Fiscal sustainability in Malaysia: a re-examination

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ABSTRACT

In this paper, I deploy a broad array of econometric tests to thoroughly examine fiscal sustainability in Malaysia. Results of the multicointegration test suggest the absence of cointegration between the cumulated cointegration errors, real government expenditure and real government revenue. Meanwhile, standard cointegration analyses indicate that the fiscal process fulfills only the weak-form sustainability. Most importantly, results from a fiscal sustainability model which incorporates revenues from oil and gas exports, do not strongly support the view that fiscal process is sustainable. Some policy-implications follow from these findings.

I. Introduction

There has been a substantial growth in the literature pertaining to fiscal sustainability in the past few years. The attention to this topic is largely a response to the subprime mortgage crisis that began in US in 2008, which has since spread to the EU and the rest of the world. Negative shocks from the crisis in US have exposed the fiscal vulnerabilities that many EU economies faced. At the time of writing, the on-going sovereign debt crisis in the EU continues to unfold with the necessary bail-out programmes being developed. Amidst these developments, issues relating to fiscal sustainability and soundness seem pertinent and important.

In Asia, there is no shortage of literature on fiscal sustainability, reflecting the vibrant debates taking place in the policy-making circles. Particularly in Malaysia, recent fiscal developments have received wide coverage in the media[1]. Part of the excitement emerged from the fact that public sector debt has surpassed the 50% of GDP threshold in 2009. While this figure is still small in comparison with Japan (see Hoshi and Ito, 2012), this development nonetheless caused a great deal of concern not least because this is the first time that debt to GDP ratio has exceeded 50% in 20 years. At the time of writing, there is a real risk that this figure would exceed the soft debt ceiling of 55%, undermining public confidence in the government's ability to manage its fiscal position. There have even been discussions on setting up an independent fiscal oversight body to enforce fiscal discipline and prudence[2]. To date, fiscal sustainability issues have become very much politicised without much independent investigations on the validity of the issues in the first place. A rigorous assessment of fiscal sustainability would be fruitful in this regard.

A review of the literature on this topic (see next section for details) suggests that there has been some coverage on Malaysia (e.g. Baharumshah and Lau, 2007, 2010 and Lau and Baharumshah, 2009). However, some gaps in the literature remain. First, studies that have been conducted so far ignore the application of multicointegration to test for fiscal sustainability. The notion of multicointegration was mooted by Granger and Lee (1990) and has since been extended by Haldrup (1994) and Engsted *et al* (1997). This approach provides another array of tests to determine the existence of fiscal sustainability and are hence of importance. In this paper, one of my contributions is to deploy these tests to re-examine fiscal sustainability in Malaysia. Second, there have been a number of approaches to test fiscal sustainability in the literature, such as unit root and standard cointegration tests. But these tests can be applied to any country regardless of

1 For context, see the news report here: http://www.themalaysianinsider.com/malaysia/article/malaysias-debts-a-potential-time-bomb-say-economists

2 News clip can be found on this link: http://www.theedgemalaysia.com/business-news/222273-independent-fiscal-oversight-body-needed.html

the country's economic structure. It has been recognised by a number of authors (e.g. Balassone, 2006, Kia, 2008) that oil-producing countries are unique in the sense that the fiscal policy in these countries is affected by the revenue streams from oil and gas exports. Hence, fiscal sustainability analyses should take account of these characteristics. It would be worthwhile to examine fiscal sustainability in Malaysia taking account of the country's dependence on oil and gas. To this end, I make my second contribution to the literature. My third contribution to knowledge is that I have undertaken more thorough statistical tests of fiscal sustainability than have been attempted previously.

The main findings of this paper are as follows. First, there is no multicointegration between government revenue and spending – this evidence undermines the view that that the fiscal process in Malaysia is sustainable. Second, standard cointegration analyses using a broad array of tests not attempted before in a single paper, mostly suggest that the Government's fiscal conduct is only weakly sustainable. Finally, after estimating a model of fiscal sustainability that takes into account the dependence on oil and gas revenue, I find that fiscal sustainability is not strongly supported by empirical evidence. Bringing all the evidence together, the sustainability of the fiscal process in Malaysia seems very much in doubt.

The paper is organised as follows. Section II. reviews the literature and key concepts briefly. Section III. presents the data and methodology. Section IV. presents the results and discussions. Finally, Section V. concludes.

II. A brief survey of the literature: some concepts pertaining to fiscal analyses

Debt dynamics are inevitably rooted upon some simple accounting identities that have for years become the building block for the intertemporal government budget constraint (IGBC). Let

B=debt level, IP=interest payment, X=primary balance and M=base money. All are in nominal terms. Following Burnside (2005), we have the following identity:

$$B_t - B_{t-1} = IP_t - X_t - (M_t - M_{t-1})$$

Net debt is thus a function of interest payment and change in money base. Dividing both sides by price level and after some manipulations and imposition of the transversality condition, the following is obtained:

$$b_{t-1} = \sum_{i=0}^{\infty} (1+r)^{-(i+1)} (x_{t+i} + s_{t+i})$$

The left hand side term denotes real public debt, r= real interest rate, x= primary balance and s=seigniorage. This exposition above is the IGBC, suggesting that government debts are financed from future primary surpluses and seigniorage[3]. A question that naturally arises from viewing the IGBC is whether certain governments are implementing fiscal policies that fulfill this budget constraint. A test of fiscal sustainability comes from a straightforward interpretation of the IGBC: if the IGBC is fulfilled, the fiscal process in a country is sustainable. In this regard, there are broadly two ways to test if the budget constraint holds. One strand of literature examines fiscal sustainability by considering public debt dynamics historically and in a forward-looking dimension. These studies make projections of future debt dynamics (see Marks, 2004, Adrogue, 2005, Budina and van Wijnbergen, 2008 and more recently, Hoshi and Ito, 2012 and the literature contained therein). Notably, since this study deals specifically with the econometric/statistical approach, I will not discuss this literature further. The second strand of literature considers implementing an array of econometric tests of the IGBC to assess fiscal sustainability. I classify these econometric tests loosely into seven main categories. This is in

[3] Note that in Fiscal Theory of Price Level, this is not interpreted as a government budget constraint. Also, interested readers can refer to Burnside (2005) for details and full derivations of the equations.

contrast to contemporary studies which provide a less elaborate classification, leaving out some important econometric tests.

The first category considers the time series properties of government spending, revenues and stock of public debts. A popular application of this method emphasises on whether the time series for debt to GDP ratio is non-stationary. This question can be addressed through the direct application of various unit root tests (see among others, Hamilton and Flavin, 1986, Uctum and Wickens, 2000, Feve and Henin, 2000 and more recently Afonso and Rault, 2009, Afonso and Jalles, 2012). The second category looks at the long-run relationship between government spending and revenues to see if some equilibrium or cointegrating relationship exists (e.g. Hakkio and Rush, 1991, Quintos, 1995, Bohn, 2004). The third category takes account of whether bubbles exist in the stock of public debts (see Adams, Ferrairini and Park, 2010 and literature therein for details). The fourth category can be found in Bohn (1995, 1998) and Burger *et al*, (2011) which have led to the notion of the 'fiscal reaction function'. Here, the primary surplus is a function of debt – so a sustainable fiscal policy is one in which primary surplus responds positively to changes in debt.

The fifth category is based on econometric tests of fiscal sustainability models after taking into consideration the characteristics of certain countries. A rather recent example of this category of tests is Kia (2008), who developed and estimated a model (Tax-Smoothing Model) of fiscal process for Iran that takes account of the fact that the country in question is an oil producing economy. The sixth category covers studies that deploy index-based indicators of fiscal sustainability. A good recent example is Polito and Wickens (2012) who developed an indicator of fiscal stance and estimated this indicator for a number of advanced EU economies. Finally, the seventh category assesses whether government spending, government revenue and public debts are multicointegrated. In this literature, not only is the question of cointegration between the levels of revenues and expenditures addressed. Additionally, the cumulated difference between revenue and expenditure (i.e. public debts) may also be cointegrated with the original level variables. If such relationships exist, then multicointegration is present in the system (see Leachman *et al*, 2005).

There are a few notable studies on fiscal sustainability covering Malaysia, including Baharumshah and Lau (2007, 2010) and Lau and Baharumshah (2009). Among these studies, Baharumshah and Lau (2007) found that Malaysia only fulfilled one necessary condition for sustainability. Baharumshah and Lau (2010) and Lau and Baharumshah (2009) found evidence to suggest that Malaysia's fiscal process is sustainable. These studies can be classified under the first and second categories of econometric tests mentioned above. The apparent gaps that appear in the literature for Malaysia include absence of studies in the fifth and seventh categories of econometric tests. Furthermore, the assessments of fiscal sustainability can be carried out with further rigour. This paper attempts to remedy these gaps and provide some answers to the fiscal sustainability issues mentioned in the Introduction. However, a word of caution here: all econometric tests are backward-looking analyses that use historical data. As such, the usefulness of econometric analyses only goes as far as giving a better understanding of the past. The results of this paper should be interpreted in the light of this shortcoming.

III. Data and Methodologies

Data

In this paper, I attempt to perform several econometric tests of fiscal sustainability. The first is based on the multicointegration test of Haldrup (1994) and Engsted *et al* (1997) to assess the existence of two levels of cointegration between government spending and revenue. The second is a series of standard cointegration tests (more of that in next section) to examine the presence of one level of cointegration between government spending and revenue. Following this, I will estimate and interpret the size of response of government expenditure to government revenue (Hakkio and Rush, 1991, Quintos, 1995). I also intend to estimate the Tax-Smoothing model of Kia (2008), where interpretations of the magnitude and statistical significance of the model's coefficients would be crucial to determine the sustainability of the fiscal process. More details of the testing and estimation cycle are found in the next section below.

I have contemplated using annual data. However, estimating the Tax-Smoothing model of Kia (2008) poses a greater demand on data availability due to the larger number of variables involved. A relatively long time series is needed to proxy for export value of petroleum and natural gas. Unfortunately there is insufficient annual time series data for the latter variable. The only option in this situation is to use quarterly data. At this frequency however, the only series on government expenditure and revenue are the total government expenditure and revenue of the Central Government, and not the fiscal variables of the consolidated public sector. All data used in the analyses are obtained from the CEIC database and cover the 1999Q1-2012Q2 period. Importantly, the time series for government expenditure and revenue are not seasonally adjusted as is the case of Baharumshah and Lau (2010). The total government expenditure and total government revenue series are deflated by CPI to obtain their respective real values (hereafter, the series are denoted as RS and RR, respectively). In estimating the Tax Smoothing model, the variables are transformed following closely the convention used in Kia (2008) (see below for details).

Methodologies

I will first perform the one-step multicointegration test of Haldrup (1994) and Engsted *et al* (1997). The notion of multicointegration is related to the standard understanding of cointegration. In the context of fiscal sustainability, if real government revenue and real government expenditure are cointegrated, it is possible that the fiscal process does not allow real government revenue, real government spending and debt (the difference between revenue and spending) to drift apart from one another. When this occurs, revenue and expenditure are also multicointegrated, i.e. there is more than one level of cointegration between the series. Testing for the presence of multicointegration is particularly important in situations where models include stock (e.g. public debt) and flow (spending and revenue) variables (Leachman *et al*, 2005). Importantly, the presence of multicointegration renders the standard testing procedures in cointegrated systems invalid. The one-step multicointegration test involves estimating the following model using OLS:

$$Y_t = A_0 + A_1 X_t + A_2 \Delta X_t + A_3 Trend + A_4 Trend^2 + v_t \qquad (1)$$

The variables in (1) are defined as:

$$Y_t = \sum_{i=1}^{t} RS_i \ , \ X_t = \sum_{i=1}^{t} RR_i \ , \Delta X_t = RR_t$$

RR denotes real government revenue and RS is real government expenditure. Both series were obtained by deflating both the Federal Government Revenue and Federal Government Expenditure series by the Consumer Price Index (CPI). Y_t and X_t are known as the cumulative real government expenditure and cumulative real government revenue respectively. Next, the residuals of the estimated model are subjected to an ADF test without intercept or trend. The critical values are not standard however, and these values are obtained from Haldrup (1994) in the model with intercept and Engsted *et al* (1997) for the model specification with linear and quadratic trend (more details in next section). The null hypothesis is that the residuals are non-stationary vs. the alternative that the residuals are stationary. Rejection of the null implies evidence of multicointegration – and hence, the fiscal process is sustainable. Importantly, the dependent variable in Equation 1 has to be an I(2) variable before the test can be implemented.

Second, fiscal sustainability can also be examined via standard cointegration tests based on the following model:

$$RR_t = B_0 + B_1 RS_t + e_t \qquad (2)$$

RR denotes real government revenue and RS is real government expenditure, as defined in the previous section on *Data*. To test the existence of cointegration in Equation 2, I deploy the systems-based approach of Johansen (1988)[4] and Saikkonen and Lutkepohl (2000a, b, c), as well as single-equation approaches such as the Engle-Granger (EG), Phillips-Ouliaris (PO), Hansen Parameter Instability (HPI) and the Autoregressive Distributed Lag (ARDL) bounds tests of Pesaran *et al* (2001).

A third approach to assess fiscal sustainability is to consider the view of Quintos (1995), where it was stated that if the coefficient on RS in Equation 2 is between 0 and 1, the IGBC is satisfied weakly regardless of whether RR and RS are cointegrated. Next, if RR and RS are not cointegrated but the coefficient of RS in Equation 2 is equal to unity, the IGBC is satisfied weakly. Third, the IGBC is satisfied strongly if RR and RS are cointegrated and the coefficient on RS in Equation 2 is unity. Finally, a zero RS coefficient implies lack of sustainability in the fiscal process.

Finally, taking account of the fact that Malaysia is able to generate substantial revenues from exporting oil and gas, these revenues could be used by the government to finance expenditure. Thus, the earlier tests may not provide a complete answer to the question of fiscal sustainability. In this regard, Kia (2008) has provided a comprehensive framework for testing the sustainability of the fiscal process of oil-producing countries. His 'Tax-Smoothing model' is specified as follows:

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[4] The test includes the version which allows up to 2 structural breaks.

$$PBGDP_t = C_0 + C_1 DBTGDP_t + C_2 GVAR + C_3 YVAR + C_4 ENERGY + u_t \quad (3)$$

Equation 3 is estimated using the same techniques as those used in estimating Equation 2 above. PBGDP is primary balance per GDP. Since there is no data on primary balance, this is estimated.[5] DBTGDP is total public sector debt per GDP. GVAR is defined as (G-G*)/GDP, where G represents Federal Government Expenditure and G* is the trend of this expenditure. YVAR is defined as {1-(GDP/GDP*)(G*/GDP)}, where GDP* is the trend of GDP. The trends for GDP and government expenditure are respectively obtained from a four-quarter moving average of the original variables[6]. A few important points are noted in interpreting the results of the empirical model for (3). The crucial information to look out for are the coefficient estimates for DBTGDP and ENERGY. These are listed as follows[7]:

A1. A positive and statistically significant DBTGDP coefficient and a positive and statistically significant ENERGY coefficient indicate fiscal sustainability.

A2. A positive and statistically significant DBTGDP coefficient and a statistically insignificant ENERGY coefficient indicate fiscal sustainability. Primary surpluses increase in response to rising debt levels although income from energy exports are not channeled towards debt reduction.

A3. A positive and statistically significant DBTGDP coefficient and a negative and statistically significant ENERGY coefficient can still indicate sustainability, since primary surpluses are still rising in response to debt.

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[5] As there is a need to calculate interest paid on expenditure in order to obtain the primary balance, interest paid on domestic debt is estimated by multiplying domestic debt with Malaysian government treasury bills rate. Multiplication of the US treasury bills rate with foreign debt gives estimates of interest paid on foreign debt. Summing up interest paid on foreign debt and interest paid on domestic debt gives interest paid on total debt. Total public sector balance is defined as the difference between total revenue and expenditure, while primary balance is the sum of total public sector balance and interest payment on total debts.

6 In Kia (2008), the author used a 10-year moving average to obtain the trends for GDP and government expenditure. Given the short time series, it would not be appropriate to use bandpass filters since this leads to substantial reduction in sample size. Alternative smoothing methods such as Hodrick-Prescott filter were attempted, but this resulted in variables that had characteristics of I(2) series. As such, the newly obtained GVAR and YVAR variables may lead to complications in estimating equation (3).

[7] I have formalised these interpretations since Kia (2008) did not furnish such details

A4. A statistically insignificant DBTGDP coefficient and a positive and statistically significant ENERGY coefficient indicate fiscal sustainability. Although rising debt levels have no significant impact on primary balance and may lead to explosive growth in debt, this is compensated by rising revenues from energy exports.

A5. A statistically insignificant DBTGDP coefficient and a negative and statistically significant ENERGY coefficient indicate lack of fiscal sustainability. Primary balances are not responsive to debt levels, while rising energy exports reduce primary balances further.

A6. Lack of statistical significance in both the DBTGDP and ENERGY coefficients indicate lack of fiscal sustainability. Primary balances are not responsive to debt levels and income from energy exports are not channeled towards debt reduction.

A7. A negative and statistically significant DBTGDP coefficient coupled with a statistically insignificant ENERGY coefficient indicates lack of fiscal sustainability. This is because primary surpluses are falling in responsive to rising debt levels, while export income from oil and gas fail to support the primary surplus position.

A8. A negative and statistically significant DBTGDP coefficient and positive and statistically significant ENERGY coefficient indicate fiscal sustainability. While primary balances are deteriorating in response to rising debts, this is compensated by energy export income.

A9. A negative and statistically significant DBTGDP coefficient and statistically insignificant ENERGY coefficient indicate lack of fiscal sustainability. Rising debt levels erode the fiscal balance but this is not compensated by energy export income.

IV. Results and findings

Results of Multicointegration Test

Before carrying out the formal econometric tests of fiscal sustainability, I conducted the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests on cumulative real government expenditure (Y), cumulative real government revenue (X) and level of real government revenue (RR). The results of these unit root tests are not reported here to conserve space but are available from author upon request. Evidence from the unit root test results suggest that 'Y' and 'X' are I (2) processes, while RR is I (1). The existence of I (2) processes makes it possible to implement the single-equation multicointegration test.

Next, I estimated a cointegrating equation with intercept as shown in Equation 1, with linear and quadratic trend omitted. This is followed by an ADF test on the residuals of the cointegrating equation. I repeated the same ADF tests on the residuals of cointegrating Equation 1, this time around including the linear and quadratic trends. Results of the ADF tests are reported in Table 1. Regardless of the number of deterministic regressors in the estimated cointegrating equation, the ADF tests all turned out to be consistent in rejecting the alternative hypothesis of multicointegration. There is insufficient evidence to reject the null hypothesis that residuals of the cointegrating equation follow an I(1) process. All the estimated equations cover the full sample of 1999Q1-2012Q2.

The absence of multicointegration suggests the absence of cointegration between the cumulated cointegration errors and the real government expenditure and real government revenue variables. It follows that standard cointegration tests of the relationship between government revenue and government expenditure would need to be carried out to determine the sustainability of fiscal policy. These are carried out in the next section.

Table 1. Results of the Multicointegration test [a/]

Cointegrating equation	ADF test statistic[a/]	Critical values[b/]
$Y_t = A_0 + A_1 x_1 + A_2 \Delta x_t + v_t$	-2.102	-3.93
$Y_t = A_0 + A_1 x_1 + A_2 \Delta x_t + A_3 Trend + v_t$	-2.103	-4.42
$Y_t = A_0 + A_1 x_1 + A_2 \Delta x_t + A_3 Trend + A_4 Trend^2 + v_t$	-2.105	-4.83

Notes:

[a/] The ADF tests are performed without intercept or trend, as suggested in Haldrup (1994) and Engsted *et al* (1997)

[b/] Critical values are reported based on 5% significance level. The critical values of the ADF test for the first row of Table 1 are taken from Haldrup (1994). ADF test for the second and third row of Table 1 are from Engsted *et al* (1997). All the critical values are obtained with number of I(1) variables (m_1)=1, number of I(2) variables (m_2)=1,and sample size N=50

Results of standard fiscal sustainability tests: are real government revenue and real government expenditure cointegrated?

In the cointegration test based on Johansen (1988), the Trace and Maximal Eigenvalue statistics detect at least one cointegrating relationship between real government revenue and real government expenditure for most specifications of the model (Table 2). The test results are robust to the inclusion of up to two structural breaks[8]. Meanwhile, the results of the Saikkonen and Lutkepohl (2000) cointegration test reject the null of no cointegration, regardless of model specifications (Table 3). The results of single-equation based cointegration tests are reported next. These tests are conducted by first estimating a cointegrating Equation 2. Various estimation techniques have been used including Fully Modified Least Squares (FMOLS), Dynamic OLS (DOLS) and Canonical Cointegrating Regression (CCR). Once the cointegrating equation is obtained, the residuals are tested for the presence of stochastic trends. From Tables 4a, 4b and 4c, the Hansen Parameter Instability Test, Phillips-Ouliaris Test and Engle-Granger test seem to provide the evidence of cointegration in most cases. This result is robust irrespective of the number of deterministic regressors or estimation techniques used. However, the results of the ARDL bounds test reject the hypothesis of cointegration (see Table 5). But

[8] A priori the breaks could have been caused by the bursting of the technology bubble in 2001 and the slowdown in 2009. These information are used to set the period where breaks occur.

since most tests support cointegration, it can be concluded that there is preliminary evidence of a sustainable fiscal process.

Table 2. Results of cointegration test based on Johansen (1988)

Panel A: No dummy variables included in model				
Number of deterministic regressors	Null hypothesis [a/]	Alternative hypothesis	Test Statistics	
			Trace Statistic	Max Eigenvalue Statistic
Case 1: No intercept, no trend	r=0 r≤1	r>0 r>1	34.11** 10.08**	24.03** 10.08**
Case 2: Unrestricted intercept, no trend	r=0 r≤1	r>0 r>1	12.53 0.00	12.52** 0.00
Case 3: Restricted intercept, no trend	r=0 r≤1	r>0 r>1	35.74** 10.38**	25.36** 10.38**
Case 4: Unrestricted intercept, restricted trend	r=0 r≤1	r>0 r>1	18.19 3.29	14.90 3.29
Case 5: Unrestricted intercept, unrestricted trend	r=0 r≤1	r>0 r>1	18.00** 3.11	14.89 3.11
Panel B: Dummy variables included in model to capture structural breaks [b/]				
Number of deterministic regressors	Null hypothesis	Alternative hypothesis	Trace statistic	
Case 1: Intercept included	r=0 r≤1	r>0 r>1	47.11** 14.14	
Case 2: Trend and intercept included	r=0 r≤1	r>0 r>1	31.43 11.19	

Notes:

[a/] ‘r’ refers to the number of cointegrating vectors

[b/] This version of the Johansen test allows up to two structural breaks. The breaks are for 2001Q1 and 2009Q1 due to recessions. Changing the break point at different quarters of the same year does not affect results of Trace test

*, ** and *** indicate 10%, 5% and 1% significance respectively. Test performed with 4 lags in the VAR model

Table 3. Results of cointegration test based on Saikkonen and Lutkepohl (2000a, b, c)

Number of deterministic regressors	Null hypothesis	Alternative hypothesis	Test statistic
Case 1: Intercept included	r=0 r≤1	r>0 r>1	28.23** 2.83
Case 2: Trend and intercept included	r=0 r≤1	r>0 r>1	15.68* 2.00

*, ** and *** indicate 10%, 5% and 1% significance respectively. Test performed with 4 lags in the VAR model

Table 4a. Results of Hansen Parameter Instability Test, Engle-Granger Test and Phillips-Ouliaris Test; estimation technique: FMOLS

Cointegration test	Number of deterministic regressors			
	None	Constant	Constant, linear trend	Constant, linear and quadratic trend
HPI	0.07	0.36	0.37	0.38
EG	-2.65* [a/] -21.57**	-1.92 -9.22	-7.16*** -107.07***	-7.32*** -111.99**
PO	-7.77*** [b/] -39.83***	-5.63*** -37.28***	-8.14*** -46.36***	-8.26*** -46.00***

Notes:

HPI - Hansen Parameter Instability, EG - Engle-Granger Test, PO - Phillips-Ouliaris Test; for Hansen Parameter Instability, the null hypothesis is cointegration, for the other tests, the null hypothesis is no cointegration

*, ** and *** indicate 10%, 5% and 1% significance respectively

[a/] The first figure refers to the Tau statistic and the second figure is the z-statistic

[b/] The first figure refers to the Tau statistic and the second figure is the z-statistic

Table 4b. Results of Hansen Parameter Instability Test, Engle-Granger Test and Phillips-Ouliaris Test; estimation technique: DOLS

Cointegration test	Number of deterministic regressors			
	None	Constant	Constant, linear trend	Constant, linear and quadratic trend
HPI	0.02	0.04	0.08	0.11
EG	-2.65* [a/] -21.57**	-1.92 -9.23	-7.17*** -107.08***	-7.32*** -111.99***
PO	-7.77*** [b/] -39.83***	-5.64*** -37.28***	-8.14*** -46.37***	-8.26*** -46.00***

Notes:

HPI - Hansen Parameter Instability, EG - Engle-Granger Test, PO - Phillips-Ouliaris Test; for Hansen Parameter Instability, the null hypothesis is cointegration, for the other tests, the null hypothesis is no cointegration

*, ** and *** indicate 10%, 5% and 1% significance respectively

[a/] The first figure refers to the Tau statistic and the second figure is the z-statistic

[b/] The first figure refers to the Tau statistic and the second figure is the z-statistic

Table 4c. Results of Hansen Parameter Instability Test, Engle-Granger Test and Phillips-Ouliaris Test; estimation technique: CCR

Cointegration test	Number of deterministic regressors			
	None	Constant	Constant, linear trend	Constant, linear and quadratic trend
HPI	781.22***	0.18	0.37	0.36
EG	-2.65* [a/] -21.57**	-1.92 -9.23	-7.17*** -107.08***	-7.33*** -111.99***
PO	-7.77*** [b/] -39.83***	-5.64*** -37.28***	-8.14*** -46.37***	-8.26*** -46.00***

Notes:

HPI - Hansen Parameter Instability, EG - Engle-Granger Test, PO - Phillips-Ouliaris Test; for Hansen Parameter Instability, the null hypothesis is cointegration, for the other tests, the null hypothesis is no cointegration

*, ** and *** indicate 10%, 5% and 1% significance respectively

[a/] The first figure refers to the Tau statistic and the second figure is the z-statistic

[b/] The first figure refers to the Tau statistic and the second figure is the z-statistic

Table 5. ARDL bounds test results

Number of deterministic regressors	Lag length (N)	F-statistic [a/]	Breusch-Godfrey LM statistic	
			At lag=1	At lag=4
Case 1: Intercept included	3	0.81	3.41 [0.072]	1.60 [0.195]
Case 2: Trend and intercept included	4	5.22	3.47 [0.071]	2.08 [0.106]

Notes:

[a/] The critical values are from Narayan (2005). Number in [ ] is the p-value. Number of forcing variable(s) is 1(k=1) and sample size is 50, so the critical value bounds for Case 1 is (5.22, 6.07) at 5% significance level. For Case 2, the critical value bounds are (6.985, 7.86) at 5% significance level. Lags are added to the Unrestricted Error Correction form for the ARDL model until evidence of autocorrelation disappears. This modelling technique is based on Lee (2008).

Alternative tests of fiscal sustainability – sustainability conditions of Quintos (1995)

Taking note of the findings in the previous section where evidence of cointegration cannot be rejected in most cases, I estimated Equation 2 as a cointegrating regression, using a variety of methods such as Modified Least Squares (FMOLS), Dynamic OLS (DOLS), and Canonical Cointegrating Regression (CCR). To ensure robustness in the results, I also reported estimates of Equation 2 using the Autoregressive Distributed Lag (ARDL) model and the normalized cointegrating vectors from the Johansen test of cointegration.

Table 6 reports the estimates of the real government spending coefficient for various econometric specifications. As mentioned in Baharumshah and Lau (2010), if the coefficient is between 0 and 1, the IGBC is weakly satisfied, regardless of whether cointegration exists or not. If the coefficient is unity and there is lack of evidence of cointegration, then there is also weak-form sustainability. If the coefficient is unity and cointegration exists, there is strong-form sustainability. Finally, a zero coefficient indicates unsustainable fiscal policy. The results in Table 6 seem to indicate a support the view of weak-form sustainability since the coefficient estimates are positive, statistically significant and less than unity. Such findings are supported by Baharumshah and Lau (2007), who found that Malaysia fulfilled only one necessary condition for sustainability. This is however in contrast to Baharumshah and Lau (2010) who obtained evidence of strong exogeneity.

Table 6. A summary of the estimated coefficient for government spending B_1

Estimation technique	Model specification	Estimated coefficient	Cointegration[a/]
FMOLS	1. $RR= c_1RS$	0.81***	Yes
	2. $RR=c_0+c_1RS$	0.71**	Yes
	3. $RR=c_0+c_1RS+ c_2trend$	0.37***	Yes
	4. $RR=c_0+c_1RS+ c_2trend+ c_3trend^2$	0.37***	Yes
DOLS	1. $RR= c_1RS$	0.80***	Yes
	2. $RR=c_0+c_1RS$	0.78***	Yes
	3. $RR=c_0+c_1RS+ c_2trend$	0.17***	Yes
	4. $RR=c_0+c_1RS+ c_2trend+ c_3trend^2$	0.17***	Yes
CCR	1. $RR= c_1RS$	0.05***	No
	2. $RR=c_0+c_1RS$	0.73***	Yes
	3. $RR=c_0+c_1RS+ c_2trend$	0.37***	Yes
	$RR=c_0+c_1RS+ c_2trend+ c_3trend^2$	0.37***	Yes
ARDL	1. $RR=c_0+c_1RS$	0.79***	No
	2. $RR=c_0+c_1RS+ c_2trend$	0.17**	No
ML[b/]	1. No intercept, no trend	0.71	Yes
	2. Unrestricted intercept, no trend	0.80***	Yes
	3. Restricted intercept, no trend		
	4. Unrestricted intercept, restricted	0.79	Yes
	trend	0.46**	No
	5. Unrestricted intercept,		
	unrestricted trend	0.46**	Yes

Notes:

[a/] If at least one test statistic supports the existence of cointegration, then it is taken to exist. This is based on the cointegration test in the previous section

[b/] Maximum Likelihood estimates of cointegrating regression from the Johansen (1988) procedure

Alternative tests of fiscal sustainability: the Tax-Smoothing Model

The conventional cointegration tests in the previous section do not capture the fact that Malaysia is an oil producing country. Such countries can continue to incur more debts without raising revenue, since the countries can sell oil to pay off their public sector debts. To reflect the role played by oil and gas revenues I estimate the Tax-Smoothing Model proposed by Kia (2008).

The model was presented in the previous section as Equation 3 in the *Methodologies* section. Prior to conducting this exercise, I once again performed unit root tests (ADF, PP and KPSS tests) on the variables of Equation 3. Results of the unit root tests (available from author but not presented here) suggest that all variables in the Tax-Smoothing Model are I (1) processes. Thus, the model can be estimated as a cointegrating equation. In this regard, I replicated a similar testing cycle of cointegration tests presented in the previous section. Table 7 reports the results of the Johansen (1988) test. It can be seen that both the Trace and Maximal Eigenvalue test statistics detected at least one cointegrating relationship at 5% significance level. Meanwhile, the single-equation based cointegration tests also provided strong evidence in support of cointegration between the variables in the tax-smoothing model (see Tables 8a, 8b and 8c). The Engle-Granger and Phillips-Ouliaris tests provide the evidence to support the existence of cointegration in the tax-smoothing model at 5% significance level and this result is robust irrespective of estimation techniques used. Nonetheless, the Hansen Parameter Instability test rejects the null of cointegration in most cases, except when DOLS is used to estimate the cointegrating equation. Finally, the ARDL and bounds test strongly support the results mentioned above (see Table 8). The F-test statistic is clearly larger than the upper bound critical value at 5% level, irrespective of model specification. To conclude, most tests indicate that the Tax-Smoothing Model (Equation 3) is a cointegrating relationship. To interpret the empirical results of the Tax-Smoothing Model, the estimated parameters are reported in Table 9. I have only reported the coefficient on DBTGDP and ENERGY as these will give some indication of fiscal sustainability based on the arguments A1-A9 presented in the *Methodologies* section. Interested readers can request the complete results from the author.

Table 7. Results of cointegration test based on Johansen (1998) - Tax Smoothing Model

Panel A: No dummy variables included in model				
Number of deterministic regressors	Null hypothesis [a/]	Alternative hypothesis	Test Statistics: Trace Statistic	Test Statistics: Max Eigenvalue Statistic
Case 1: No intercept, no trend	r=0	r>0	97.25**	57.04**
	r≤1	r>1	40.22**	18.76
	r≤2	r>2	21.46	13.90
	r≤3	r>3	7.56	7.47
	r≤4	r>4	0.09	0.09
Case 2: Unrestricted intercept, no trend	r=0	r>0	125.21**	73.49**
	r≤1	r>1	51.72**	30.09**
	r≤2	r>2	21.63	10.88
	r≤3	r>3	10.75	8.77
	r≤4	r>4	1.98	1.98
Case 3: Restricted intercept, no trend	r=0	r>0	138.78**	73.58**
	r≤1	r>1	65.21**	31.73**
	r≤2	r>2	33.47*	17.92
	r≤3	r>3	15.55	8.81
	r≤4	r>4	6.75	6.75
Case 4: Unrestricted intercept, restricted trend	r=0	r>0	150.91**	73.85**
	r≤1	r>1	77.06**	42.28**
	r≤2	r>2	34.79	17.79
	r≤3	r>3	17.00	10.30
	r≤4	r>4	6.70	6.70
Case 5: Unrestricted intercept, unrestricted trend	r=0	r>0	149.64**	73.65**
	r≤1	r>1	75.99**	42.07**
	r≤2	r>2	33.92	16.98
	r≤3	r>3	16.94	10.30
	r≤4	r>4	6.64	6.64

Panel B: Dummy variables included in model to capture structural breaks [b/]			
Number of deterministic regressors	Null hypothesis	Alternative hypothesis	Trace statistic
Case 1: Intercept included	r=0	r>0	214.82**
	r≤1	r>1	104.90**
	r≤2	r>2	51.92**
	r≤3	r>3	22.38
	r≤4	r>4	7.28
Case 2: Trend and intercept included	r=0	r>0	238.58**
	r≤1	r>1	117.33**
	r≤2	r>2	62.55**
	r≤3	r>3	37.33**
	r≤4	r>4	14.10

Notes:

[a/]'r' refers to the number of cointegrating vectors

[b/] This version of the Johansen test allows up to two structural breaks. The breaks are for 2001Q1 and 2009Q1 due to recessions. Changing the break point at different quarters of the same year does not affect results of Trace test

*, ** and *** indicate 10%, 5% and 1% significance respectively. Test performed with 4 lags in the VAR model

Table 8a. Results of Hansen Parameter Instability Test, Engle-Granger Test and Phillips-Ouliaris Test; estimation technique: FMOLS

Cointegration test	Number of deterministic regressors			
	None	Constant	Constant, linear trend	Constant, linear and quadratic trend
HPI	0.36	1.91**	2.07**	2.92**
EG	-5.98*** [a/] -42.46***	-6.66*** -92.32***	-6.32*** -83.76***	-6.81*** -102.52***
PO	-5.92*** [b/] -38.26***	-6.55*** -38.08***	-6.62*** -39.23**	-6.93*** -38.60**

Notes:

HPI - Hansen Parameter Instability, EG - Engle-Granger Test, PO - Phillips-Ouliaris Test; for Hansen Parameter Instability, the null hypothesis is 'cointegration', for the other tests, the null hypothesis is 'no cointegration'

*, ** and *** indicate 10%, 5% and 1% significance respectively

[a/] The first figure refers to the Tau statistic and the second figure is the z-statistic

[b/] The first figure refers to the Tau statistic and the second figure is the z-statistic

Table 8b. Results of Hansen Parameter Instability Test, Engle-Granger Test and Phillips-Ouliaris Test; estimation technique: CCR

Cointegration test	Number of deterministic regressors			
	None	Constant	Constant, linear trend	Constant, linear and quadratic trend
HPI	0.82	1.30**	1.70**	2.03**
EG	-5.98*** [a/] -42.46***	-6.66*** -92.32***	-6.32*** -83.76***	-6.81*** -102.52***
PO	-5.92*** [b/] -38.26***	-6.55*** -38.08***	-6.62*** -39.23**	-6.93*** -38.60**

Notes:

HPI - Hansen Parameter Instability, EG - Engle-Granger Test, PO - Phillips-Ouliaris Test; for Hansen Parameter Instability, the null hypothesis is cointegration, for the other tests, the null hypothesis is no cointegration

*, ** and *** indicate 10%, 5% and 1% significance respectively

[a/] The first figure refers to the Tau statistic and the second figure is the z-statistic

[b/] The first figure refers to the Tau statistic and the second figure is the z-statistic

Table 8c. Results of Hansen Parameter Instability Test, Engle-Granger Test and Phillips-Ouliaris Test; estimation technique: DOLS

Cointegration test	Number of deterministic regressors			
	None	Constant	Constant, linear trend	Constant, linear and quadratic trend
HPI	0.05	0.10	0.11	0.14
EG	-5.98*** [a/] -42.46***	-6.66*** -92.32***	-6.32*** -83.76***	-6.81*** -102.52***
PO	-5.92*** [b/] -38.26***	-6.55*** -38.08***	-6.62*** -39.23**	-6.93*** -38.60**

Notes:

HPI - Hansen Parameter Instability, EG - Engle-Granger Test, PO - Phillips-Ouliaris Test; for Hansen Parameter Instability, the null hypothesis is cointegration, for the other tests, the null hypothesis is no cointegration

*, ** and *** indicate 10%, 5% and 1% significance respectively

[a/] The first figure refers to the Tau statistic and the second figure is the z-statistic

[b/] The first figure refers to the Tau statistic and the second figure is the z-statistic

Table 9. ARDL bounds test results

Number of deterministic regressors	Lag length (N)	F-statistic [a/]	Breusch-Godfrey LM statistic	
			At lag=1	At lag=4
Case 1: Intercept included	3	4.87**	0.06 [0.805]	1.47 [0.245]
Case 2: Trend and intercept included	3	7.49**	0.18 [0.671]	0.26 [0.901]

Notes:

[a/] The critical values are from Narayan (2005). Number in [ ] is the p-value. Number of forcing variable(s) is 4 (k=4) and sample size is 50, so the critical value bounds for Case 1 is (3.136, 4.416) at 5% significance level. For Case 2, the critical value bounds are (3.834, 5.064) at 5% significance level. Lags are added to the Unrestricted Error Correction form for the ARDL model until evidence of autocorrelation disappears. This modelling technique is based on Lee (2008).

Looking at Table 9, only in 6 cases do the pairs of coefficients on DBTGDP and ENERGY (shaded in yellow) appear to fall under the sustainable fiscal policy scenarios mentioned in the *Methodologies* section. Among these cases, most of the yellow-shaded rows have statistically insignificant coefficient on DBTGDP (i.e. primary balance does not strengthen in response to rising debt levels) and statistically significant coefficient on ENERGY (i.e. rising income from energy exports contributes to strengthening primary balance) at least at the 10% significance level. These cases fall under scenario A4 in the *Methodologies*, implying fiscal sustainability.

Nonetheless, most cases are where pairs of coefficients on DBTGDP and ENERGY fall under scenario A6 (i.e. primary balances are not responsive to debt levels and income from energy exports are not channeled towards debt reduction). Thus, the evidence from the Tax Smoothing Model do not strongly support the view that the fiscal process in Malaysia is sustainable.

Table 10. Coefficient estimates of Tax Smoothing Model

Estimation technique	Model specification	Estimated coefficients on:	
		DBTGDP	ENERGY
FMOLS	1.As specified in Equation 2, but without intercept	-0.025	0.618***
	2.As specified in Equation 2	0.027	0.337*
	3.As specified in Equation 2, with linear trend	-0.029	-0.475
	4.As specified in Equation 2 with linear trend and quadratic trend	-0.017	-0.801***
DOLS	1.As specified in Equation 2 but without intercept	-0.032	0.77**
	2.As specified in Equation 2	0.029	0.379
	3.As specified in Equation 2 with linear trend	0.024	0.293
	4.As specified in Equation 2 with linear trend and quadratic trend	0.019	-0.318
CCR	1.As specified in Equation 2 but without intercept	-0.015	0.634**
	2.As specified in Equation 2	0.025	0.371*
	3.As specified in Equation 2 with linear trend	-0.022	-0.327
	4.As specified in Equation 2 with linear trend and quadratic trend	-0.020	-0.832*
ARDL	1. As specified in Equation 2	0.027	0.296
	2. As specified in Equation 2 with linear trend	-0.010	-0.195
ML [a/]	1. No intercept, no trend	0.037***	0.097***
	2. Unrestricted intercept, no trend	0.445	0.209
	3. Restricted intercept, no trend	0.476	0.286
	4. Unrestricted intercept, restricted trend	0.372	2.119
	5. Unrestricted intercept, unrestricted trend	0.370	2.180

Notes:

[a/] Maximum Likelihood estimates of cointegrating regression from the Johansen (1988) procedure

V. Conclusion

This study takes fiscal sustainability in Malaysia seriously. This is in view of some shortcomings in the literature. First, studies that have been conducted so far ignore multicointegration tests of fiscal sustainability. The notion of multicointegration which was mooted by Granger and Lee (1990) and has since been extended by Haldrup (1994) and Engsted *et al* (1997), provides another test to determine the existence of fiscal sustainability and are hence of importance. In this paper, one of my contributions is to re-examine fiscal sustainability in Malaysia using this test. Second, there have been a number of approaches to test fiscal sustainability in the literature, such as unit root and standard cointegration tests. But the literature has so far ignored an alternative testing procedure developed by Kia (2008), who developed a model for oil-producing countries. In the light of this model, it would be worthwhile to examine fiscal sustainability in Malaysia again. To this end, I make my second contribution to the literature. Finally, to complement existing literature, I performed more thorough statistical tests of fiscal sustainability than have been attempted in the literature so far.

The main findings of this paper are as follows. First, there is no multicointegration between government revenue and spending – hence fiscal sustainability has to be further tested using a battery of standard statistical tests. In this regard, a wide range of cointegration tests using numerous estimation techniques mostly do not reject the existence of cointegration between government revenue and spending – this finding seems to support fiscal sustainability. However, an inspection of the responsiveness of government revenue to expenditure indicates that sustainability is somewhat weak. Finally, the coefficient estimates of the Tax Smoothing Model of Kia (2008) do not strongly support fiscal sustainability – this result puts the sustainability of the fiscal process very much in doubt. This key finding is important since amongst all the tests conducted, the Tax Smoothing Model is one that best captures fiscal sustainability in oil producing countries. The findings here should however be taken as preliminary and indicative rather than confirmatory, as more research on this area needs to be done before formulating detailed policy advice. Given the results of the tests, it would seem that the Government needs to alter its fiscal conduct to prevent a rapid escalation of public debts. Further tests of fiscal sustainability that focus on oil-producing countries are warranted, as are studies that stress test the future path of public debt using stochastic simulations in various macroeconomic environments.

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