Souphanouvong University Journal of Multidisciplinary Research and Development
2026, Vol. 12, No. 02, 144-154
https://doi.org/10.69692/SUJMRD1202144

The Impact of Fiscal Changes on the Economic Growth of the Lao PDR

Chansouk SIRIVONG*, Pheng HER[2] and Mongkhoun VATTHANA[3]
Faculty of Economics and Tourism Souphanouvong University Luangprabang Lao PDR

Correspondence:Chansouk SIRIVONG, Department of Economics, Faculty of Economics and Tourism, Souphanouvong University, Luangprabang Province, Lao PDR*
E-mail:
Chansouksirivong5@gmail.com ,
Tel: *+856-20-856-20-5555 7305*

Article Info:
Submitted: February 09, 2026
Revised: March 20, 2026
Accepted: April 22, 2026

Abstract

This study analyses the impact of fiscal reforms on economic growth in Laos during the period 2001-2024. To examine both the scale and sustainability of fiscal policy, the analysis draws on annual time-series data from the World Bank's world development indicators, focusing on two main fiscal measures: real government expenditure (RGE) and primary balance (PB). The study applies OLS regression to investigate quantitative associations between fiscal variables and GDP growth, complemented with Granger causality tests for determining the causation.

The empirical results reveal that real government spending has a positive but statistically insignificant effect on economic growth and it suggests that 'size does not matter' for growth in the absence of efficient and allocative effectiveness. On the other hand, the primary balance has positive and significant impact, it implied that thriftiness as well as maintaining low leverages are important for long-term growth. Based on Granger causality tests, two-way causality between government spending and economic growth is confirmed in accordance with the Keynesian and Wagnerian views. This implies that in Lao PDR, fiscal policy has been focused more on growth and stabilizing the economy.

The results reveal the need for a more rules-based fiscal framework to bring more stability and effectiveness. Policy recommendations include streamlining spending, raising money the government gets from its own citizens, concentrating on public investments that will pay off in the long-run and ensuring that public finances are managed transparently and accountably.

Keywords: *Fiscal Changes, Government expenditure, Primary balance, economic growth*

1. Introduction

Lao PDR is one of the developing country desirous to further develop the economy. But growth still needs to keep going to lift poor people out of poverty, create jobs and increase living standards. Fiscal policy (government spending, taxes and budget balance) is one of the most significant macroeconomic levers for growth. It is a stabilizer and an accelerator of economic performance. Fiscal reforms have been an important element of economic management in the Lao PDR since the early 2000s. This is because the goal of government policy has been to bring about macroeconomic stability in order to promote long-term development. These changes to the budget have involved changing how the government spends money, changes in the tax system and attempts to maintain a stable budget in the face of shocks from outside and restraints at home (World Bank Group, 2021).

The Lao economy has evolved significantly in the last 20 years, particularly due to resources and investment-based industries, foreign investments and regional integration under countries part of the ASEAN Economic Community as well as ASEAN+1 or ACMECS through China–Laos economic Corridor. From 2001 to 2019, real GDP growth was above 6% per year on average, further develop the economy to Lao PDR is a developing country seeking to accelerate economic development (World Bank, 2023). But this expanding growth trajectory has brought persistent issues with the budget. Government spending has increased rapidly, especially in energy, infrastructure and social services. But the government has not been able to generate enough money to keep pace. Consequently, fiscal deficits are part of the furniture and public debt is up a heck of a lot, to levels that have raised concerns about the long-term health of the economy (International Monetary Fund,

2023).

Laos's economy is in an even more fragile state due to external vulnerabilities as well as internal structural weaknesses. The economy has had significant challenges due to the COVID-19 pandemic, which reduced tax-revenues but increased demand for government assistance (World Bank, 2022; International Monetary Fund, 2023). The Lao kip has depreciated and inflation is increasing, meaning that the real impact of foreign-denominated public debt has grown heavier." This has placed additional strain on the government's fiscal resources (Asian Development Bank, 2023; International Monetary Fund, 2023). As a result, the government has initiated several fiscal reforms to make public financial management more efficient, open and transparent. These are programs to reform the revenue administration and spending in a more rational manner (World Bank, 2023; Ministry of Finance, 2022). Yet despite these continuing efforts, the question of how much fiscal adjustments-particularly actions related to real government spending and the primary balance - have contributed or detracted from the country's growth remains relevant, especially as debt vulnerabilities grow larger and recovery from the pandemic becomes more challenging (International Monetary Fund, 2023; Asian Development Bank, 2023).

The impact of fiscal policy on growth has been theorized over the years. In this view, government spending increases aggregate demand and output, particularly in developing countries that have excess capacity (Keynes, 1936). Meanwhile, neoclassical and endogenous growth theories emphasize that it is how money is spent and taxes are designed which matter in the long-term effects of fiscal policy (Barro, 1990; Romer, 1990). Spending on infrastructure, education and health may improve people's skills and productivity and foster long-term growth. But you can borrow to spend too much, and when you have excessively large budget deficits, you can generate such macroeconomic instability that private investment has to be crowded out and inflation ensues (Easterly & Rebelo, 1993). So, just how fiscally expansionary and irresponsible they want to get to be a real driver for the economy.

Fiscal policy in Lao PDR has alternated between periods of growth and stability. When growth was high and external financing was ample, the government employed expansionary spending in a bid to accelerate development. But that often resulted in larger deficits and increased national debt (World Bank Group, 2024). On the other hand, fiscal contractions designed to restore stability sometimes impeded growth by means of reduced public investment. The implication of this kind of cyclical pattern in government's spending, however, appears to be that the relationship between change in government's spending and economic growth in Laos may be complex, variable and situational. In addition, few empirical studies have attempted to measure this relationship with the aid of current time-series data.

We'll be watching the 1) primary balance and 2) real government spending as the key fiscal indicators that illustrate these changes. Real government spending adjusted for inflation is a measure of how much money the government has left to spend and it translates directly into overall demand and capacity. The primary balance total revenue minus total spending, excluding interest payments is a measure of how stable and sustainable the government's finances are. A positive primary balance is the government showing that it behaves responsibly with its money, and could pay off its debts. However, a chronic structural deficit indicates that the government is in difficulty and must borrow money (Blanchard, 1990). For Lao PDR, the dynamics of these variables demonstrate how challenging it is to calibrate development spending with the goal of keeping the budget in balance.

Considering all these reasons, it is important to empirically analyze the effects of fiscal variables on the economic growth in Lao PDR. International evidence provides useful learnings but given Laos' specific economic structure, its institutional framework and the

degree of external dependence the analysis must be adapted to these considerations. Laos is particularly vulnerable to financial shock because its resources are finite, it has a small tax base and it owes billions to other countries. The government's commitment to achieving the Sustainable Development Goals (SDGs) by 2030 is another illustration of how crucial it is for fiscal policies to be evidence-based and find the right balance point between growth stimulation and debt sustainability.

This paper is motivated by the lack of understanding about how fiscal adjustment, especially in terms of its real government spending and primary balance affect growth performance in Laos. Despite all those policy changes, the economy remains volatile, and government is still spending too much. Policy-makers face this balancing act: how to stimulate the finance expansionist fiscal policy while keeping financial stability in place. The weak evidence base makes it difficult to reach conclusions about the best fiscal policies. This makes the investigation of the causal effects of fiscal changes on short- and medium-term economic growth highly relevant from a political perspective.

The present research attempts to fill an important gap in the development literature and policy debate by systematically investigating the impact of fiscal changes on economic growth in Lao PDR, using annual data spanning from 2001 to 2024. The article uses econometric analyses such as OLS and Granger corpus Test to determine whether fiscal changes affect growth significantly, and to review the nature of this relationship being one-way or two-way. It is expected to provide valuable input for policymakers in designing fiscal frameworks that are conducive to sustainable and inclusive growth, contributing to overall fiscal sustainability.

The objective of this paper is to examine the effect of tax changes on economic growth in Lao PDR and we used Granger to test a cause-and-effect relationship.

2. Materials and Methods

2.1 Research Design

This study contributes to the literature by using the quantitative method, which is time-series econometric analysis, to examine the impact of changes in fiscal policies on economic growth in Lao PDR 2001-2024. Third, the quantitative approach allows for empirical calibration of the relation between fiscal variables (Real Government Expenditure, RGE and Primary Balance, PB) and economic growth (GDP). The paper is interested in understanding the sign and size of the Fiscal-Growth link through statistical estimation and causality testing.

2.2 Data Collection

The research relies exclusively on secondary data from world-wide recognised and reliable sources in order to ensure consistency and comparability. We mainly use the World Bank's World Development Indicators (WDI) database (https://data.worldbank.org/indicator). The variables in the dataset are represented as follows (availability is yearly): Economic Growth in 2015 ; Real Government Expenditure (RGE) has been deflated to capture the fiscal efforts of government; and Primary Balance (PB), representing the difference between total revenue and total expenditure, excluding interest payments, which represents government's true independent fiscal position. All amounts are provided in constant figures to be able to compare over times,avoiding inflation's harmful effects.

2.3 Models

To analyze the impact of fiscal changes on growth, the study employs two main econometric models:

1. Ordinary Least Squares (OLS) Regression Model:

$$Growth_t = \beta_0 + \beta_1 LnRGE_t + \beta_2 LnPB_t + \varepsilon_t$$

$Growth_t$: Real economic growth

$LnRGE$: Natural logarithms of real government expenditure

$LnPB_t$: Natural logarithms of primary balance

ε_t: Error terms

This model estimates the direct effect of fiscal changes on GDP growth.

2. Granger Causality Test

To determine the direction of causality, the study applies the Granger causality test using the following formulation:

$$Growth_t = \sum_{i=1}^{n} \alpha_i \, Growth_{t-i} + \sum_{i=1}^{n} \beta_i \, LnRGE_{t-i} + \sum_{i=1}^{n} \gamma_i \, LnPB_{t-i} + \mu_t$$

and conversely:

$$LnRGE_t = \sum_{i=1}^{n} \emptyset_i \, LnRGE_{t-i} + \sum_{i=1}^{n} \theta_i \, Growth_{t-i} + \eta_t$$

This analysis tests whether fiscal changes Granger-cause economic growth or vice versa, thereby distinguishing proactive from reactive fiscal policy behavior.

Hypothesis:

H_1: Fiscal changes (RGE and PB) have a statistically significant impact on economic growth in the Lao PDR.

H_2: There exists a causal relationship between fiscal changes and economic growth in the Lao PDR.

2.4 Process

The following steps guide the analytical process:

1) Data Transformation: Convert nominal variables into real terms using GDP deflator (base year 2015).
2) Stationarity Testing: Employ Augmented Dickey-Fuller (ADF) tests to ensure variables are stationary and avoid spurious regressions.
3) Model Estimation: Use OLS regression to estimate the relationship between fiscal changes variables and economic growth.
4) Diagnostic Tests: Conduct residual diagnostics (autocorrelation, heteroscedasticity, and normality) to validate model robustness.
5) Causality Analysis: Apply Granger causality tests to examine the direction of influence between fiscal changes and economic growth.

3. Results

The results of the ADF unit root tests (Table 1) indicate that the test statistics at level for $Growth_t$ and $LnRGE_t$ are both greater than the 5% critical value, but their p-values (0.6226 and 0.7049 respectively) reveal no statistical significance. This indicates that these two variables are not stationary in levels, and therefore shocks to these series may have a permanent component. Nevertheless, LnPB yields the ADF statistic of-3.142; lower than the 5% critical value, and statistically significant at the level of 5%. In other words, LnPB is mean revertible, that means It will go back to its average over time. Once we take first differences, we see that all of the variables this are stationary. The first column shows that D.Growth and D.LnPB of the differenced series have ADF statics that are significantly less than 1% critical value, which indicate they are very stationary. Similarly, D.LnRGE test statistic has value of -2.610 and it is slightly less than its critical values of 10%. This indicates that it is not very robust at the 10% significance level.

In TABLE 2 (correlation matrix) it can be observed that Growth and LnPB exhibit moderate and positive correlation among them, r(Growth,LnPB)=0.6575. This suggests a strong relationship between positive primary balances and economic growth, which might be explained by more efficient use of borrowed money. On the other hand, Growth and LnRGE are not closely related (r = -0.0014), which suggests government spending shocks have relatively small impact on output growth directly with some potential inefficiency in fiscal policies implementation or lagged budget allocation. The small negative magnitude of correlation (r = -0.0709) between LnRGE and LnPB further indicates that government spending and fiscal balance hardly affect each other at all. Taken together, it looks as if primary balance is positively associated with growth but that government spending does not have much impact either on growth or borrowing. This may indicate that there are problems in

terms of the transmission of fiscal policy, and more econometric work is therefore required.

The empirical analysis results:

$$\widehat{Growth}_t = -0.6891 + 0.1679LnRGE_t + 0.8773LnPB_t$$

$$t: \quad (-0.14)^{ns} \quad (0.28)^{ns} \quad (4.02)^{***}$$

N=24, R^2=0.4343, F= 8.06, Prob= 0.0025, Root MSE=1.6535

Taken as a whole, the result is statistically significant with F-statistic of 8.06 and a corresponding *p*-value of 0.0025, indicates that the explanatory variables explain a considerable amount of variation in economic growth at 1%. The R^2 of the model is 0.4343, which suggests that government spending as well as primary balance explain around 43.4% of economic growth variation. The R^2 criterion is 0.3805, reflecting the limited number of observations on which to base this evaluation. Focusing on the individual coefficients, LnPB has a positive and very significant impact on economic growth with a coefficient of 0.8773. This means that if the primary balance rises by 1%, the economy will grow by about 0.88%, everything else being equal. It is observed that LnPB is highly significant suggesting the fact that the primary balance is important to finance productive investment and growth promoting fiscal operations in the economy. Neutral is the coefficient of LnRGE, which takes a positive value (0.1679), albeit not significant. This implies that recent government spending does not have a strong short-run growth impact in this sample. Meaning, perhaps, that money isn't being spent well or too much is being spent on things that don't help the economy, or there's a lag between when government policy spends money and when it has an effect on the economy. Also, the constant term is also not statistically significant which implies that there is no bias in model's predictions. The regression findings illustrate that primary balance is a significant determinant of growth during our sample period. But government spending alone does not produce a detectable effect. It's a lesson in the importance of prudent fiscal management and making efficient use of borrowed funds for long-term economic growth.

Durbin's alternative test for autocorrelation (Table 3) results in a chi-square of 3.207. There is not enough evidence to reject the null hypothesis that there is no autocorrelation given its p-value (larger than 0.05). But the evidence on first-order autocorrelation is weak at 10% level. Overall, it appears that the model residuals are mostly free of serial dependence, although we also have some hint of smaller autocorrelations. To minimize possible bias, it is best to use Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors. The Breusch Godfrey LM Chi-square statistic= (3.316, df = 1) (Table 4) indicates that the null hypothesis of no serial correlation cannot be rejected at the 5% level significance; however, there is some weak evidence first order autocorrelation to be present at the 10% level). This implies that there are essentially no omitted dynamics behind what would cause the model to be mis-specified. For increased robustness, we can also rely on Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors (Newey & West, 1987).

OLS robust by Newey and West (1987):

$$\widehat{Growth}_t = -0.6891 + 0.1679LnRGE_t + 0.8773LnPB_t$$

$$t: \quad (-0.14)^{ns} \quad (0.28)^{ns} \quad (4.02)^{***}$$

$$N = 24, \; R^2 = 0.4343, \; F = 4.19, \; Prob = 0.0295$$

The regression results are corrected by Newey-West (1987) HAC standard errors that allow for possible serial correlation and heteroskedasticity, ensuring robust inference. The model shows that from 24 observations with one lag the F-statistic is 4.19, indicating the explanatory variables are statistically significant at 5%. Primary balance (LnPB) remains positive and significant (β = 0.8773), indicating that a 1% increase in primary balance increases growth by 0.88%. This demonstrates that its large positive impact remains unchanged even if serial dependence is accounted for. In contrast, as for the real government expenditures (Ln RGE) it is positive but not significant (β = 0.1679) and so it does not have an effect on growth in short- run. This may be due to waste

in the government's finances or the influence of investments that take a long time to emerge. The intercept is not statistically significant, indicating no systematic bias. What we see when the HAC correction is applied: primary balance accounts for growth, and government spending has almost no short-term impact.

Because increases in real government spending don't consistently produce or make it clear that they can lead to growth, this might suggest that the government is not getting good value-for-money for its spending; that much of what it spends is not productive (i.e., under a waste-not-want-not account); or, alternatively, if there are lags between government-spending actions and when their effects work their way through the real economy. Therefore, the author addressed this concern by adding a lagged term of real government expenditure and the primary balance variable to the model in order to obtain results as follows:

$$\widehat{Growth}_t = 1.9141 + 4.6564LnRGE_t - 4.7795LnRGE_{t-1} + 0.3827LnPB_t + 0.4150LnPB_{t-1}$$

$$t: \ (0.50)^{ns} \quad (2.79)^{**} \quad (-2.61)^{**} \quad (1.43)^{ns} \quad (2.12)^{**}$$

$$N = 23, \ R^2 = 0.6336, \quad F = 9.32, \quad Prob = 0.0003, Root\ MSE = 1.4357$$

The model adequately fits the data, with F-statistic of 9.32 and p-value =.0003. It accounts for approximately 63% of the variation in real GDP growth (R^2 = 0.6336). The coefficient on LnRGE is 4.66 and significant at the level of 5%, i.e., a 1% increase in real government spending is associated with an increase in economic growth by 4.66% during the same period under consideration. A further characteristic of the lagged impact of LnRGE is negative and significant (-4.78), suggesting that high government spending in the previous period hinders growth in current period, perhaps because of crowding-out effects or presence of persistent short-run inefficient use of the expenditure. The contemporaneous coefficient for the primary balance (LnPB) is positive but not significant statistically (0.38), which also indicates that it has a weak short-term effect on growth. The lagged primary balance (L1. LnPB) is positive and strongly statistically significant (0.42) at the 5% level. What this means is that fiscal surpluses, or from the previous period the primary balance of public finances improving itself, help the economy to grow today. The coefficient of the constant term (1.91) is positive but not statistically significant: this means that growth isn't statistically different from zero if government spending or primary balance does not change. The results indicate that there are effects of both present and past fiscal policy on growth. Short-term government spending stimulates growth, but long-ago spending slows it down. Fiscal balances, in contrast, have a delayed positive influence.

The Granger causality Wald test (Table 5) indicates that strong causalities exist between the economic growth (Growth), the real government spending (LnRGE,), and primary balance (LnPB). LnRGE Granger-causes Growth significantly (Chi2= 6.428) when Growth is dependent, but LnPB does not. By contrast, when LnRGE is taken as a dependent variable, Growth exerts a significant Granger-cause impact on government spending (Chi2= 34.893), which corroborates the Wagnerian view. In contrast, LnPB has a weak effect. When LnPB is the endogenous variable, Growth and LnRGE are highly causative, indicating that as both economy and government get bigger people want to borrow more money. Overall evidence is consistent with an asymmetrical relationship between government spending and growth, one also-sided between the primary balance and each fiscal variable. This indicates that the economy is in a dynamic fiscal-growth feedback mechanism.

Table 6 presents the results of Lagrange Multiplier (LM) test in which, when it is lag 1, Chi2 is found to be 8.7015 and df = 9. This indicated that the null hypothesis could not be rejected which meant that no first order autocorrelation existed. At lag 2, Chi2= 16.1097 i.e not a lot of evidence for lag-2 autocorrelation. The patterns of the RR can be read as residuals are generally un-correlated but there are remains of some

residual dependence at high lag. In particular, all the Eigenvalues for Table 7 are far less than unity. The highest modulus is 0.938, 0.612, 0.232 and finally: 0.0099. The stability requirement is satisfied by this model as none of these values exceed one. This implies that the system that we found is stable and does not evolve over time. Namely, the dynamic properties of these relationships appear to be governed by convergence forces following a shock emanating from economic growth, real government spending or primary balance.

4. Discussion

Regression and robustness tests reveal that the effect of fiscal factors on growth is heterogeneous in the context of Lao PDR. OLS estimates reveal that real government expenditure (LnRGE) has a positive though insignificant impact, implying a fettered short-term influence on growth. On the contrary, the one-lag of PB (LnPB) has a positive and significant effect. That is, it's been activities that are funded with borrowed money that have influenced economic growth to a greater extent. These findings emerge with full force even after adjusting for heteroskedasticity and autocorrelation using standard errors. Meanwhile, that LnRGE is not significant suggests inefficiencies in the composition of expenditure such as there is a high share of budget being spend on current expenditures rather than spending to make Laos more productive. This is coherent with what we know regarding the size of fiscal multipliers in developing countries, which are generally low (Ilzetzki et al., 2013), at least partially due to these countries' high import content and institutional impediments. Meanwhile, the positive significant impact of LnPB confirms that borrowing for infrastructure and capital formation driven projects such as hydropower development and transportation has played a critical role in Lao PDR's growth strategy, consistent with the endogenous growth model by Barro (1990). However, the escalating public debt levels projected to exceed 70% of GDP by 2022 (International Monetary Fund, 2023). Debt-financed investment has supported growth, but excessive borrowing without altering how the government raises revenue could make the economy riskier. Stability tests indicate that the model is dynamically stable, so that fiscal surprises revert to their mean and long-run equilibrium is preserved. The policy implications are plain: Laos should concentrate on investments that aren't wasteful and produce high returns, and it should shift money from activities that do not create value to those that do. To continue growth, fiscal governance needs to be strengthened and there should be better project evaluation and debt control. Chanmavong et al. (2020) found that the long-term impact of fiscal and monetary policies was complementary to the economic growth of Lao PDR through government expenditure, customs- taxation, determination of money supply in the economic system and exchange rate. Fiscal and monetary policies through taxation and exchange rate could also have an impact on the economic growth of the Lao PDR.

To conclude, there are two points concerning Laos's fiscal policy: first, general spending has had little short-run effect and second, investment financed through borrowing continues to drive growth. The extent of fiscal prudence would be crucial for the sustainability of development. That is, you ought to borrow for investments that will raise productivity and make the economy more durable in the long run.

The Granger causality findings offer important perspectives on the direction of growth interactions. There was evidence of a unilateral granger causality running from real government expenditure (LnRGE) to economic growth thereby indicating that lagged changes in government spending were statistically significant determinant of GDP growth. This lends credence to the Keynesian notion that fiscal policy can be utilized in order to spur output, particularly in cases where resources are underemployed. In contrast, the primary balance (LnPB) did not Granger-cause growth. This is a way of saying that borrowing can facilitate growth by building capital, but it cannot simply ordain growth immediately. The

study also finds significant two-way relationship between government spending and economic growth, consistent with Wagnerian hypothesis. That's because when the economy is growing, people demand more infrastructure, welfare and services so that government ends up spending more money (it's Wagner's Law). Similar results are reported by Arestis & Sawyer (2003) who emphasize that economic and fiscal expansion are mutually reinforcing in developing countries. Further, Granger-causality ran from economic growth and government spending to the primary balance an indicator of how fiscal expansion and debt dynamics are intertwined. This two-way relationship demonstrates that fiscal stimulus can support growth, but it also brings the potential to make borrowing needs larger, and to be beneficial fiscal vulnerabilities worse if not managed properly. As such, maintaining a sustainable primary balance is important for permanence (International Monetary Fund, 2023; Nganga et al., 2019).

The results on causality indicate that the fiscal policy conduct in Laos has been predominantly pro-growth, but also responsive. Fiscal spending is expansionary will always be fueling growth, but fiscal changes often respond to economic cycles rather than leading them. We need right now a more rules-based fiscal framework with clear budget processes and credible debt limits, because this is the kind of behavior that demonstrates how important it is. This will ensure that fiscal expansion contributes to development objectives in a sustainable manner (Asian Development Bank, 2023; Ministry of Finance, 2022).

5. Conclusion

We examined the impact of fiscal changes on economic growth in Lao PDR from 2001 to 2024 with a focus on real government expenditure and primary balance as the two major fiscal variables. The results of the empirical analysis show that the real government expenditure has a positive, but statistically insignificant effect on economic growth while that of primary balance is both significant and positive. This result shows that, for sustainable economic growth, the fiscal discipline and skillful debt management are more important than only the scale of public expenditure.

The causality test shows one way causation from government spending to economic growth, which confirms the Keynesian's claim that fiscal policy can stimulate output in the short run. Meanwhile, the existence of bidirectional causality relationship between economic growth and expenditure confirms Wagner's Law that postulates a direct effect running from GDP growth to public expenditure for Laos. These interactions reveal a circular nature of the relationship between fiscal policy and growth as it gets feedback from economic performance.

The bottom line is that the results demonstrate how essential quality fiscal policy is relative to quantity. The Lao government can help ensure long-term stability and promote inclusive development by concentrating on improving the efficiency of public spending, broadening its revenue base and establishing a rules-based fiscal framework grounded in transparency and accountability. While these reforms should be pursued, the focus of further fiscal reform efforts need to include: reallocation of funds from current expenditures to productive spending; improvements in project assessment procedures and prudent debt management aimed at safeguarding macro stability.

Future studies should extend this analysis by incorporating additional fiscal and institutional variables, employing more advanced econometric techniques such as vector error correction model (VECM) or dynamic panel data approaches. These analyses will contribute to a more comprehensive understanding of the nature of the interplays between fiscal policy, institutional quality and long-term growth dynamics in Lao PDR.

6. Conflict of Interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Table 1: Unitroot test

H_0: has unit root		H_1: stationary		
Before 1st differences				
	Interpolated Dickey-Fuller			
Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	MacKinnon (Sig. Level)

$Growth_t$	-1.314	-3.750	-3.000	-2.630	0.6226[ns]
$LnRGE_t$	-1.125	-3.750	-3.000	-2.630	0.7049[ns]
$LnPB_t$	-3.142	-3.750	-3.000	-2.630	0.0236**
			After 1st differences		
$D.Growth_t$	-5.201	-3.750	-3.000	-2.630	0.0000***
$D.LnRGE_t$	-2.610	-3.750	-3.000	-2.630	0.0910*
$D.LnPB_t$	-8.425	-3.750	-3.000	-2.630	0.0000***

Note: ***,**,* Statistical significance levels of 0.01, 0.05 and 0.1 respectively.

[ns] non-significance

Table 2: Multicollinearity test

	Growth	LnRGE	LnPB
Growth	1		
LnRGE	-0.0014	1	
LnPB	0.6575	-0.0709	1

Table 3: Durbin's alternative test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	3.207	1	0.0733*
	H0: no serial correlation		

Note: ***,**,* Statistical significance levels of 0.01, 0.05 and 0.1 respectively.

Table 4: Breusch–Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	3.316	1	0.0686*
	H0: no serial correlation		

Note: ***,**,* Statistical significance levels of 0.01, 0.05 and 0.1 respectively.

Table 5: Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
Growth	LnRGE	6.428	2	0.040**
Growth	LnPB	0.29223	2	0.864[ns]
Growth	ALL	6.5794	4	0.160[ns]
LnRGE	Growth	34.893	2	0.000***
LnRGE	LnPB	3.4693	2	0.176[ns]
LnRGE	ALL	41.788	4	0.000***
LnPB	Growth	86.713	2	0.000***
LnPB	LnRGE	31.592	2	0.000***
LnPB	ALL	109.43	4	0.000***

Note: ***,**,* Statistical significance levels of 0.01, 0.05 and 0.1 respectively.

[ns] non-significance

Table 6: Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	8.7015	9	0.46527[ns]
2	16.1097	9	0.06463*

H_0: no autocorrelation at lag order

Note: ***,**,* Statistical significance levels of 0.01, 0.05 and 0.1 respectively.

[ns] non-significance

Table 7: Eigenvalue stability condition

Eigenvalue	Modulus
0.9074214 + 0.2376321i	0.938021
0.9074214 - 0.2376321i	0.938021
-0.2875992 + 0.539753i	0.611593
-0.2875992 - 0.539753i	0.611593
-0.2319301	0.23193
0.00991895	0.009919