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The Relationship Between State's Revenues and Expenditures in Malaysia: Some Robust Results

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The Relationship Between State's Revenues and Expenditures in Malaysia: Some Robust Results

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Abstract

Motivation and aim: The primary objective of this study is to examine the causative relationship between revenue and expenditure at the state level in Malaysia. This study provides the opportunity to explore several hypotheses in order to investigate the tax collection and spending behavior of the Malaysian government. The tax-spend hypothesis posits that governments generate tax revenues prior to initiating new expenditures. In contrast, the spend-tax hypothesis posits that governments first engage in spending activities and afterwards augment tax receipts in order to fund their expenditures. Another concept that exists is the fiscal synchronization hypothesis, which posits that governments make choices about both revenues and spending concurrently. Finally, there exists the potential for autonomy in relation to the choices pertaining to expenditure and the generation of income.

Methods and material: In this study, we employed five estimators, namely, Ordinary Least square (OLS-robust), Fully Modified OLS (FMOLS), Dynamic OLS (DOLS), Canonical Cointegration Regression (CCR) and Robust regression. We test both states' revenues and expenditures for unit root and cointegration for arriving at the valid long-run model. The study uses states' annual data for 13 states that span from 1990 to 2018.

Key findings: Based on an empirical investigation conducted on yearly data including revenue and expenditure of 13 Malaysian states from 1990 to 2018, the findings derived from our Granger long-run causality by employing the error-correction framework, indicate consistent results that support the fiscal synchronization hypothesis.

Policy implications: Our study supports the fiscal synchronization hypothesis between states' expenditure and states' revenue for all thirteen states in Malaysia for the period 1990-2018. The policy implication is that state budget's reduction could be achieved through state government spending cut, accompanied by contemporaneous tax controls.

JEL Classifications:
E62, H50, H72

Keywords:
Tax-spend, Spend-tax, Fiscal synchronization, States, Malaysia

The Relationship Between State's Revenues and Expenditures in Malaysia: Some Robust Results

1. INTRODUCTION

The empirical examination of the relationship between government expenditures and tax receipts is a well investigated subject within the field of macroeconomics. Determining the causal relationship between government expenditures and tax receipts at the macroeconomic level will aid policymakers in discerning the underlying causes of any fiscal imbalances that may be present. As a result, this would enhance endeavors to formulate an appropriate fiscal reform approach.

The examination of the causal relationship between revenues and expenditures has given rise to several opposing theories. The fiscal synchronization concept posits that the fiscal authorities make taxes and expenditure choices together. According to the Granger concept, the link between tax income and government expenditure may be characterized as a bi-directional association. Furthermore, there exists a unidirectional connection whereby income influences spending, thus providing support for the tax-and-spend concept. The hypothesis posits that there exists a relationship between government income and government spending, suggesting that controlling tax revenue might serve as an effective strategy to decrease the magnitude of government expenditure. Conversely, the spend-and-tax theory posits that there exists a relationship between government spending and subsequent fluctuations in tax collections. To clarify, the direction of causation may be seen as flowing from government expenditure towards tax income. Lastly, the concept of institutional separation between government spending and taxing choices posits that revenues and expenditures are mutually exclusive.

One of the earlier works on the tax-spend nexus in Malaysia was conducted by Aziz et al. (2000). It has been observed that Malaysia's government expenditures have continuously surpassed government earnings during the majority of the decades since 1959, with the exception of the years between 1959-1961 and 1993-1997. The budget deficits created may primarily be attributed to the government's dedication to pursuing fast economic growth programs, as seen in the several five-year Malaysian development plans. However, the increased involvement of the public sector has led to a significant increase in government spending. In their study, Aziz et al. (2000) discovered that the annual data on Malaysia's tax revenue and expenditures provided support for the fiscal synchronization hypothesis

during the testing of the aforementioned hypotheses. The statement suggests the presence of a reciprocal causal link, as defined by Granger, between government income and expenditure. This result was further supported by the work by Taha and Loganathan (2008), who found bidirectional Granger causality running from direct tax revenues, as well as indirect tax revenues to government spending for the period 1970-2006.

Nevertheless, unidirectional Granger causality between tax spending and tax revenue was also found by several studies on Malaysia. For example, the work of Wong and Lim (2005) show that government revenue leads government expenditure for the period 1965-2002, supporting the tax-spend hypothesis. On the other hand, recent work by Khan et al. (2021) also supported the tax -spend hypothesis for Malaysia. Using data for the period 1990-2019, and by employing the vector error-correction model framework, the Granger causality showed a one-way relation between government revenues and expenditures; expenditures are supported by tax revenues, thus implies that the tax-spend hypothesis is supported.

Nonetheless, the spend-tax hypothesis is not without support in Malaysia. Karim et al. (2006) investigate the tax-spend behavior of five ASEAN economies, including Malaysia for the period 1972-2000. They found that Malaysia, Indonesia and the Philippines supported the spend-tax hypotheses; while Thailand and Singapore supported the tax-spend hypotheses. The tax-spend hypothesis for Malaysia was also supported by the work of Tan (2009) using annual data from 1970-2007; Sanusi et al. (2012) using data spanning from 1975-2006; and Mele et al. (2020) for the period 1985-2016. On the other hand, using quarterly data for the period 1970:1 – 1990:4, Mithani and Goh (1999) found a one-way Granger causality running from government expenditure to government revenue, thus supporting the spend-and-tax hypothesis implying higher government spending leads to higher taxes.

Saha and Mukhopadhyay (2014) investigated the relationship between government expenditure and government revenue in Malaysia for the period of 1963-2007. They found that for the period 1963-2007, fiscal neutrality hypothesis is supported for Malaysia, which implies that tax revenue and tax spending is independently determined. However, when the periods of the study were divided into three sub-periods 1963-1980, 1981-1997 and 1998-2007, the directions of the causality give mixed results. For the sub-period 1963-1980, the annual data supported the fiscal neutrality hypothesis; while for both sub-periods 1981-1997 and 1998-2007 supported the spend-and-tax hypotheses.

At the state level, Asri et al. (2015) investigated the tax and spend nexus using annual data for the period 1970 to 2008 for 11 states, namely Selangor, Negeri Sembilan, Perlis, Kedah, Kelantan, Terengganu, Pahang, Johor, Melaka, Perak and Penang. Using the popular autoregressive distributed lag (ARDL) model approach, their finding suggest that the tax-spend hypothesis was supported, implying that the state's government determine the level of tax revenue before making decision to spend. However, the work of Jalil and Harun (2012), found that using data from 1980-2009, the state of Kelantan supported the spend-and-tax hypothesis; while the state of Penang supports the fiscal neutrality hypothesis.

On the other hand, at the municipality level in the state of Sabah, Dayang-Affizzah et al. (2006) examined annual data on revenues and expenditures for 16 municipalities in Sabah over the period 1965 to 2003, by employing the vector error correction model procedure and the results are at best mixed. On one hand, municipals in Papar, Sandakan, Tambunan, Tawau, Tenom and Tuaran support the tax-and-spend hypothesis. This implies that these municipals decide first on the amount of tax collections and then decide on how much to spend. On the other hand, municipals in Keningau, Lubuk and Sugut, Lahad Datu and Ranau support the spend-and-tax hypothesis. This would imply that the fiscal authorities of these municipals decide to spend first and then increase tax collection to cover expenses. Only Kota Kinabalu supports the fiscal synchronization hypothesis and implies that under this scenario, the fiscal authority of Kota Kinabalu should try to raise revenues and cut spending simultaneously in order to control budget deficits; while municipals in Beaufort and Kuala Penyu suggest that revenues and expenditures are not interrelated in the long-run. This implies that the independent determination of revenue and spending suggest the absence of coordination between expenditure and revenue decisions in the respective municipalities

The primary objective of this study is to examine the causative relationship between revenue and expenditure at the state level in Malaysia for the time frame spanning from 1990 to 2018. The use of cointegration and causality models allows for the analysis and evaluation of the proposed hypotheses. In this section, a concise summary of the hypotheses will be presented, along by an examination of pertinent scholarly works pertaining to the tax-spend issue. Section 3 provides an in-depth examination of the technique used and the data utilized in the study. The empirical results are presented in Section 4, and the conclusion is provided in Section 5.

2. LITERATURE REVIEW

In the developed countries, the relationship between government income and spending may be classified into four primary conflicting hypotheses. The fiscal synchronization concept posits that the fiscal authorities make taxes and expenditure choices in a synchronized manner. According to the Granger concept, the link between tax income and government expenditure is characterized as a bi-directional association. Musgrave (1966) posits that voters engage in a comparative analysis of the incremental advantages and disadvantages associated with government services, in order to make informed decisions on the optimal levels of government income and expenditures. Therefore, according to the fiscal synchronization concept, choices about income and spending are concurrently decided. Several studies have provided support for the fiscal synchronization concept, including the works of Musgrave (1966), Meltzer and Richard (1981), Miller and Russek (1990), Bohn (1991), Bhat et al. (1993), Payne (1998), Koren and Stiassny (1998), Kollias and Makrydakis (2000), Kollias and Paleologou (2006), Chang and Chiang (2009), Vamvoukas (2011), Mutascu (2016), Irandourst (2017), Jaen-Garcia (2019), Karakas and Turan (2019), and Tashevska et al. (2020).

Furthermore, there exists a unidirectional causation that originates from income and leads to spending, so providing support for the tax-and-spend theory. The hypothesis posits that there exists a relationship between government income and government spending, suggesting that controlling tax revenue might serve as an effective policy measure to decrease the magnitude of government expenditure. Friedman (1978) posits the tax-and-spend hypothesis, which asserts that alterations in government income result in corresponding adjustments in government spending. According to Friedman, the implementation of tax hikes is likely to result in corresponding increases in government expenditures, hence limiting the effectiveness of such measures in reducing budget deficits. Several studies conducted by Friedman (1972, 1978), Buchanan and Wagner (1977, 1978), Darrat (1998), Blackley (1986), Marlow and Manage (1987), Joulfaian and Mookerjee (1990, 1991), Payne (1998), and Koren and Stiassny (1998) have consistently shown that government tax collections have a causal effect on government spending. More recent studies that support the tax-and-spend hypothesis include Tashevska et al. (2020), and Kollias and Makrydakis (2000),

Conversely, the spend-and-tax theory posits that government spending has a causal effect on alterations in tax income. To clarify, the direction of causation may be seen as flowing from government expenditure towards tax income. According to Peacock and Wiseman (1979), it is posited that transient surges in government spending triggered by crises have the potential to result in enduring augmentations in government revenues. The spend-and-tax theory finds support in many

research conducted by Peacock and Wiseman (1961, 1979), Jones and Joulfaian (1991), Anderson et al. (1986), von Furstenberg et al. (1986), Provopoulos and Zambaras (1991), Joulfaian and Mookerjee (1991), Hondroyiannis and Papapetrou (1996), Darrat (1998), Koren and Stiassny (1998), Almasri and Shukur (2003), Konstantinou (2004), Richter and Dimitrios (2013), Mutascu (2016, 2017), Karakas and Turan (2019), and Kirikkaleli and Ozbeser (2023).

Last but not least, according to Wildavsky (1988) and Baghestani and McNown (1994), in cases when there is no causal relationship between revenue and expenditure, the collection of tax income and spending are considered to be independent of each other. The non-causal relationship between revenue and expenditure is known as the fiscal neutrality or institutional separation or fiscal independence hypotheses. Kollias and Paleologou (2006) found that Austria, Belgium and Germany support the institutional separation hypothesis. Other studies by Ewing et al. (2006) have also found the fiscal neutrality hypothesis for the United States; for Estonia, Latvia, Lithuania, Poland and Romania by Mutascu (2016); and Karakas and Turan (2019) for Romania and Poland.

As shown above, generally even in the developed nations, the empirical data pertaining to the aforementioned conflicting hypotheses is, at best, mixed and inconclusive. Various studies examining the relationship between government income and spending have shown diverse outcomes, which may be attributed to variations in the time frame considered, the duration of lag, and disparities among various tiers of government. For example, the study conducted by Manage and Marlow (1986) revealed that using varying lag durations had distinct outcomes. By manipulating the lag length within the range of two to five, the findings consistently demonstrate a unidirectional link in all instances. Specifically, the lower and higher lag lengths consistently reveal a causative relationship, where expenditures have a significant impact on revenues. Conversely, the utilization of an intermediate lag time offers substantiation for a bidirectional causal association between the two variables. In their study, Ram (1988) used a combination of yearly and quarterly data to investigate the relationship between expenditures and revenues in both the Federal government and State and Local government. The investigation yielded contradictory findings as well. For instance, when examining yearly data, the findings provide empirical support for the fiscal synchronization theory within the context of the federal government.

However, the use of quarterly data yielded findings that indicate a causal relationship from revenues to expenditures, hence providing support for the tax-and-spend theory. However, when examining data at the state and municipal level, both yearly and quarterly figures show outcomes that align with the spend-and-tax theory. In a separate investigation, Owoye (1995) conducted an examination of the

causal association between taxes and expenditures among the G7 nations. Owoye observed that while the sample nations have comparable economic environments, the outcomes of the causation linkages differ. The findings derived from the error-correction models provide empirical evidence that supports the fiscal synchronization theory in relation to the United States, Germany, United Kingdom, France, and Canada. This suggests that the fiscal authorities in these nations engage in collaborative decision-making processes about taxation and expenditure. In contrast, it can be seen that the direction of causation in Japan and Italy is from revenues to expenditures, so providing support for the tax-and-spend theory.

The government tax revenue and government expenditures relationship in the developing countries has also shown similar conflicting results. There is a substantial body of research on the tax-spend relationship in developing economies. Notable studies among others, include Chang and Ho (2002a) for China, Fuess et al. (2003) and Chang and Ho (2002b) for Taiwan, Al-Foul and Baghestani (2004) for Egypt and Jordan, Ewing and Payne (1998) for Latin America, and Carneiro et al. (2004) for Guinea-Bissau.

Chang and Ho (2002a) conducted a study using annual time series data for China from 1977 to 1999. They employed multivariate error correction models to examine the relationship between government revenues and government expenditures. Their findings revealed the presence of bi-directional Granger causality, providing support for the fiscal synchronization hypothesis in the context of China. Regarding Taiwan, the tax-and-spend hypothesis, which posits a unidirectional causal relationship from government revenues to expenditures, is supported by the research conducted by Chang and Ho (2002b) as well as Fuess et al. (2003).

According to Ewing and Payne's (1998) research, it was determined that Chile and Paraguay provide support for the fiscal synchronization concept among Latin American nations. There exists empirical data in the cases of Colombia, Ecuador, and Guatemala that suggests a causal relationship between revenues and expenditures, hence providing support for the tax-and-spend theory. According to the research conducted by Al-Foul and Baghestani (2004) on the countries of Egypt and Jordan, the findings reveal that the data pertaining to Egypt demonstrate a unidirectional causation from income to expenditure. Specifically, it was seen that an increase in revenue is associated with a corresponding increase in spending. The findings pertaining to Jordan demonstrate a reciprocal relationship between revenue and expenditure, hence providing empirical support for the fiscal synchronization concept. On the other hand, a study by Alagidede and Tweneboah (2015) fiscal synchronization hypothesis for the Latin America for the period 1990-2012. Cheng (1999) shows that Chile, Panama, Brazil and Peru

bidirectional causality between taxes and expenditure supporting the institutional separation hypothesis. Studies by Gounder et al. (2007) support the fiscal neutrality hypothesis for Fiji; while for Nigeria by Shuaibu and Ibrahim (2013); Ghana by Takumah (2014); South Africa by Moyo et al. (2021) and Nyamongo et al. (2007); India by Akram and Rath (2019); China by (Chang and Ho (2002a), Ho and Huang (2009), Li (2001) and Karlsson (2019); and Pakistan by Raza et al. (2019).

In their study on Guinea-Bissau, Carneiro et al. (2004) discovered the presence of a durable equilibrium between government spending and income. The spend-and-tax theory posits that the government exhibits a tendency to first allocate cash towards expenditures and thereafter seeks to generate tax revenues and/or get grants to finance these outlays, as opposed to adopting a strategy of first acquiring funds to support spending. Similar spend-and-tax hypothesis can be found in the work by Narayan and Narayan (2006) for Haiti; Diky et al. (2023) for Indonesia; Hayat et al. (2017) for Pakistan; Sanusi (2020) for South Africa; and Nzimande and Ngalawa (2021) for Mauritius and Mozambique.

A study conducted by Chang et al. (2002) examined the tax-and-spend hypothesis in three newly industrialized countries in Asia (South Korea, Taiwan, and Thailand) as well as seven industrialized countries (Australia, Canada, Japan, New Zealand, South Africa, UK, and the USA). The findings of this study revealed that the data supported the tax-and-spend hypothesis for Japan, South Korea, Taiwan, UK, and the USA. However, the spend-and-tax hypothesis was found to be applicable only to Australia and South Africa. Canada, in the context being discussed, aligns with and provides evidence for the fiscal synchronization concept. Moreover, the study conducted by Chang et al. (2002) revealed that there is no significant correlation between revenues and expenditures in both New Zealand and Thailand.

In another study, the tax-and-spend hypothesis was also found by Nzimande and Ngalawa (2021) for Botswana; Narayan and Narayan (2006) for Mauritius, El Salvador, Haiti, Chile and Venezuela; Sriyana (2009), and Solikin and Nizar (2023) for Indonesia; Mohanty and Mishra (2017) for India; Rahman and Wadud (2014) for Bangladesh; Al-Khulaifi (2012) for Qatar; Rezael (2014) for Iran; Yinusa and Adedokun (2017), and Obioma and Ozughalu (2010) for Nigeria; Craigwell et al. (1994) for Barbados; Masenyetse and Motelle (2012) for Lesotho; and Cheng (1999) for Columbia, the Dominican Republic, Honduras and Paraguay.

Several studies have also found the fiscal independent hypothesis between government tax revenue and government expenditure. The works by Babarinde (2022) for the fiscal independent hypothesis

holds for Nigeria; Sere and Choga (2017) for South Africa; and Narayan and Narayan (2006) for Peru, South Africa, Guatemala, Uruguay and Ecuador.

3. METHODOLOGY

3.1 Testing for Long-Run Relationship between Revenue and Expenditure

In accordance with the existing literature and to maintain a sufficient level of flexibility, we establish the long-term model for states' spending and income in this study as follows,

$$\exp_t = \theta_0 + \theta_1 \mathrm{rev}_t + \omega_t \quad (1)$$

where $\omega_t \sim \mathrm{NID}(0, \sigma^2)$; $\exp_t$ is the total states' expenditure to states' GDP ratio; rev_t is states' total tax revenue to states' GDP. The error term ω_t is assumed to has mean zero and constant variance.

To estimate Equations (1), we employ the Ordinary Least Square (OLS) with robust standard error due to Newey-West (Newey & West, 1987) procedure. Newey-West standard error method is a robust method/estimator which is highly accurate when there is a presence of heteroskedasticity and autocorrelation. Due to the fact that the time series variables are nonstationary, and most likely the regressions results will be spurious, we test the model for the presence of cointegration. To test for cointegration, we employ the conventional cointegration test proposed by Engle and Granger (1987). The two-step Engle-Granger cointegration test is done by estimating Equation (1) using OLS first. In the second step, the residuals are saved and then tested for the presence of unit root. The rejection of a unit root in the residuals will suggest cointegration. If the variables are found to be cointegrated in Equations (1), the estimated long-run models are said to be valid, the OLS estimation is efficient and the results are nonspurious.

In this study, we also employ the Fully Modified OLS (FMOLS), Dynamic OLS (DOLS), Canonical Cointegrating Regression (CCR) procedure and Robust regression using the M-estimator to estimate the long-run models as per Equations (1). The FMOLS, DOLS and CCR are robust and more efficient and robust than the OLS, particularly for small samples, to work with models with heteroscedasticity, autocorrelation, and non-normality of errors (Phillips & Hansen, 1990; Stock & Watson, 1993; Park, 1992). For the long-run models estimated using FMOLS, DOLS and CCR, the test for cointegration

is perform using the Hansen L_c statistics (Hansen, 1992) with testing the null hypothesis of cointegration and the alternative hypothesis of no cointegration.

For further robustness test, we also employ the Robust regression. The Robust regression is efficient to the presence of outliers. Barnett and Lewis (1994) stated that the presence of outliers can lead to inflated error rates and substantial distortions of parameter and statistical estimates when using either parametric or non-parametric tests. Statistically, the increase in error variance will reduce the power of statistical tests, decrease normality, and seriously bias or influence parameter estimates (Perez et al., 2013). According to Rousseeuw (1984), robust regression is the best method to detect outliers and provides results that are resistant to outliers. The most common general method of robust regression is the M-estimation method introduced by Huber (1964).

In this study, to ascertain the tax-spend hypothesis, we estimate the following error-correction model (Granger, 1986; Engle & Granger, 1987),

$$\Delta \exp_t = \gamma_0 + \sum_{i=1}^{m} \gamma_{1i} \Delta \exp_{t-i} + \sum_{i=0}^{n} \gamma_{2i} \Delta rev_{t-i} + \lambda_1 ECM_{t-1} + \eta_t \quad (2)$$

$$\Delta rev_t = \delta_0 + \sum_{i=1}^{m} \delta_{1i} \Delta \exp_{t-i} + \sum_{i=0}^{n} \delta_{2i} \Delta rev_{t-i} + \lambda_2 ECM_{t-1} + \mu_t \quad (3)$$

where $\exp_t$ and rev_t are expenditure and revenue respectively, and Δ is the difference operator. The ECM term was derived from the residual lagged one period of the long-run Equation (1) above,

$$ECM_{t-1} = \omega_{t-1} = \exp_{t-1} - [\theta_0 + \theta_1 rev_{t-1}] \quad (4)$$

The Granger long-run causality between revenue and expenditure is tested using the statistically significant of the parameter lambda (λ) in Equations (2) and (3). A negative and significant of the estimated coefficient of λ_1 in Equation (2) and a negative and non-significant of λ_2 in Equation (3) would suggest the tax-and-spend hypothesis; while a negative and non-significant of the estimated coefficient of λ_1 in Equation (2) and a negative and significant of λ_2 in Equation (3) would suggest the spend-and-tax hypothesis. A bi-directional causal relationship between revenue and expenditure or a fiscal synchronisation hypothesis is supported when λ_1 in Equation (2) and λ_2 in Equation (3) are both negative and significant. On the other hand, the negative and non-significant of both λ_1 in Equation (2) and λ_2 in Equation (3) would suggest the fiscal neutrality hypothesis of the institutional separation hypothesis. The estimated value for $\lambda's$ usually lies between 0 and -2 (Fromentin & Leon, 2019; Loayza & Rancière, 2006; Samargandi et al., 2015).

3.2 Sources of Data

The data pertaining to the total tax revenue and expenditures of thirteen Malaysian states from 1990 to 2018 were gathered from various editions of the State Financial Yearbook, which is produced by the Department of Statistics Malaysia. The series variables were converted into ratio to state's Gross Domestic Product and into natural logarithms for the purpose of the analysis in this study. Figure 1 demonstrates the trends in real Gross Domestic Product (GDP) for the 13 states in Malaysia; while Figure 2 illustrates the trend in the ratios of tax revenue and expenditure to GDP for all thirteen states in Malaysia for the period 1990-2018. Both figures clearly suggest that the revenue and expenditure series are integrated economic variables.

4. EMPIRICAL RESULTS

4.1 Descriptive Statistics and Correlation Matrix

Before we proceed estimating Equations (1) to (4), the descriptive statistics of all the variables involved in the study are presented in Table 1. In general, the mean for all series is positive. The states that are having mean expenditure ratio to GDP of more than 5% include Perlis, Sabah, Sarawak and Terengganu; while states that are having mean tax revenue ratio to GDP of more than 5% include Sabah and Sarawak. At the mean level, it is observed that all states experienced deficits, implies that mean expenditure is more than mean revenue. As a matter of fact, as shown in Figure 2, the states' ratios of expenditure to GDP in most of the time is higher than the ratios of revenue to GDP, implying that in most of the time, the states are experiencing fiscal deficits.

More importantly, most variables demonstrate substantial standard deviations, skewness and kurtosis. All twenty-six variables are skewed showing asymmetry. As for kurtosis, the variables that show the size of greater than 3 include expenditure for Johor, Kelantan, Sabah and Selangor, and revenue for Johor, Perak, Perlis, Sabah and Sarawak. This indicates that the variables show longer or fatter tail on the right side of the distribution. In other words, the kurtosis shows a leptokurtic type of distribution for the series. Nevertheless, the Jarque-Bera test for normality of the series is rejected for Johor (expenditure and revenue), Kelantan (expenditure), Perak (revenue), Perlis (revenue), Sabah (expenditure and revenue), Sarawak (revenue), and Selangor (expenditure and revenue). In view of that, many of the variables involved in our analysis demonstrate extreme skewness and kurtosis and

have non-normal distribution, the common method to circumvent these problems is to transform all variables into logarithm (McKinney et al., 2009; Naidoo & Adamowicz, 2001; Ehrhardt-Martinez et al., 2002).

In Table 2, we present the correlation matrix between the ratios of expenditure to GDP and ratios of tax revenue to GDP for each state. In all cases, all the thirteen states suggest that the correlation between revenue and expenditure is positive and they are statistically significant at the 1% level. In other words, an increase in states' tax revenue is associated with an increase in states' expenditure.

4.2 Results of Unit Root Tests

Before conducting the cointegration test on Equations (1), the order of integration of each of the variable is to be determined. To test for integration, we employ the standard Augmented Dickey-Fuller (Dickey & Fuller, 1981) unit root test. The test is conducted for both variables in level as well as their first-differences. For each unit root test, we include the intercept and/or trend as the deterministic components when conducting a unit root test. The results of the unit root test are presented in Table 3. The unit root test results suggest that all variables in their levels are integrated of order one, that is, I(1). After first-differencing, no unit root is detected which means that they are stationary in their log changes. In other word, all series are I(0), that is, stationary in first-differences.

4.3 Results of the Long run Model

The estimated long-run spend-tax equations for the thirteen states in Malaysia is presented in Table 4. First, results in Table 4 suggest that the OLS-robust estimates of Equation (1) are cointegrated as shown by the DF_t statistics which reject the null hypothesis of a unit root of the residuals at least at the 10% level (Johor, Negeri Sembilan, and Sarawak), 5% level (Kelantan, Penang, and Terengganu) and 1% level (Kedah, Melaka, Pahang, Perak, Perlis, Sabah, and Selangor). Second, the results of the L_c statistics for the FMOLS, DOLS and CCR estimates suggest that the null hypothesis of cointegration cannot be rejected, thus implies long-run relationships between states' expenditure and states' revenue for the period 1990-2018. Third, in all estimated equations, the revenue variable is statistically significant at least at the 10% level and show positive sign. This suggest that in the long-run an increase in state's tax revenue will increase state's expenditure. And fourthly, the elasticity of revenue of more than one is registered for the states of Johor, Melaka, Pahang, Sabah and Sarawak, thus, implies that a 1% increase in the state's tax revenue, state's expenditure will increase by more than 1%. On the other hand, states that are having elasticity of revenue less than one include Kedah,

Kelantan, Negeri Sembilan, Penang, Perak, Perlis, Selangor and Terengganu. A 1% increase in state's tax revenue will increase state's expenditure by less than 1%.

Table 5 presents the estimated long-run model for all thirteen states in Malaysia using the Robust regression using the M-estimator. The state's revenue variable is statistically significant at the 1% level in all cases and showing positive relationship with state's expenditure. The expenditure in the states of Johor, Melaka, Pahang, Sabah and Sarawak are more responsive the changes in state's tax revenue; while the expenditure in the states of Kedah, Kelantan, Negeri Sembilan, Penang, Perak, Perlis, Selangor and Terengganu were less responsive to the changes in the state's tax revenue during the period 1990-2018. These results were consistent with the earlier results indicated by OLS-robust, FMOLS, DOLS and CCR.

4.4 Results of Granger Long-run Causality

In estimating the error-correction framework as per Equations (2) and (3), we follow the work of Pesaran et al. (2001). According to Pesaran et al. (2001), the optimal lag structure of the error-correction models can be from estimating the Autoregressive Distributed Lag (ARDL) model with its optimal lag structure. In Table 6, the optimal lag structure of the ARDL(p,q) model with p is the lag period for the dependent variable and q is the lag period for the independent variable, are shown for each state. It varies from ARDL(1,0) for Sarawak to ARDL(3,3) for Terengganu. The optimal lag length was chosen using the Akaike Information Criterion.

In this study, we are interested in testing the long-run tax-spending hypothesis (as shown by the significant of the lambda, $\lambda's$) for Malaysia rather than the short-run tax-spending hypothesis (as shown by the significant of the Δ's operator). In Table 6, we present the estimated coefficients of the parameter λ, that is, the coefficient of the ECM_{t-1} term. If the ECM_{t-1} term is negative and significant in the expenditure equation but not in the revenue equation we have unidirectional Granger long-run causality running from revenue to expenditure, thus supporting the tax-and-spend hypothesis; while a unidirectional Granger long-run causality running from expenditure to revenue is established if the ECM_{t-1} term in the revenue equation is negative and significant but not in the expenditure equation, thus supporting the spend-and-tax hypothesis. On the other hand, if the ECM_{t-1} term in both the revenue and expenditure equations are negative and significant, then we have bidirectional Granger long-run causality running between revenue and expenditure, thus supporting the fiscal synchronization hypothesis. Lastly, if ECM_{t-1} term is not significant in both the revenue and

expenditure equations, the data support the institutional separation hypothesis or the fiscal neutrality hypothesis.

As shown in Table 6, in all thirteen states, the ECM_{t-1} term is negative and statistically significant at least at the 5% level in the expenditure equation; and similarly, again in all thirteen states, the ECM_{t-1} term is negative and statistically significant at least at the 10% level in the revenue equation. These results suggest bidirectional Granger long-run causality running in both direction between revenue and expenditure. It therefore supports the fiscal synchronization hypothesis. The fiscal synchronization hypothesis, thus implies that the states' government of the thirteen states, make decision about state's consumption expenditure and state's tax collection simultaneously; and that the public understand the benefits of the state's government services in relation to their costs. Nevertheless, the best strategy for narrowing fiscal deficits is to undertake simultaneous measures to increase revenues and cut spending.

5. CONCLUSION

The purpose of the present study is to test the revenue and expenditure or tax and spend nexus in the thirteen states in Malaysia for the periods 1990 to 2018. The thirteen states included in the study are Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Penang, Sabah, Sarawak, Selangor and Terengganu. Four tax-spending hypotheses was tested, namely the spend-and-tax hypothesis, tax-and-spend hypothesis, fiscal synchronization hypothesis, and the institutional separation or fiscal neutrality hypothesis.

To test these hypotheses, we used the ratio of states' tax revenue and expenditure to states' GDP, and transform them into logarithm. In this study, the revenue and expenditure variables were tested for unit root; and we employed several estimators to test for cointegration to established whether there is long-run relationship between expenditure and revenue in the thirteen states. The estimators are Ordinary Least Square (OLS) with robust standard error, Fully Modified OLS (FMOLS), Dynamic OLS (DOLS), Canonical Cointegrating Regression (CCR) and Robust Regression with M-estimator. On the other hand, the tax-spending hypotheses was tested using the error-correction model framework following Pesaran et al. (2001). Within the error-correction framework, we employed the ECM term lagged one period to ascertain the Granger long-run causality between revenue and expenditure.

Our results suggest that: First, both ratios of states' revenue and expenditure to states' GDP are non-stationary in levels, but they are stationary in first-difference. Second, in all thirteen states, revenue and expenditure are cointegrated, implies that there is long-run relationship between states' expenditure and states' revenue over the time periods 1990 to 2018; and all five different estimators give consistent results. Third, the long-run tax-spending models indicate that 5 states response more to 1% changes in revenue while 8 states response less to 1% changes in revenue. And fourthly, our study supports the fiscal synchronization hypothesis between states' expenditure and states' revenue for all thirteen states in Malaysia for the period 1990-2018. The policy implication is that state budget's reduction could be achieved through state government spending cut, accompanied by contemporaneous tax controls.

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Table 1: Descriptive statistics

Variables	Unit	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	J-B test	Obs
Expenditure:									
Johor	% GDP	2.22	10.32	0.69	2.05	2.56	10.13	93.17***	29
Kedah	% GDP	2.80	4.62	1.59	0.77	0.75	2.70	2.85	29
Kelantan	% GDP	4.45	8.83	2.75	1.66	1.30	3.95	9.28***	29
Melaka	% GDP	2.74	4.83	0.97	1.29	0.06	1.59	2.43	29
Neg.Sembilan	% GDP	2.20	3.85	0.86	1.00	0.12	1.44	3.01	29
Pahang	% GDP	3.35	7.03	1.13	2.08	0.66	1.78	3.91	29
Perak	% GDP	2.45	3.61	1.86	0.45	0.77	2.67	2.97	29
Perlis	% GDP	5.34	8.79	2.99	1.74	0.62	2.36	2.37	29
Penang	% GDP	1.25	1.75	0.76	0.29	0.04	1.97	1.30	29
Sabah	% GDP	7.60	18.69	4.19	3.91	1.58	4.50	14.71***	29
Sarawak	% GDP	22.77	47.99	9.31	11.92	0.57	1.84	3.19	29
Selangor	% GDP	1.92	4.31	1.01	0.85	1.45	4.73	13.74***	29
Terengganu	% GDP	5.48	8.14	1.53	2.01	-0.58	2.24	2.35	29
Revenue									
Johor	% GDP	1.84	6.89	1.01	1.17	3.26	13.74	190.7***	29
Kedah	% GDP	1.50	2.70	0.85	0.57	0.58	1.98	2.89	29
Kelantan	% GDP	2.83	4.34	1.77	0.75	0.36	1.91	2.08	29
Melaka	% GDP	1.74	3.38	0.69	0.75	0.49	2.34	1.69	29
Neg.Sembilan	% GDP	1.83	3.70	0.87	0.99	0.64	1.83	3.64	29
Pahang	% GDP	2.69	5.40	0.91	1.48	0.56	1.82	3.23	29
Perak	% GDP	1.84	3.13	0.94	0.51	1.06	3.92	6.44**	29
Perlis	% GDP	3.41	11.13	1.64	1.78	2.93	13.26	168.5***	29
Penang	% GDP	1.00	1.52	0.63	0.23	0.15	2.15	0.99	29
Sabah	% GDP	5.62	11.91	3.30	2.38	1.50	4.21	12.67***	29
Sarawak	% GDP	16.07	29.48	9.99	5.13	1.06	3.29	5.58*	29
Selangor	% GDP	1.43	3.22	0.60	0.76	1.15	2.94	6.36**	29
Terengganu	% GDP	2.89	6.19	0.81	1.82	0.38	1.54	3.27	29

Notes: Asterisks ***, **, and * denote statistically significant at the 1%, 5% and 10% level, respectively. All variables were in percentage to state's gross domestic product. J-B test denotes Jacque-Bera test on normality of the variables.

Table 2: Correlation matrix

States' Expenditure	States' Revenue	Correlation coefficients
Johor	Johor	0.88***
Kedah	Kedah	0.81***
Kelantan	Kelantan	0.57***
Melaka	Melaka	0.87***
Negeri Sembilan	Negeri Sembilan	0.91***
Pahang	Pahang	0.97***
Perak	Perak	0.64***
Perlis	Perlis	0.78***
Penang	Penang	0.75***
Sabah	Sabah	0.94***
Sarawak	Sarawak	0.78***
Selangor	Selangor	0.82***
Terengganu	Terengganu	0.45**

Notes: Asterisks ***, and ** denote statistically significant at the 1%, and 5% level, respectively. All variables were in logarithm.

Table 3: Results of unit root tests

Series	Series in level:		Series in difference:	
	Intercept	Intercept+trend	Intercept	Intercept+trend
Johor:				
Revenue	-1.5619 (0)	-2.2837 (1)	-3.2233***(1)	-5.7665***(0)
Expenditure	-1.1148 (0)	-2.7391 (0)	-5.9847***(0)	-6.8376***(0)
Kedah:				
Revenue	-0.3303 (1)	-2.2779 (2)	-7.0877***(0)	-4.3960***(2)
Expenditure	-1.2729 (0)	-3.0635 (3)	-4.3672***(1)	-5.3138***(1)
Kelantan:				
Revenue	-1.9056 (1)	-2.4592 (2)	-8.0647***(0)	-6.1719***(1)
Expenditure	-1.4813 (1)	-1.9533 (1)	-6.7080***(0)	-6.7637***(0)
Melaka:				
Revenue	-1.1122 (3)	-1.6148 (2)	-5.7435***(0)	-8.1506***(0)
Expenditure	-0.6680 (0)	-2.5938 (2)	-4.4412***(1)	-4.9347***(3)
Negeri Sembilan:				
Revenue	-0.6905 (0)	-1.4863 (2)	-7.0830***(0)	-5.9864***(1)
Expenditure	0.2228 (0)	-2.7986 (0)	-5.0987***(0)	-5.8911***(0)
Pahang:				
Revenue	-0.3230 (0)	-2.3047 (2)	-5.2880***(0)	-6.4114***(0)
Expenditure	0.1344 (0)	-2.0854 (0)	-4.9867***(0)	-5.1155***(0)
Penang:				
Revenue	-1.5862 (0)	-1.6945 (0)	-6.2178***(0)	-6.5048***(0)
Expenditure	-1.4740 (2)	-1.9644 (2)	-5.5077***(0)	-5.9272***(0)
Perak:				
Revenue	-1.2086 (2)	-2.3068 (4)	-5.1458***(3)	-5.1707***(3)
Expenditure	-1.8027 (1)	-2.3966 (4)	-8.7673***(0)	-8.9855***(0)
Perlis:				
Revenue	-1.7029 (0)	-2.6187 (1)	-4.1177***(0)	-5.8757***(0)
Expenditure	-1.1374 (0)	-2.0199 (3)	-7.5927***(0)	-7.7659***(0)
Sabah:				
Revenue	-1.4026 (0)	-2.4102 (0)	-9.2936***(0)	-9.5000***(0)
Expenditure	-0.7392 (0)	-1.5192 (0)	-5.1496***(0)	-5.5407***(0)
Sarawak:				
Revenue	-0.7965 (0)	-2.2331 (0)	-6.2286***(0)	-6.5522***(0)
Expenditure	-1.0411 (0)	-0.8250 (0)	-4.7773***(0)	-5.1993***(0)
Selangor:				
Revenue	-0.6390 (0)	-2.4205 (0)	-5.0511***(0)	-5.0488***(0)
Expenditure	-1.0031 (0)	-2.2472 (0)	-4.1757***(0)	-4.2874***(0)
Terengganu:				
Revenue	-1.3569 (0)	-2.5561 (1)	-3.1298**(0)	-3.3270**(0)
Expenditure	-1.7473 (6)	-1.6372 (6)	-5.2519***(0)	-5.4862***(0)

Notes: Asterisks ***, ** denote statistically significant at the 1% and 5% level, respectively. Critical values for the series with Intercept, refer to MacKinnon (1996); while critical values for series with Intercept and Trend, refer to Elliot et al. (1996, Table 1).

Table 4: Results on long-run models

States/Independent variables	OLS-robust	FMOLS	DOLS	CCR
Johor:				
constant	-0.2588	-0.5108	-0.5153**	-0.4306
	(-1.4717)	(-1.2355)	(-2.1382)	(-1.2962)
revenue	1.5487***	1.9028**	2.1914***	1.7082***
	(8.3941)	(2.4999)	(3.9863)	(3.5591)
R^2	0.777	0.702	0.712	0.701
Cointegration tests:				
$DF_{t-statistic}$	-1.7096*			
$L_{c-statistic}$		0.2581	0.0197	0.1405
Kedah:				
constant	0.5857***	0.7768***	0.8081***	0.7745***
	(18.864)	(20.752)	(20.405)	(19.890)
revenue	0.7970***	0.7241***	0.6600***	0.7203***
	(5.6651)	(9.0698)	(8.3373)	(8.9822)
R^2	0.663	0.686	0.777+	0.688
Cointegration tests:				
$DF_{t-statistic}$	-5.3466***			
$L_{c-statistic}$		0.2713	0.0684	0.1560
Kelantan:				
constant	0.7031***	0.5620	0.5258	0.5167
	(3.6754)	(1.1933)	(1.2569)	(0.9559)
revenue	0.7280***	0.8611*	0.9014**	0.9054*
	(3.8672)	(1.9007)	(2.2172)	(1.7334)
R^2	0.334	0.324	0.367	0.315
Cointegration tests:				
$DF_{t-statistic}$	-2.4816**			
$L_{c-statistic}$		0.1227	0.0262	0.1371

Notes: Asterisks ***, ** and * denote statistically significant at the 1%, 5% and 10% level, respectively. The two-step cointegration test ($DF_{t-statistic}$) with null hypothesis of non-cointegration; while the Hansen cointegration test ($L_{c-statistic}$) with null hypothesis of cointegration. Prewhitening lag 1 was used for FMOLS and CCR; while for DOLS, lead equals 1, and lag equals 1.

Table 4: Results on long-run models (continue)

States/Independent variables	OLS-robust	FMOLS	DOLS	CCR
Melaka:				
constant	0.3900***	0.4093***	0.3639***	0.4109**
	(4.8695)	(2.8058)	(2.9549)	(2.6587)
revenue	1.0586***	1.0518***	1.1192***	1.0487***
	(10.719)	(4.5545)	(6.1965)	(4.2991)
R^2	0.772	0.766	0.771	0.766
Cointegration tests:				
$DF_{t-statistic}$	-3.1998***			
$L_{c-statistic}$		0.2058	0.0266	0.2094
Negeri Sembilan:				
constant	0.2732***	0.1563	0.2238***	0.1595
	(3.4648)	(1.3460)	(3.0898)	(1.3930)
revenue	0.8597***	0.9701***	0.8635***	0.95928***
	(9.8848)	(5.6648)	(8.6575)	(6.0158)
R^2	0.838	0.797	0.876	0.798
Cointegration tests:				
$DF_{t-statistic}$	-1.9728*			
$L_{c-statistic}$		0.1211	0.0285	0.0783
Pahang:				
constant	0.1218**	0.1273	0.1244	0.1297
	(2.3467)	(1.6278)	(1.5193)	(1.5811)
revenue	1.9732***	1.1036***	1.0899***	1.0992***
	(23.374)	(13.852)	(14.421)	(13.656)
R^2	0.954	0.947	0.956	0.948
Cointegration tests:				
$DF_{t-statistic}$	-2.9035***			
$L_{c-statistic}$		0.1582	0.0257	0.1229

Notes: Asterisks ***, ** and * denote statistically significant at the 1%, 5% and 10% level, respectively. The two-step cointegration test ($DF_{t-statistic}$) with null hypothesis of non-cointegration; while the Hansen cointegration test ($L_{c-statistic}$) with null hypothesis of cointegration. Prewhitening lag 1 was used for FMOLS and CCR; while for DOLS, lead equals 1, and lag equals 1.

Table 4: Results on long-run models (continue)

States/Independent variables	OLS-robust	FMOLS	DOLS	CCR
Penang:				
constant	0.2160***	0.2017***	0.2278***	0.2027***
	(4.5793)	(3.2756)	(4.7728)	(3.3201)
revenue	0.7502***	0.6859**	0.8149***	0.6937***
	(5.1818)	(2.5455)	(3.6522)	(2.6938)
R^2	0.570	0.533	0.612	0.534
Cointegration tests:				
$DF_{t-statistic}$	-2.2836**			
$L_{c-statistic}$		0.2168	0.0305	0.1421
Perak:				
constant	0.6332***	0.5533***	0.3782***	0.4584***
	(7.7897)	(7.3071)	(3.3129)	(4.2145)
revenue	0.4321***	0.5657***	0.8662***	0.7287***
	(3.9318)	(4.6330)	(4.4208)	(4.0148)
R^2	0.413	0.351	0.535	0.190
Cointegration tests:				
$DF_{t-statistic}$	-4.2245***			
$L_{c-statistic}$		0.3620	0.0743	0.2100
Perlis:				
constant	0.8946***	0.5674***	0.5169***	0.6153***
	(6.9332)	(3.6307)	(4.8466)	(4.1983)
revenue	0.6416***	0.9365***	0.9837***	0.8864***
	(6.0124)	(6.8178)	(10.387)	(7.0975)
R^2	0.623	0.652	0.830	0.659
Cointegration tests:				
$DF_{t-statistic}$	-5.0747***			
$L_{c-statistic}$		0.0761	0.0572	0.0850

Notes: Asterisks ***, ** and * denote statistically significant at the 1%, 5% and 10% level, respectively. The two-step cointegration test ($DF_{t-statistic}$) with null hypothesis of non-cointegration; while the Hansen cointegration test ($L_{c-statistic}$) with null hypothesis of cointegration. Prewhitening lag 1 was used for FMOLS and CCR; while for DOLS, lead equals 1, and lag equals 1.

Table 4: Results on long-run models (continue)

States/Independent variables	OLS-robust	FMOLS	DOLS	CCR
Sabah:				
constant	0.0717	-0.0488	-0.0472	-0.0519
	(0.5956)	(-0.4560)	(-0.4125)	(-0.4848)
revenue	1.1210***	1.1866***	1.1777***	1.1876***
	(14.785)	(18.439)	(16.694)	(18.702)
R^2	0.899	0.874	0.957	0.874
Cointegration tests:				
$DF_{t-statistic}$	-5.9550***			
$L_{c-statistic}$		0.1327	0.0316	0.1232
Sarawak:				
constant	-0.8187	-1.4852	-2.2995***	-1.2406
	(-0.9788)	(-0.8991)	(-3.2448)	(-1.3071)
revenue	1.3946***	1.5451***	1.8942***	1.4547***
	(4.8418)	(2.5469)	(7.2315)	(4.2297)
R^2	0.609	0.319	0.867	0.318
Cointegration tests:				
$DF_{t-statistic}$	-1.8306*			
$L_{c-statistic}$		0.1220	0.0286	0.0479
Selangor:				
constant	0.4050***	0.2920***	0.3360***	0.2913***
	(6.7847)	(3.6247)	(6.4218)	(3.6541)
revenue	0.6878***	0.7133***	0.6180***	0.7144***
	(4.3368)	(4.3098)	(5.7551)	(4.8961)
R^2	0.682	0.549	0.761	0.548
Cointegration tests:				
$DF_{t-statistic}$	-2.4068***			
$L_{c-statistic}$		0.0996	0.0358	0.1112

Notes: Asterisks ***, ** and * denote statistically significant at the 1%, 5% and 10% level, respectively. The two-step cointegration test ($DF_{t-statistic}$) with null hypothesis of non-cointegration; while the Hansen cointegration test ($L_{c-statistic}$) with null hypothesis of cointegration. Prewhitening lag 1 was used for FMOLS and CCR; while for DOLS, lead equals 1, and lag equals 1.

Table 4: Results on long-run models (continue)

States/Independent variables	OLS-robust	FMOLS	DOLS	CCR
Terengganu:				
constant	1.3444***	1.4510***	1.3180***	1.4381***
	(5.3201)	(3.6437)	(6.8041)	(3.8654)
revenue	0.3150*	0.2449	0.3607*	0.2583
	(1.9093)	(0.6763)	(2.0003)	(0.7809)
R^2	0.206	0.188	0.368	0.193
Cointegration tests:				
$DF_{t-statistic}$	-2.4461**			
$L_{c-statistic}$		0.1787	0.0296	0.1305

Notes: Asterisks ***, ** and * denote statistically significant at the 1%, 5% and 10% level, respectively. The two-step cointegration test ($DF_{t-statistic}$) with null hypothesis of non-cointegration; while the Hansen cointegration test ($L_{c-statistic}$) with null hypothesis of cointegration. Prewhitening lag 1 was used for FMOLS and CCR; while for DOLS, lead equals 1, and lag equals 1.

Table 5: Results on long-run models with Robust regressions

Independent variables	Johor	Kedah	Kelantan	Melaka	Negeri Sembilan
constant	-0.2862***	0.7714***	0.6615***	0.3399***	0.2624***
	(-2.5533)	(19.294)	(3.5933)	(5.3597)	(4.7958)
revenue	1.5760***	0.6442***	0.7039***	1.0815***	0.8635***
	(9.0383)	(7.9967)	(3.9732)	(10.894)	(10.999)
R^2	0.687	0.548	0.292	0.682	0.734
	Pahang	Penang	Perak	Perlis	Sabah
constant	0.1287***	0.2090***	0.6332***	0.8728***	0.0548
	(2.6468)	(6.5267)	(7.7897)	(7.2409)	(0.4596)
revenue	1.0738***	0.7635***	0.4321***	0.6498***	1.1384***
	(22.183)	(5.6692)	(3.9318)	(6.4906)	(16.162)
R^2	0.744	0.520	0.413	0.564	0.672
	Sarawak	Selangor	Terengganu		
constant	-0.9131	0.4030***	1.6246***		
	(-1.4722)	(7.9552)	(14.771)		
revenue	1.4306***	0.7019***	0.1449***		
	(6.3384)	(7.2291)	(1.4291)		
R^2	0.584	0.603	0.043		

Notes: Asterisk *** denotes statistically significant at the 1% level. Figures in brackets are z-statistics.

Table 6: Results of Granger long-run causality

Dependent variable	Johor	Kedah	Kelantan	Melaka	Negeri Sembilan
Expenditure	ARDL(1,1)	ARDL(4,4)	ARDL(1,0)	ARDL(4,1)	ARDL(1,4)
λ_1, ECM_{t-1}	-0.1465**	-1.4661***	-0.4209***	-0.3415**	-0.4527***
	(-2.0744)	(-4.1335)	(-3.8097)	(-2.6758)	(-3.8525)
Revenue:	ARDL(1,1)	ARDL(4,1)	ARDL(3,1)	ARDL(2,4)	ARDL(1,1)
λ_2, ECM_{t-1}	-0.3453***	-0.5200***	-0.3782*	-0.3876**	-0.3161**
	(-3.9542)	(-4.7760)	(-1.7612)	(-2.1613)	(-2.1958)
	Pahang	Penang	Perak	Perlis	Sabah
Expenditure	ARDL(2,2)	ARDL(1,1)	ARDL(1,3)	ARDL(3,4)	ARDL(1,0)
λ_1, ECM_{t-1}	-0.4014***	-0.3339**	-1.0360***	-1.5597***	-0.4779***
	(-3.0980)	(-2.2535)	(-5.0231)	(-4.9871)	(-6.1022)
Revenue	ARDL(1,0)	ARDL(2,4)	ARDL(2,0)	ARDL(1,0)	RDL(1.0)
λ_2, ECM_{t-1}	-0.7022***	-0.2544***	-1.5618***	-0.8923***	-1.0955***
	(-6.8427)	(-3.6900)	(-7.1206)	(-6.1585)	(-8.2171)
	Sarawak	Selangor	Terengganu		
Expenditure	ARDL(4.0)	ARDL(1,0)	ARDL(2,0)		
λ_1, ECM_{t-1}	-0.2085**	-0.3298***	-0.3028***		
	(-2.3312)	(-4.3825)	(-3.3426)		
Revenue	ARDL(1,0)	ARDL(1,4)	ARDL(3,3)		
λ_2, ECM_{t-1}	-0.2145***	-0.1983***	-0.0286***		
	(-2.7066)	(-3.0264)	(-3.6899)		

Notes: Asterisks ***, ** and * denote statistically significant at the 1%, 5% and 10% level, respectively. Figures in brackets are t-statistics.

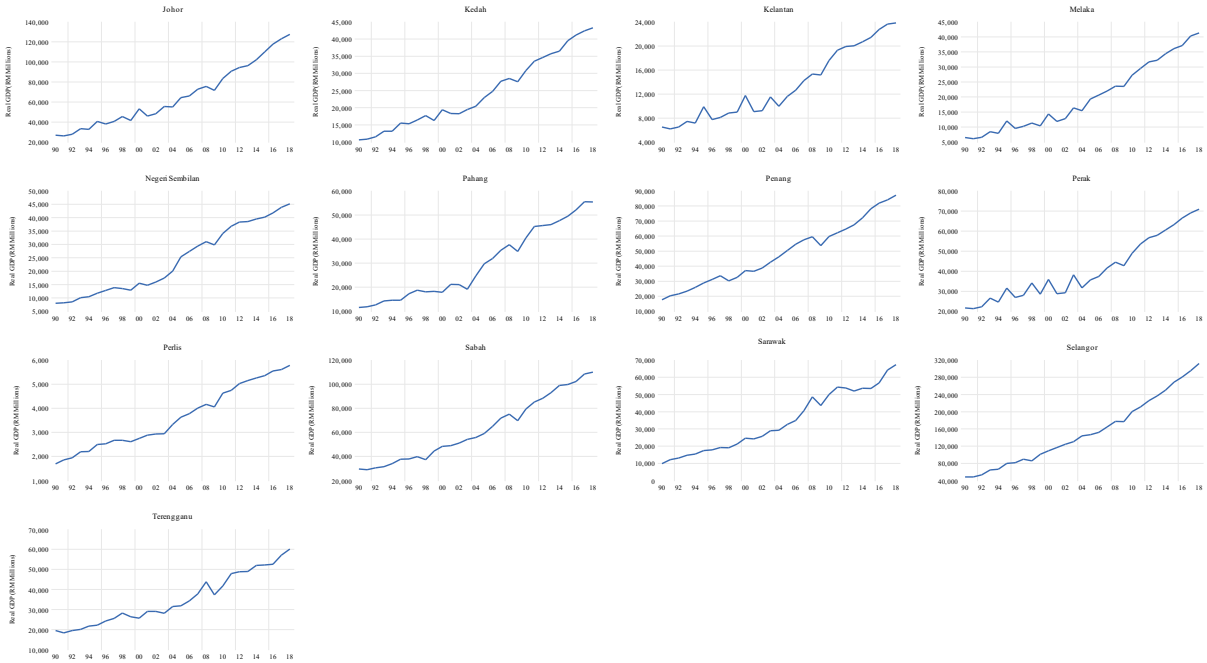

Figure 1: Trend in states' Real GDP, 1990-2018

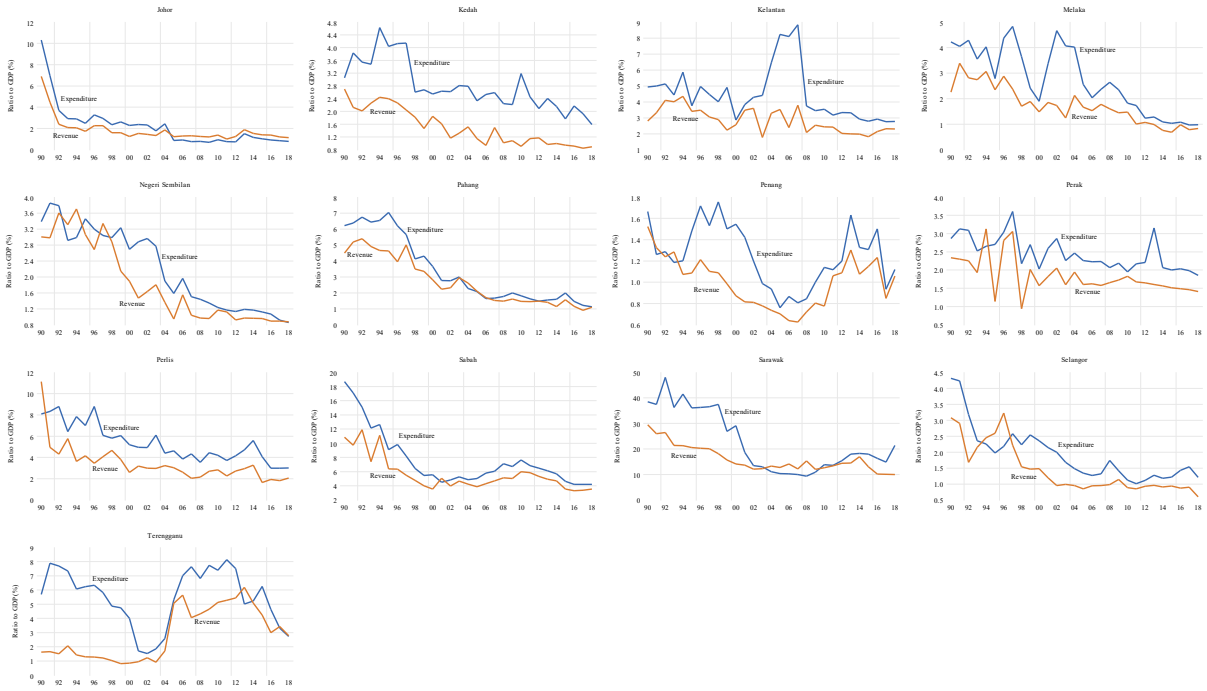

Figure 2: Trends in ratio of states' total tax revenue and expenditure to state's GDP, 1990-2018

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