - the Augmented Dickey-Fuller (ADF) test by Dickey and Fuller (1979, 1981), and the KPSS test by Kwiatkowski et al (1992). The ADF test, assumes the series is non stationary, hence failure to reject the null hypothesis implies the time series has a unit root. In contrast, the KPSS test postulates that the series is (trend) stationary under the null against the alternative of a non-stationary series.

Given the finding of Kim (2007) that both the average tax ratio and the potential tax revenue method cause a biased estimator for tax effort, this study has adopted the recommended Kalman filter estimation, which gives a more accurate measure of tax effort.³ The Kalman filter is a set of mathematical equations that provides an efficient computational (recursive) means to estimate the state of a process, in a way that minimizes the mean of the squared error. The filter is very powerful in several aspects: it supports estimations of past, present, and even future states, and it can do so even when the precise nature of the modeled system is unknown (Welch and Bishop, 2006). Maybeck (1979) further noted that the Kalman filter is optimal with respect to virtually any criterion that makes sense. In general, the state-space form is represented by two equations – one that can be measured (Equation 1) and one that has unknown variables that cannot be solved (Equation 2). Equation (1) is referred to as the measurement equation while Equation (2) is the transition equation.

$$Y_t = \alpha X_t + \beta A_t + \varepsilon_t \quad (1)$$

$$X_{t+1} = \tau X_t + \mu_{t+1} \quad (2)$$

$$\begin{pmatrix} \varepsilon_t \\ \mu_t \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} h_t & 0 \\ 0 & q_t \end{pmatrix} \right)$$

where Y_t is the tax revenue at time t , X_t represents the unknown parameters for tax effort given by α , A_t a vector of other factors affecting the revenue except for revenue effort, and the error terms ε_t and μ_{t+1} are both serially uncorrelated with a mean of zero and a covariance matrix h_t and q_t , respectively. Equations (1) and (2) allow us to derive the state-space model, which is also built on the assumptions that the two disturbances are uncorrelated with each other and the initial state variable for all time periods, and that the initial vector, X_t , has a known mean α_0 and a variance b_0 . Therefore, if the variances of the error terms and the initial values of revenue effort and its variance are known, tax revenue effort can be derived with the following Kalman filter equations:⁴

$$\hat{X}_{t+1,t} = \tau \hat{X}_{t,t} \quad (3)$$

³ See Maybeck (1979) for the basic assumptions behind the Kalman filter estimation of revenue effort.

⁴ For the derivation of Kalman Filter algorithms, see Tanizaki (1996).

$$P_{t+1,t} = \tau^2 P_{t,t} + q^2 \quad (4)$$

$$B_{t+1,t} = \alpha^2 P_{t+1,t} + h^2 \quad (5)$$

$$\hat{\varepsilon}_{t+1,t} = Y_{t+1} - \alpha \hat{X}_{t+1,t} - \beta A_{t+1} \quad (6)$$

$$K_{t+1} = P_{t+1,t} \alpha B_{t+1,t}^{-1} \quad (7)$$

$$\hat{X}_{t+1,t+1} = \hat{X}_{t+1,t} + K_{t+1} \hat{\varepsilon}_{t+1,t} \quad (8)$$

$$P_{t+1,t+1} = (1 - K_{t+1} \alpha) P_{t+1,t} \quad (9)$$

Where $P_{t+1,t+1}$ is the mean square error of tax revenue effort at time t . The Kalman filter approach assumes that the initial value of tax revenue effort $\hat{X}_{0,0}$ and its mean standard error $P_{0,0}$ are known. Therefore, we can derive a tax revenue effort series, $\{\hat{X}_t\}_{t=0}^T$ by computing Equations 3 through Equation 9. This process is completed until convergence is achieved. Given that there are unknown parameters in these equations, the maximum likelihood (ML) method is used for estimating the parameters and variances of error terms. The ML technique maximizes an innovation form of the likelihood function by filtering algorithms.

Empirical Results

Table 2 shows the degree of integration for each of the variables. We conclude that each of the variables contain a unit root at the 5% level of significance and becomes stationary when expressed in first differences. This therefore implies that all variable are integrated of order one, I(1).

Table 2: Unit Root Tests

Variables	ADF		KPSS	
	Level	1 st Difference	Level	1 st Difference
CONS	-1.19	-4.46***	0.70++	0.23
MANU	-0.09	-4.72***	1.14+++	0.27
OP	-1.54	-5.02***	1.19+++	0.14
PY	-0.87	-3.50**	1.04+++	0.16
TAXR	-2.38	-23.71***	1.15+++	0.08
TOUR	-3.18**	-5.67***	0.43+	0.07
WHOLE	-1.67	-5.37***	0.53++	0.13

Notes:

(1) *, **, *** are the MacKinnon critical values for the rejection of the null hypothesis of a unit root at the 10%, 5% and 1% levels, respectively.

(2) +, ++, +++ are the critical values for the LM statistic of the KPSS test and denote rejection of the null hypothesis of stationarity at the 10%, 5% and 1%, respectively .

To estimate the tax effort we ran equation (1) using state space modeling, where all variables are expressed as a ratio to real gross domestic product. The R-square, a measure of goodness of fit, indicates that approximately 79% of the tax revenue share is explained by the regression. When all relevant diagnostic checks are performed, we found no evidence of non-normality, serial correlation or heteroscedasticity.

Table 3: State Space Results

Dependent: TAXR		
	Coefficient	Std. Error
CONS	3.53	0.99
OP	0.15	0.05
TOUR	7.2	0.73
WHOLE	-2.33	0.91
R ² = 0.79		
Log-likelihood = 66.25		
Breusch-Pagan-Godfrey Heteroscedasticity: Prob. = 0.62		
Jacque-Bera Normality Test = 1.53; Prob. = 0.47		
Autocorrelation: F = 1.24; Prob. F(8,83) = 0.29		

The coefficient estimates in Table 3 show that the sign of the coefficient on tourism share of GDP is positive. This is expected given that Barbados depends heavily on the tourism sector, as it is the key earner of foreign exchange and driver of economic activity. The construction share also positively impacts tax revenue share and this can be linked to the level of economic activity occurring within the tourism sector as a vibrant tourism sector causes a spill-over effect to the other sectors, especially construction. For wholesale and retail share, the findings suggest that it is inversely related to the tax ratio, as a one unit change in WHOLE brings about a reduction in tax revenue share by \$2.33 million. It is expected that wholesale and retail share should move in line with the level of economic activity, hence in turn having a positive influence on tax collections. The level of openness of the economy (measured as the ratio of imports and exports to real GDP) was also found to influence tax share/tax capacity positively. Manufacturing share and per capita income were found to be insignificant in determining tax share. The most vibrant industries in the manufacturing sub-sector are beverages and tobacco and chemicals components, the contribution of the other industries to gross domestic product such as garments, food processing and wooden furniture have deteriorated over the years as they found it difficult to remain competitive within the regional and international arena. As a result, the manufacturing share of GDP has consistently declined over the years hence a negligible potential impact on tax share and possible insignificance. The impact of per capita income on tax share is not as expected given that per capita income is a measure of the overall development of the economy and is expected to be positively correlated with tax share as found in Mertens (2003). However, per capita income is more so an indicator on the rationale that all citizens would benefit from their country's increased economic production and is not a measure of personal income.

In Table 4, the tax effort coefficient is statistically significant and is approximately 0.87. However, we expected the result to be approximately equaled to one or higher given that Barbados is a high taxed jurisdiction and relies heavily on taxes to support their expenditure patterns. The ratio of revenue to GDP in Barbados is on average approximately 30% during any given year. Eltony (2002) further noted that countries with a relatively high tax share usually have tax effort ratios equivalent to one or above. One possible reason for the low tax coefficient in Barbados is the level of outstanding tax arrears, especially value added and personal tax

arrears. Thus, a reduction in areas may potentially result in a higher tax effort coefficient for Barbados.

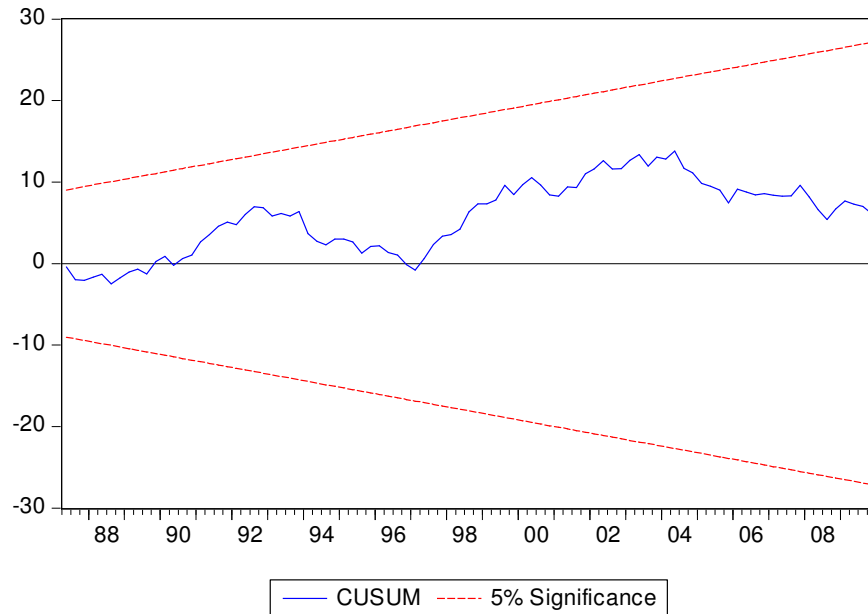
Table 4: Kalman Filter Results

	Coefficient
Tax effort	0.867
	(0.047)
	[0.00]

Notes: Root mean square error (RMSE) is in parenthesis below coefficient; P-value is given below RMSE in square brackets.

Figure 1 provides the plot of the cumulative sum of squares for the recursive residuals. Given that the model for tax share is within the 5% standard error bands across the entire sample of properties, we could conclude that the inclusion of the unobserved factor in the model, tax effort, contributed to the explanatory power of the model.

Figure 1: Recursive Residual for Tax effort



Conclusion

Our primary objective is to investigate tax effort in Barbados using the Kalman Filter estimator. The results of the study suggest that significant determinants of tax revenue share in Barbados are the share of tourism in GDP, the share of construction in GDP and the share of wholesale and retail in GDP. In addition, the inclusion of the unobserved factor in the model, tax effort was found to be statistically significant. The tax effort ratio for Barbados is found to be less than one, and this was not expected given that Barbados has a high tax revenue to GDP ratio. Most studies have found that countries with a high tax ratio to GDP usually have a high level of tax effort, (Stotsky and WoldeMariam, 1997).

It is recommended that Barbados aim to increase its tax effort over time by revisiting and implementing processes that can lead to the efficient collection of taxes, outstanding arrears and minimization of tax evasion that in turn can improve revenue mobilization. Consequently, the gap between potential tax revenue and actual tax revenue is likely to be minimized.

In order for Barbados to reduce its fiscal deficit position transparency and improvement in tax revenue collection should be encourage without relying largely on foreign financing which in the long run can lead to problems of debt sustainability. Given Barbados has limited space to

increase tax revenues, the next step to be considered, in an attempt to correct fiscal imbalance, is expenditure management.

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