Is the Thai Government Revenue-Spending Nexus Asymmetric?

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Abstract

This paper examines the relationship between government revenue and spending in Thailand using a nonlinear framework. Both TAR and MTAR models are estimated. The empirical results from the estimate of the TAR model show the presence of asymmetry in the long-run relationship between revenue and spending. The results of short-run dynamics indicate that both revenue and spending respond to budgetary disequilibrium when there is improving government budget. Furthermore, bidirectional causality is found. The evidence appears to support the fiscal synchronization hypothesis with asymmetric adjustment towards the long-run equilibrium. This finding implies that policymakers should cut deficits when they exceed the threshold level.

Keywords: Government revenue and expenditures, TAR, MTAR, synchronization hypothesis
JEL *Classification*: C32, E62

1. Introduction

It is well-recognized in the literature that budget deficits can be sustainable in the long-run for some countries, especially the US. Even though budget deficits can be expansionary, they are related to political support by the public. Previous studies employ linear cointegration tests to investigate the relationship between government revenue and expenditures (e.g. Hakkio and Rush, 1991, and Quintos, 1995).[1] However, the government budget deficit can be sustainable in the long run and policymakers will try to reduce the deficit when it reaches a certain threshold level (Arestis et al. 2004: Cipolini et al. 2009, among others). Payne and Saunoris (2010) estimate an asymmetric error correction model for the UK and find asymmetric adjustment toward long-run equilibrium. Their finding lends support for the spend-and-tax hypothesis. Paleologou (2013) examines the revenue-expenditure nexus in Sweden, Germany and Greece and finds that asymmetric adjustment towards the long-run equilibrium is found for Greece only. Athanesenas et al. (2014) re-examines the revenue-expenditure relationship for Greece. They find evidence of asymmetric interactions between the two variables in both the long- and short-run time horizon. Their evidence supports the synchronization hypothesis while the evidence found by Paleologou (2013) supports the spend-and-tax hypothesis for Greece. Tiwari and Mutascu (2016) examine the relationship between government revenue and spending in Romania using threshold regression. They find the existence of nonlinear and asymmetric adjustment to the long-run equilibrium. Their results also support the spend-and-tax hypothesis. Saunoris (2015) examines the dynamics of

[1] See a brief description of the four hypotheses pertaining to the revenue-spending relationship in Paleologou (2013) and Tiwari and Mutascu (2016).

the intertemporal budget constraint in the US states. The overall results lend support to the tax-and-spend hypothesis even though the dynamics differ in some states.

Thailand has been confronted with larger sizes of budgetary disequilibria as a result of the global financial crisis beginning in 2008. Figure 1 shows fluctuations in the Thai government budgets measured by surpluses and deficits as percentage of GDP.

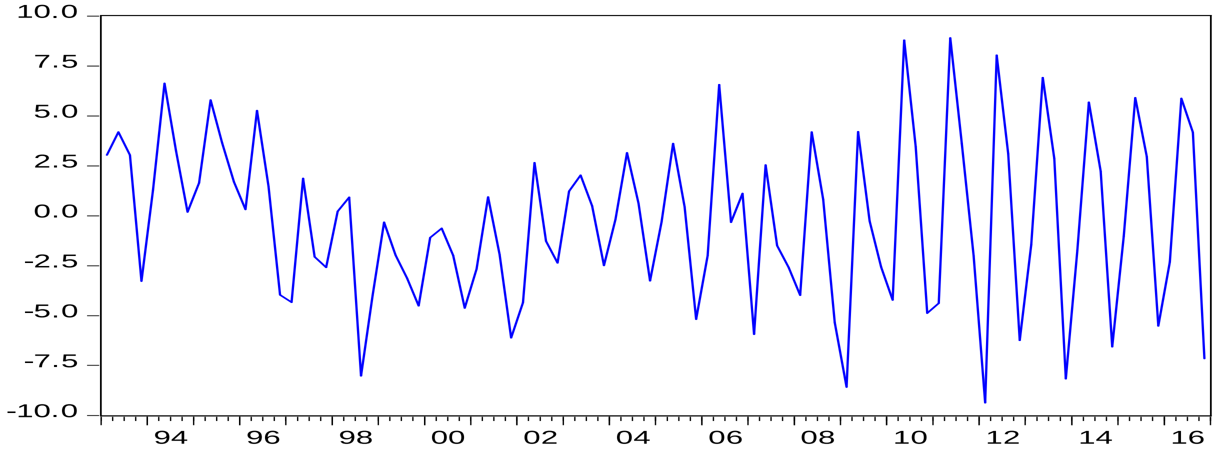

Figure 1. Budgetary Disequilibrium in Thailand, 1993-2016.

The smoother period of fluctuations in the government budgets seems to be few years after the Asian financial crisis in 1997.

The main purpose of this study is to investigate the relationship between government revenue and spending by employing nonlinear cointegration tests using quarterly data during 1993 and 2016. The threshold autoregressive (TAR) and momentum threshold autoregressive (MTAR) models are used to test whether the revenue-spending nexus is nonlinear and asymmetric. This paper is organized as follows. Section 2 explains the data and estimation techniques used in the analysis. Section 3 presents empirical results and the last section concludes.

2. Data and Estimation Techniques

2.1 Data

Quarterly data on general government revenue (R_t), and spending (G_t) are retrieved from the website of the Bank of Thailand. Nominal GDP are obtained from the Office of National Economic and Social Development Board. All series are measured in millions of baht (Thai currency). The government budget as a percentage of GDP is computed as the difference between revenue and spending divided by GDP. The time series data cover the period from 1993 to 2016. The revenue and expenditure series are transformed to the logarithmic series. The time series property is obtained by performing unit root tests.

The Augmented Dickey-Fuller (ADF) tests with optimal lag length determined by Akaike Information Criterion (AIC) are performed to determine the property of time series data used in the analysis. The results of unit root tests are reported in Table 1.

Table 1
Results of Unit Root Tests.

Variable	ADF Statistic (constant)	ADF statistic (constant+trend)
R	-0.656	-1.979
ΔR	-5.007***	-4.978***
G	-1.228	-2.496
ΔG	-17.367***	-17.326***

Note: *** indicates significance at the 1% level.

The results in Table 1 indicate that the revenue and expenditure series are non-stationary in level, but they are stationary in first differences. Therefore, they are integrated of order one, i.e., I(1) series.

2.2 Estimation Techniques

The starting point on the adjustment of revenue and spending toward the long-run equilibrium can be drawn from the studies by Hakkio and Rush (1991) and Cunado et al. (2004). Testing for cointegration between government and expenditure time series can reveal evidence that support the intertemporal budget constraint of the government. An empirical model for a long-run relationship between government revenue and spending using the power functional form is expressed as:

$$GR_t = AGS_t^{\beta}\varepsilon_t \quad (1)$$

where GR_t denotes government revenue, GS_t denotes government spending, ε_t is the error term, A is a constant, and β is the coefficient. By using log transformation of equation (1), the linear equation can be expressed as:

$$R_t = \alpha + \beta G_t + e_t \quad (2)$$

where R_t is the log of government revenue, G_t is the log of government spending, α is the log of A, and e_t is the log of ε_t. By allowing for a shift in the intercept, the long-run equation can be rewritten as:

$$R_t = \alpha + \delta D_t + \beta G_t + e_t \quad (3)$$

where D_t is the dummy variable that captures the impact of September 2008 US subprime crisis, which became the global financial crisis. In this respect, it can be claimed that the crisis will affect the decision of fiscal policymakers. This dummy variable takes the value of 1 at the time the crisis occurred and after the crisis, and 0 otherwise.

The residual-based test for cointegration proposed by Engle and Granger (1987) is used to determine whether there is a linear long-run relationship between government revenue and spending. The residual series obtained from the estimate of equation (3) is used to test the null hypothesis of no cointegration. The test equation is expressed as:

$$\Delta\hat{e}_t = \rho\hat{e}_{t-1} + \sum_{i=1}^{k}\beta_i\Delta\hat{e}_{t-i} + u_t \quad (4)$$

where k is the optimal lag length determined by AIC. The ADF statistic, which is the t-statistic of the coefficient ρ is compared with MacKinnon (1996) critical value. If the ADF statistic is larger than the critical value, the null hypothesis will be rejected. On the contrary, the null hypothesis will be accepted if the ADF statistic is smaller than the critical value.

In case of the absence of linear cointegration between revenue and spending, it is possible that the long-run relationship is nonlinear and asymmetric. Therefore, the threshold autoregressive (TAR) and momentum threshold autoregressive (MTAR) models are utilized. The two models are residual-based tests developed by Enders and Granger (1998) and Enders and Siklos (2001). The residuals from the estimate of equation (3) are decomposed and the test equation is expressed as:

$$\Delta\hat{e}_t = I_t\rho_1\hat{e}_{t-1} + (1-I_t)\rho_2\hat{e}_{t-1} + \sum_{i=1}^{k}\beta_i\Delta\hat{e}_{t-i} + v_t \qquad (5)$$

where $v_t \sim$ iid.$(0,\sigma^2)$ and the lagged augmented term ($\Delta\hat{e}_{t-i}$) can be added to yield uncorrelated residuals of the estimates of equation (5). The Heaviside indicator function for TAR is specified in equation (6) while this function for MTAR is specified in equation (7), which are:

$$I_t = \begin{cases} 1\_if\_\hat{e}_{t-1} \geq \tau \\ 0\_if\_\hat{e}_{t-1} < \tau \end{cases} \qquad (6)$$

and

$$I_t = \begin{cases} 1\_if\_\Delta\hat{e}_{t-1} \geq \tau \\ 0\_if\_\Delta\hat{e}_{t-1} < \tau \end{cases} \qquad (7)$$

where the threshold value τ is endogenously determined by Bai and Perron (1998) tests of 1 to M globally determined thresholds. If the evidence indicates the existence of linear cointegration between revenue and spending, the time series dynamics of the relationship between the two variables can be explored by a bivariate vector autocorrelation mechanism VECM. The VECM can be expressed as:

$$\Delta R_t = \alpha_0 + \sum_{i=1}^{k}\alpha_i\Delta R_{t-i} + \sum_{i=1}^{k}\beta_i\Delta G_t + \lambda_1\hat{e}_{t-1} + v_{1t} \qquad (8)$$

and

$$\Delta G_t = \tilde{\alpha}_0 + \sum_{i=1}^{k}\tilde{\alpha}_i\Delta R_{t-i} + \sum_{i=1}^{k}\tilde{\beta}_i\Delta G_t + \lambda_2\hat{e}_{t-1} + v_{2t} \qquad (9)$$

where k is the lag order, λ_1 and λ_2 are the coefficients showing the speeds of adjustment. The short-run dynamics allow for testing the alternative hypotheses pertaining to the revenue-spending nexus. The coefficients of the lagged differences for government revenue and spending show the short-run dynamics while the coefficients of the asymmetric errors correction terms are the speeds of adjustment toward the long-run equilibrium. Equations (8) and (9) can also be used to test for short-run causality between revenue and spending.

3. Empirical Results

Since the revenue and expenditure series are integrated of order one, the Engle and Granger (1987) residual based test for cointegration, which relies on the ADF test, is performed by taking into account of known structural break (the impact of 2008 global economic crisis. The results of ADF cointegration test are shown in Table 2.

Table 2

Results of the Residual-Based Cointegration Test.

$R_t = 4.696^{***} + 0.306^{***}D_t + 0.617^{***}G_t$
(4.875) (4.067) (7.919)
ADF Statistic = -2.570 (p-value = 0.455)

Note: t-statistic in parenthesis, *** indicates significance at the 1% level, p-value is provided by MacKinnon (1996).

The results in Table 2 show that the possible long-run relationship between government revenue and spending is significantly positive. A 1% increase in government expenditure causes revenue to increase by 0.62%. Furthermore, the impact of the global economic crisis strengthens this relationship. However, the ADF statistic accepts the null hypothesis that the series are not cointegrated.[2] Therefore, it can be concluded that the government revenue and expenditure do not share a long-run stochastic trend.

Since the standard tests of cointegration between series assume that the cointegrating equation is time invariant, the rejection of cointegration might be due to a shift in the cointegrating equation or the relationship might be nonlinear and asymmetric. To overcome this problem, the TAR and MTAR models are estimated. The results are shown in Table 3. The lag of augmented term is 1 (κ =1) for the estimated TAR and MTAR models. The estimates of TAR and MTAR models show that the null hypothesis of no threshold cointegration cannot be rejected at the 1% level of significance.

Table 3

Estimates of the Budgetary Disequilibrium: TAR and MTAR Models.

Parameters	Models	
	TAR	MTAR
ρ_1	-1.378***(-10.369)	-1.825***(-8.250)
ρ_2	-0.679***(-3.659)	-0.947***(-7.285)
Threshold Value	-0.118	0.240
$F_{2,91}$ (ρ_1=ρ_2=0)	55.937***	57.318***
$F_{1,91}$ (ρ_1=ρ_2)	10.957***	12.345***
κ	1	1
AIC	-0.452	-0.465
Q(2)	3.631 (p-value=0.163)	7.499**(p-value= 0.024)
JB	2.417 (0.299)	4.546 (0.103)

Note: t-Statistic in parenthesis. *** and ** indicate significance at the 1% and 5% level, respectively. κ is the number of lag.

Evidence of threshold cointegration in terms of TAR and MTAR is found since the F-statistic of the TAR model for testing the null hypothesis that ρ_1=ρ_2=0 is 55.94 is larger than the critical value of 9.39 at the 1% level of significance while the F-statistic for the MTAR model

[2] The p-value provided by MacKinnon (1996) does not account for deterministic regressors (intercept and dummy variable). Using automatic lag selection, the optimal lag in this test is 4 determined by AIC.

is 57.32 is larger than the critical value of 10.67 at the 1% level of significance.[3] Also, evidence of asymmetry is found by testing the null hypothesis that $\rho_1=\rho_2$ because this hypothesis is rejected by the standard F-tests. The Jarque-Bera statistic (JB) accepts the null hypothesis of normality in the residuals in both models. For the MTAR model, there appears to have serial correlation in the residuals.[4] Therefore, the estimate of TAR model seems to be more reliable. The results from the TAR estimate are used in the analysis of asymmetric VECM. The results from the estimated asymmetric VECM are reported in Table 4.

Table 4
Results from the Estimates of Bivariate Threshold VECM.

Threshold Estimate of the Lagged Error = -0.118				
	Regime 1		Regime 2	
	ΔR_t	ΔG_t	ΔR_t	ΔG_t
Intercept	0.030**	0.002	0.177	0.034*
	(0.017)	(0.018)	(0.022)	(0.020)
$\hat{e}_{t-1}$	-0.897***	0.619***	-0.164	0.363*
	(0.118)	(0.118)	(0.209)	(0.183)
ΔR_{t-1}	0.175*	-0.458***	-0.247**	-0.183**
	(0.099)	(0.099)	(0.105)	(0.092)
ΔG_{t-1}	-0.350***	-0.303***	-0.169	-0.183***
	(0.093)	(0.093)	(0.115)	(0.101)
Adjusted R^2	0.415	0.343	0.046	0.178
F-Statistic	22.955***	17.186***	2.495*	3.969**
	[prob.=0.000]	[prob.=0.000]	[prob.=0.065]	[prob.=0.049]
Q(1)	0.326	1.447	2.495	3.969
	[prob.=0.568]	[prob.=0.229]	[prob.=0.065]	[prob.=0.123]
Observations	62		32	

Note: Standard error in parenthesis. ***, **and *indicates significance at the 1%, 5% and 10%, respectively.

Since $\hat{e}_{t-1} = R_{t-1} - \hat{\alpha} - \hat{\delta}D_t - \hat{\alpha}_1 G_{t-1}$, $\hat{e}_{t-1} > 0$ indicates budget surplus while $\hat{e}_{t-1} < 0$ indicates a budget deficit. The results from the estimated TAR model show that the threshold level of the residuals is -0.118, for which the size of budget deficit appears to be 2.48 trillions of baht. The first regime, which is the normal regime, contains 66% of observations with budget surpluses and deficits when the deficits are equal to and above the threshold value of 2.48 trillions of baht. The second regime with 34% of observations, contains budget deficits less than the threshold value (in minus sign), which indicates that it is the unusual regime with larger sizes of budget deficits. The results in Table 4 show that the coefficient of the error correction term (e_{t-1}) is highly significant in the ΔR_t equation in the first regime. On the contrary, the coefficient of the error correction term ($\hat{e}_{t-1}$) in the ΔR_t equation is insignificant in the second regime. Therefore, it can be concluded that the sizes of budget deficits of larger than 2.48 trillions of baht in absolute value can cause deviations from the long-run equilibrium that cannot be corrected. For the ΔG_t equation in the first regime, government

[3] According to Hansen and Seo (2002), the F-test for TAR and MTAR models has a non-standard distribution due to the presence of nuisance parameters that are only identified by the alternative hypothesis. Therefore, the test critical values must be computed. However, the critical values are obtained from Wane et al. (2004) for two variables with the lag of 1.

[4] By increasing the number of lags, the problem of serial correlation is still present.

spending responds positively to budget surpluses and deficits in absolute value that are larger than the threshold value. By contrast, the coefficient of the error correction term in the ΔG_t equation is not significant at the 5% level. Therefore, government spending does not respond to large budget deficits. In other words, the responses of government revenue and spending are apparent when there is an improving government budget, but these responses disappear when there is a worsening budget deficit. This finding is contrary to the finding by Paleologou (2013) in the case of Greece. Therefore, policymakers should not allow too large budget deficits because they cannot be adjusted to the normal level if political support is important to the government.

The standard causality tests are performed on the estimated bivariate VECM in the first regime. The results are reported in Table 5.

Table 5
Results of Granger Causality tests.

Null Hypothesis	F-Statistic	p-Value
ΔG_t does not cause ΔR_t.	14.118***	0.000
ΔR_t does not cause ΔG_t.	21,201***	0.000

Note: *** indicates significance at the 1% level.

The Wald F-test is performed on the coefficient of ΔG_{t-1} in the ΔR_t equation while the test is performed on the coefficient of ΔR_{t-1} on the ΔG_t equation. The results in Table 5 reveal that the null hypotheses that ΔG_t does not cause ΔR_t and that ΔR_t does not cause ΔG_t are rejected at the 1% level of significance. Therefore, the results confirm the existence of bidirectional causality between revenue and spending. The results confirm that both revenue and spending respond to improving budget. The evidence of bidirectional causality supports the fiscal synchronization hypothesis proposed by Meltzer and Richard (1981) and Musgrave (1966), which postulates that the voters' choice determines the concurrent adjustment in both tax revenue and spending. This finding is in line with the finding by Tiwari and Mutascu (2016) in the case of Romania and Athanasenas et al. (2014) in the case of Greece.

4. Conclusion

This study examines the nexus between government revenue and spending in the case of Thailand during 1993 and 2016. To detect the possibility of asymmetric adjustment toward long-run equilibrium, the TAR and MTAR models are used. The results show that both models exhibit nonlinear cointegration between government revenue and spending because the null hypothesis of no threshold cointegration can be rejected. However, the estimated MTAR model does not pass all diagnostic tests. Therefore, the TAR model is suitable and lends support for the presence of asymmetric adjustment process toward long-run equilibrium. By finding the evidence in favor of nonlinear cointegration between revenue and spending, the time series dynamics of the relationship between the two variables are explored in a bivariate VECM framework. It is found that government revenue and spending respond well to budget surpluses and deficits when the deficits are not larger than the absolute value of the threshold level. On the contrary, the two variables do not respond to budget deficits when the absolute values of the deficits are larger than the threshold level.

The finding in this paper gives some policy implications. Even though budget deficits can be expansionary to the economy, there is an upper limit for policymakers to design appropriate budget to gain political support. The size of budget deficit beyond the threshold can be out of control.

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