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The Dynamic Impact of Economic Growth, Foreign Direct Investment and Infrastructure in Laos

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Abstract **Original Research Article**

This study examines the dynamic impacts of economic growth, foreign direct investment, and some infrastructure variables in Laos with the time series data from 1995-2020, which have used the Generalized Method of Moments (GMM) and Autoregressive Distributed Lag (ARDL) model approach. The unit root test to check the stationarity of all variables in this study using the Augment Dicky Fuller (ADF) test with considering both level and at first difference. The empirical results of GMM found that the FDI is a major catalyst for economic growth in Laos which has a positive impact and is statistically significant at the level. Similarly, the role of infrastructure variables such as agriculture, industry, and service is the main of the most important indicators in supporting the economic growth in Laos, while telecommunication, electricity, air transport, and trade are positive but insignificant at the level. However, this study also found some variables such as labor, population growth, and life expectancy in support of economic growth which have a strongly positive and significant impact at the level, but the human capital is insignificant at the level. We, therefore, recommend that the government of Laos should attract and sustain more foreign direct investment and increase the infrastructural development to achieve the target of sustainable economic growth in the near future.

Keywords: FDI, Infrastructure, Economic growth, GMM, ARDL, Laos PDR.

1. INTRODUCTION

Foreign direct investment (FDI) plays a very important role in infrastructure development and the country's economic growth, especially in the group of developing countries and least developed countries such as Lao PDR. FDI plays a determinant of economic growth, new jobs, and the development of labor skills through new technology and innovation we will introduce FDI inflows in the sectors that contribute to the economic growth in Laos as FDI and international trade both play an important role in promoting economic growth of the host countries (Pegkas 2015; Adhikary 2012; Kakar and Khilji 2011; Belloumi 2014; Majumder 2022). The attracting FDI inflows into agricultural infrastructure (Oloyede 2014) explained that FDI has a positive and significant impact on the agriculture sector in the long run. Epaphra and Mwakalasya (2017) examined the impact of FDI inflows on the agriculture sector and economic growth in Tanzania. The empirical results of this study confirm that FDI and real GDP growth both have a positive relationship, but no significant effect of FDI inflows on agriculture value added to GDP. However, FDI inflows into agriculture sectors can promote economic growth in the host countries proved by Mousavian (2021). In particular, FDI can be improved by new technologies, innovations, technical, management, and other systems that benefit developing countries (Nyiwul and Koirala 2022) showed that FDI inflows on value added in agriculture have positive and significant effects in the medium to long term. The industrial infrastructure is an important sector of the country's economic development, growth of production, increasing employment, and new technological innovations in host countries under foreign direct investment were explained by (Akpan and Eweke 2017; Zhao and Zhang 2010; Umer and Alam 2013; Markusen and Venables 1999). The Lao PDR is a developing country and economy's expansion so electricity consumption grows faster through the infrastructure process develops quickly, including an increase in the demand to serve people's consumption. However, FDI inflows on electricity infrastructure are still a key factor in promoting economic growth were showed by (Long, Ngoc, and My 2018; Qazi, Alam, Ahmad, and Ambreen 2021; Atchike, Zhao, and Bao 2020). Many previous empirical studies on the role of infrastructure (transport, ICT, and electricity) in supporting economic growth such as Sahoo and Dash

(2012); Lydon and Williams (2005); Williams (2015), and Masron (2017); Amos and Jidda (2018); Baita (2021); Pereira (2020); Ekeocha (2022).

This chapter analyses the dynamic impacts of economic growth, FDI, and infrastructure in Laos covering the period 1995-2020 by employing the GMM approach to achieve this study. The stationary properties of the time series variables to a unit root test using the Augment Dickey-Fuller (ADF). The ARDL model was used to determine the direction of the causal relationship between variables in this study. The paper is organized into 5 sections 1 section is the introduction; 2 section presents the empirical literature; section 3 is the methodology; section 4 presents empirical results and discussion; the conclusion and recommendation are discussed in section 5.

2. LITERATURE REVIEW

Pegkas (2015) analyzes the causal relationship between the FDI and economic growth and estimates the impact of FDI on economic growth in the Eurozone countries by employing the Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS) methods and panel data over an 11-year period 2002–2012. The empirical results showed that the long-run cointegrating among the variables of FDI stock and economic growth have positive effects and are significant on economic growth in the Eurozone countries.

Adhikary (2012) examines the long-run equilibrium effect of foreign direct investment, trade openness, domestic demand, and exchange rate on the export performance of Bangladesh by using the vector error correction (VEC) model and under the series over the period of 1980–2009. The empirical results can confirm a long-run equilibrium relationship among the variables. Besides, in the short run and long run causal flow was evidenced between FDI and exports. However, this study did not trace any significant association among the variables for the cases of domestic demand, exports, and exchange rate.

Kakar and Khilji (2011) investigated the role of FDI and trade openness relationship to economic growth for Pakistan and Malaysia which covers the time series data from 1980-2010. The empirical results of the Granger causality test for both Pakistan and Malaysia confirmed that trade openness has a positive effect on economic growth in the long run. Similarly, the results show that Pakistan and Malaysia have a unidirectional relationship between FDI, exchange rate, and economic growth.

Belloumi (2014) investigated the dynamic causal relationship between FDI, labor, trade openness, capital stock, and economic growth in Tunisia over the time series period from 1970 to 2008 by using the ARDL approach to cointegration for the long-run relationship among variables. The results of the Granger causality in the short run confirm that there is no significant from economic growth to FDI or FDI to economic growth. In the same case, there is also no significant from economic growth to trade or from trade to economic growth in the short-run on determinants of the Granger causality test.

Majumder (2022) has investigated about impacts of FDI on economic growth in Bangladesh using the Generalized Method of Moments (GMM) model and Auto Regressive Distributed Lag (ARDL). The empirical result of GMM found that the GDP growth and FDI both have a strongly positive and statistically significant impact relationship in accelerating export processing zones. If the FDI and economic growth increase by 1 percent, the export of production in export processing zones increases by 0.74 and 2.54 percent respectively. However, some variables as gross capital formation, telephone subscription, electricity, and gas consumption are positive and significant at the level of export processing zones.

Oloyede (2014) has investigated the effects of FDI on the agricultural sector development in Nigeria with the secondary time series data from 1981 to 2012 and by using the ADF test as a unit root testing for stationarity and a Granger causality test for the relationship among the variables. The study found that FDI has a positive impact relationship on agriculture sector development in the short run and long run. Specifically, it is also a distribution of income within the country which promotes the agricultural sector. Epaphra and Mwakalasya (2017) show that there is an effect of foreign direct investment on agricultural sector development but has a significant at percent level on real GDP growth in Tanzania. FDI can be improved by new technologies, innovations, technical, management, and other systems that benefit developing countries (Nyiwul and Koirala 2022) showed that FDI inflows on value added in agriculture have positive and significant effects in the medium to long term.

Tashfeen, Shah, Ali, and Anis (2022) studied the imperative role of foreign direct investment and communication technology on the country's economic growth in selected developing countries by using time series panel data from 2004 to 2019. The empirical result showed that the relationship between GDP dependent and FDI, information and communication technology, urban population, and exports independent variables has played important roles in determining and supporting economic growth in developing countries.

Tiong, Cheng, and Choong (2022) investigated the roles of telecommunications infrastructure on foreign direct investment in Malaysia by employing the generalized method of moments (GMM) approach and data for the period between 2002 to 2016. The empirical results are found to show a positive and significant role of telecommunications infrastructure on FDI. Lastly, As a results, the government of Malaysia should attract and

sustain more foreign direct investment to boots to information and communication technology (ICT) telecommunications infrastructure, this can be used in conjunction with the ownership-location-internalization (OLI) paradigm to explain factors FDI in the new economy.

Long (2018) showed the causal relationship between FDI, electricity consumption, and economic growth in Vietnam in the period 1990-2015 by employing the ARDL and Toda-Yamamoto approach. The empirical results are found to show a strongly positive and significant impact of electricity and FDI at the two-way causal relationship on economic growth in both the short and long run. At the same time, Qazi (2021) has also confirmed that there is a positive and significant effect long-run relationship between FDI and electricity consumption on the economic growth of Pakistan.

Zhang *et al*., (2017) investigated the causal relationship between electricity consumption and economic growth in China spanning for the period 1978 to 2016 by using VAR and VECM models are explore the relationship among variables. This study explores an extensive overview of some key issues in the relationship between electricity consumption and economic growth in China on three dimensions such as the time dimension, the industrial dimension, and the regional dimension the conclusions summarized in this study provide evidence to support an interaction between China's electricity use and economic growth.

Xu (2022) has examined the causal relationship between China's electricity consumption and economic growth by using national-level data for the period 1978 to 2019. This study provides an understanding of the direct and indirect causal mechanisms among the electricity use economic growth in China. The empirical results in this study provide encouraging evidence for economic growth there are three main conclusions. First, shows that the bilateral causal relationship between electricity use and economic growth has strengthened with time through both the direct and indirect effects of causal mechanisms. Second, shows that the indirect effects of China's electricity consumption on economic growth with time are stronger than the direct effects, and third, the ecological and pollution awareness increase with economic growth in China displays that demand for clean energy sources such as wind energy, solar energy, and other renewable energy. To achieve the target of high economic growth so Chinese government should formulate policies to facilitate high-quality electricity production to accelerate the development process.

Zhang's (2020) empirical studies focused on the relationship between air transport infrastructure and economic growth. This paper explores the importance of air transport which improves economic performance. The results show that the access to aggregate air transport infrastructure to economic performance in more developed economies. Special, the causal association relationship is more probably to get ahead in less developed economies.

Tolcha (2020) investigated the causal relationship between economic development and air transport demand in six sub-Saharan African countries under panel data from 1981 to 2018 by analyzing long- and short-run causalities between dependent and explanatory variables employing vector error correction and vector autoregression models. The results reveal that in South Africa, Nigeria, and Kenya there is directional causality from economic development to air transport demand in the long run, but causality runs in the opposite direction from air transport promoting economic development can be seen in low-income countries as Ethiopia, and for Senegal and Angola, there is too weak to determine causal directions from causality from economic development to air transport demand.

Ali (2023) explored the causal relationship between economic growth and air transport in BRICS countries with balanced panel data from 1993–2019 by using the Vector Error Correction Model and Dumitrescu and Hurlin tests applied for causal analysis. This study investigated both short-run and long-run causalities. The results reveal one-way long-run causality has significance from air transportation such as numbers of air passengers and air freight to economic growth in host countries. Similarly, short-run economic growth in these countries determines air transportation.

3. RESEARCH METHODOLOGY

3.1 Model specification of study

The GMM model of this study for FDI inflows on infrastructure development that contribute to the economic growth in Laos can be written as bellow:

$$GDP = f\left(FDI, LA, HU, PO, LIFE, X\right) \quad \text{..... (1)}$$

$$\log GDP_t = \beta_1 + \beta_2 \log FDI_t + \beta_3 \log LA_t + \beta_4 \log HU_t + \beta_5 \log LIFE_t + \beta_6 \log X_t + \varepsilon_t$$

Where GDP: gross domestic production; FDI: foreign direct investment; LA: labor force participation; HU: human capital; PO: population growth; LIFE: life expectancy; X: some control variables such as AG: agriculture; SER: service; IND: industry; MO: telecommunication; ELE: electricity; TRA: trade.

As describe economic growth under FDI in the above. Next to, we applied Autoregressive Distributed

Lag (ARDL) model that applied by Pesaran *et al*., (2001) to identify the existence any long-run relationship between FDI and economic growth in Laos, as below:

$$\begin{aligned}\Delta \log FDI_t = \beta_0 &+ \sum_{i=1}^{N_1} \beta_1 \Delta \log FDI_{t-i} + \sum_{i=1}^{N_2} \beta_2 \Delta \log GDP_{t-i} + \sum_{i=1}^{N_3} \beta_3 \Delta \log TRA_{t-i} \\ &+ \sum_{i=1}^{N_4} \beta_4 \Delta \log PO_{t-i} + \sum_{i=1}^{N_5} \beta_5 \Delta \log LA_{t-i} + \lambda_1 \log FDI_{t-1} + \lambda_2 \log GDP_{t-1} \\ &+ \lambda_3 \log TRA_{t-1} + \lambda_4 \log PO_{t-1} + \lambda_5 \log LA_{t-1} + \varepsilon_t \end{aligned} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Where β_0 : Intercept, $\beta_1, \beta_2, ..., \beta_5$: Short-run coefficients, $\lambda_1, \lambda_2, ..., \lambda_5$: Long-run coefficients

ε : Error term, $N_1, N_2, ..., N_5$: Lag order, t : Time period, Δ : First different.

We have applied the F statistics to verify the intensity of the cointegration of the ARDL model to know the long-run relationship among variables. The null hypothesis is no long-run relationship or no cointegration and the alternative hypothesis is long-run relationship or cointegration. If the F-statistic is greater than the upper and lower bound values we will reject the null hypothesis and then accept the alternative hypothesis which means there is the long run relationship among variables.

The error correction model has given as below:

$$\begin{aligned}\Delta \log FDI_t = \beta_0 &+ \sum_{i=1}^{N_1} \theta_1 \Delta \log FDI_{t-i} + \sum_{i=1}^{N_2} \theta_2 \Delta \log GDP_{t-i} + \sum_{i=1}^{N_3} \theta_3 \Delta \log TRA_{t-i} \\ &+ \sum_{i=1}^{N_4} \theta_4 \Delta \log PO_{t-i} + \sum_{i=1}^{N_5} \theta_5 \Delta \log LA_{t-i} + \varphi ECT_{t-1} + \varepsilon_t \end{aligned} \quad \ldots\ldots (3)$$

The error correction term (ECTt-1) in model 3 indicates the speed adjustment of foreign direct investment in Laos from short-run - long-run equilibrium. Most importantly, the ECTt-1 value must be negative and statistically significant at the 5% level.

3.2 Data and empirical methodology

This paper has used various sources of secondary data to analyze the long-run relationships among the variables, to confirm the empirical result more accurately and can be used in the real economic situation of the Lao PDR which covered the period 1995-2020. The variables are used from the World Development Indicator (WDI 2022).

Table 1: The variables in this study

Variables	Description	Source
GDP	Gross domestic production (current US$)	WDI
FDI	Foreign direct investment, net inflows (BoP, current US$)	WDI
LA	Labor force participation rate, total (% of total population ages 15+) (modeled ILO estimate)	WDI
HU	Human capital (School enrollment, secondary (% gross))	WDI
PO	Population growth	WDI
TRA	Trade in services (% of GDP)	WDI
AG	Agriculture, forestry, and fishing, value added (current US$)	WDI
IND	Industry (including construction), value added (current US$)	WDI
SER	Services, value added (current US$)	WDI
MO	Mobile cellular subscriptions	WDI
ELE	Access to electricity (% of population)	WDI
AIR	Air transport, passengers carried	WDI
LIFE	Life expectancy at birth, total (years)	WDI

The stationary of the time series variables will apply the Augment Dickey-Fuller (Dickey & Fuller, 1979) test to the unit root. We will apply the GMM and ARDL model estimator for the FDI inflows on Laos'

economic growth and to obtain of cointegration relationship between FDI and economic growth in the long run, respectively. Specifically, the residual and coefficient diagnostic tests for GMM estimations have been applied by Jarque-Bera statistics and confidence ellipse respectively. After that, we applied the F statistics to verify the intensity of the cointegration of the ARDL model and diagnostic test using the Jarque-Bera test, Breusch-Godfrey Serial Correlation LM test, Breusch-Pagan-Godfrey test, and Harvey test. Besides, checking the stability of the model by using the CUSUM and CUSUMQ test.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1 Results of unit root tests for all the variables

Table 2 shows the specific results of the ADF test as unit root testing for all variables.

Table 2: The specifically results of unit root tests

Variables	Level		First Difference	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
log(GDP)	-3.2355**	-1.1427	-3.0434**	-3.0025
log(MO)	-3.5987**	-0.0519	-1.3778	-4.1773**
log(ELE)	-2.8277*	-4.6541***	-3.7931***	-5.0119***
log(AIR)	-2.0425	-2.2380	-5.4926***	-5.7262***
log(AG)	-2.7185*	-1.0637	-5.5448***	-5.6341***
log(SER)	-2.5766	-0.3518	-3.9231***	-3.0073
log(IND)	0.2726	-2.9104	-3.6203**	-1.6436
log(PO)	-4.1983***	-3.8551**	-3.4134**	-3.8784**
log(FDI)	-0.8939	-2.1355	-5.1858***	-5.1912***
log(LA)	0.9405	-2.2870	-3.4630**	-3.2806*
log(LIFE)	-1.1396	-0.3707	-2.1186	-3.7382**
log(HU)	-1.6670	-2.3033	-5.1362***	-5.0616***
log(TRA)	-3.1119**	-3.0739	-4.6471***	-3.3410*

***, ** and * indicate significance at the 1, 5 and 10 percent levels, respectively

4.2 Empirical results of GMM estimations

The empirical results of the GMM regressions present the impact of FDI, infrastructure, and some other factors on economic growth in Laos which consists of eight models for analyzing the influence of each variable to support economic growth. The results show that some independent variables have positive and significant impacts on economic growth. The FDI inflows into Laos can be considered as the main variable to determine economic growth as shown output for model A-model H in Table 3. Model A is defined as the initial model in which the independent variables are used as FDI inflows in Laos, labor, human capital, population, and life expectancy. The results of the GMM model show that all the independent variables have positive and significant impacts on the acceleration of economic growth, but the human capital is insignificant at this level. The coefficient of FDI imported to invest in Laos is 0.0765, which means that for a one percent increase in FDI inflows, the GDP will increase by 0.0765 percent. The coefficient of labor in the estimated regression line is 13.9711, which means that a one percent increase in labor will result in 13.9711 percent increase in GDP. The coefficient of population is 0.9794, which means that a one percent rise in population would result in about 0.1407 percent increase in GDP. The coefficient of life expectancy is 21.8153, which means that for a one percent rise in life expectancy, GDP will increase by about 21.8153 percent. The estimated R-squared and adjusted R-squared values for model A are 0.9940 and 0.9924 respectively. The result of model A can confirm that no inconsistency and the D-W is 1.9586.

The results of model B present the independent variables have positive and significant at the level of economic growth but labor, human capital, and population are insignificant. The coefficient of FDI inflows is 0.0508 which is a positive impact and significant at 1 percent level. If the FDI inflows rise by one percent, the economic growth of Laos will also rise by 0.0508. The coefficient of life expectancy is 12.5582 which is a strongly positive impact and significant at the 1 percent level, if a one percent increase in life expectancy will increase by 12.5582 percent in GDP. The coefficient of agriculture is 0.5480, if one percent increase in agriculture will result in 0.5480 percent in economic growth. The estimated R-squared and adjusted R-squared values for model B are 0.9981 and 0.9975 respectively. We can confirm that no inconsistency and the D-W is 2.2900.

The results of model C show that the independent variables such as FDI, PO, LIFE, and SER, are positive and significant at the level of economic growth, but both LA and HU are positive and negative with insignificant respectively. Explain clearly that the coefficients of FDI, PO, LIFE, and SER are 0.0340, 0.3300, 9.2520, and 0.5724 respectively. This means an increase of one percent in FDI, PO, LIFE, and SER will result the Laos' economic growth of 0.0340, 0.3300, 9.2520, and 0.5724 percent respectively. Especially, the

human capital variable is negative (-0.1231) and insignificant at the level, therefore, we cannot explain the statistical conclusion. However, the R-squared and adjusted R-squared values for model C are 0.9983 and 0.9978 respectively. The D-W value is 1.8872, so we can confirm that refer to the model C of this study has been normally distributed.

Model D are some variables that have a positive impact and are significant at the level of economic growth such as PO, LIFE, and IND which are 0.6341, 9.4194, and 0.4554 respectively. The one percent increase in PO, LIFE, and IND will cause the economy to grow by 0.6341, 9.4194, and 0.4554 percent respectively, but the FDI, LA, and HU have a positive impact which cannot be explained in terms of statistics due to the statistically insignificant. At the same time, the residual series of model D is normal according to the D-W value is 1.7891 with the R-squared and adjusted R-squared values for model D are 0.9961 and 0.9949 respectively.

Model E shows economic growth by considering the independent variables of the economy. The coefficient of FDI, LA, PO, and LIFE have positive, and significant at levels which are 0.0667, 11.1448, 1.1428, and 20.4705 respectively, which represents a one percent rise in independent variables as FDI, LA, PO, and LIFE will make the economic growth by 0.0667, 11.1448, 1.1428 and 20.4705 percents respectively. In particular, both HU and MO variables there are positive impacts on economic growth but are not statistically significant at a level which means that it cannot be generalized in terms of statistics. However, model E has no inconsistency which D-W statistic is 1.9321 with the R-squared and adjusted R-squared values for model E are 0.9940 and 0.9920 respectively.

The coefficient of independent variables in model F has a positive impact and is significant at the level of economic growth as FDI, LA, PO, and LIFE are 0.0766, 14.1318, 0.9900, and 21.7518. An increase of one percent in FDI, LA, PO, and LIFE would lead to economic growth of 0.0766, 14.1318, 0.9900, and 21.7518 percent respectively. On the other hand, the values of HU and ELE are positive impacts with statistically insignificant and the R-squared and adjusted R-squared values for model F are 0.9940 and 0.9920 respectively. At the same time, it can also be said that model F has been normally distributed because the value of the D-W is 1.9480.

The coefficient of independent variables in model G has a positive impact and is significant at the level of economic growth as FDI, PO, and LIFE are 0.0691, 1.0529, and 19.8280. An increase of one percent in FDI, PO, and LIFE would lead to economic growth of 0.0691, 1.0529, and 19.8280 percent respectively. On the other hand, the values of LA, HU, and AIR are statistically insignificant with positive impact and the R-squared and adjusted R-squared values for model G are 0.9941 and 0.9922 respectively. At the same time, it can also be said that model G has been normally distributed because the value of the D-W is 1.8544.

Finally, model H shows the coefficient of FDI, PO, and LIFE is important to ensure economic growth in Lao PDR which are statistically significant impact and strongly positive at the level. The results show that 0.0768, 0.9303, and 19.6461 are the values of FDI, PO, and LIFE respectively. The values of LA, HU, and TRA cannot be summarized as statistical principles because no significance at the level but there are positive effects on economic growth. If the one percent increase in FDI, PO, and LIFE will ensure economic growth by 0.0768, 0.9303, and 19.6461 percent respectively. The R-squared, adjusted R-squared and D-W are 0.9941, 0.9921, and 1.8524 respectively with model H also normal.

Table 3: The particularly results of GMM estimations

Variables	**Model A**	**Model B**	**Model C**	**Model D**
log(FDI)	0.0765***	0.0508***	0.0340**	0.0031
log(LA)	13.9711**	7.1677	6.0776	2.9645
log(HU)	0.3042	0.1559	-0.1231	0.4945
log(PO)	0.9794***	0.2350	0.3300*	0.6341***
log(LIFE)	21.8153***	12.5582***	9.2520**	9.4194**
log(AG)		0.5480***		
log(SER)			0.5724***	
log(IND)				0.4554***
C	-127.4467***	-71.7316	-54.0945	-38.7633
R-squared	0.9940	0.9981	0.9983	0.9961
Adjusted R-squared	0.9924	0.9975	0.9978	0.9949
Durbin-Watson stat	1.9586	2.2900	1.8872	1.7891

Continue

Variables	Model E	Model F	Model G	Model H

log(FDI)	0.0667**	0.0766***	0.0691**	0.0768***
log(LA)	11.1448*	14.1318**	8.9385	9.3704
log(HU)	0.5165	0.3071	0.2644	0.2800
log(PO)	1.1428**	0.9900**	1.0529***	0.9303**
log(LIFE)	20.4705***	21.7518***	19.8280***	19.6461***
log(MO)	0.0136			
log(ELE)		0.0263		
log(AIR)			0.0647	
log(TRA)				0.0372
C	-110.2990	-127.9615	-98.3591*	-99.4748
R-squared	0.9940	0.9940	0.9941	0.9941
Adjusted R-squared	0.9920	0.9920	0.9922	0.9921
Durbin-Watson stat	1.9321	1.9480	1.8544	1.8524

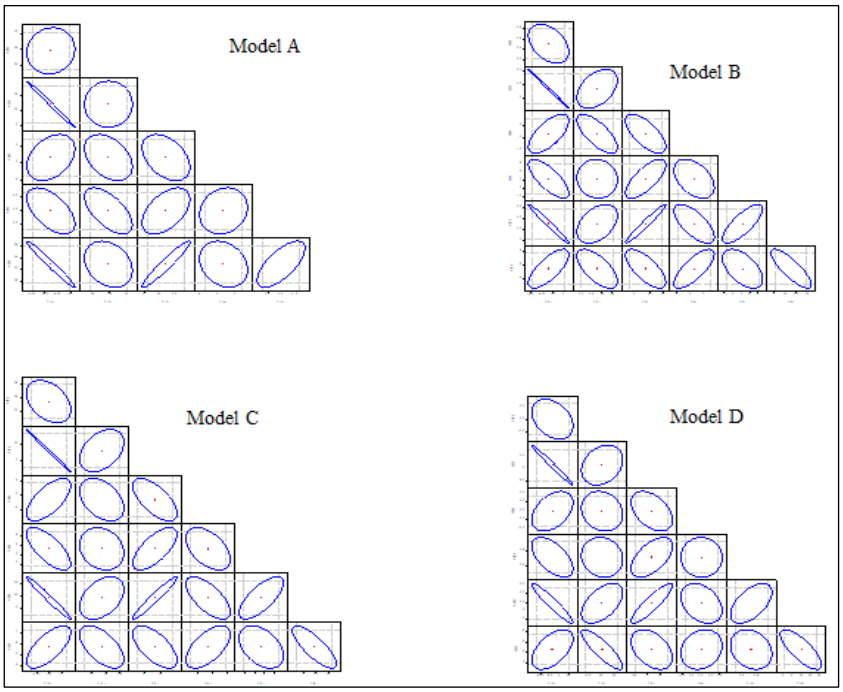
***, ** and * indicate significance at the 1, 5 and 10 percent levels, respectively

4.2.1 Residual diagnostics test results of GMM estimation

This empirical study can be tested using the diagnostic test of GMM estimation as a Normality test, using the Jarque-Bera statistics, and the probability value must be more than 5%. Model A-H show that the Jarque-Bera (probability) are 0.2441 (0.8850), 0.0237 (0.9882), 1.2031 (0.5479), 0.6764 (0.7130), 0.1494 (0.9280), 0.2391 (0.8872), 0.4092 (0.8149) and 0.4867 (0.7839) respectively. The result of residual diagnostics tests for model A-H confirms that those models have been normally distributed which is given in Table 4.

Table 4: Residual Diagnostics of models

Estimated Models	Normality test	
	Jarque-Bera	Prob.
Model A	0.2441	0.8850
Model B	0.0237	0.9882
Model C	1.2031	0.5479
Model D	0.6764	0.7130
Model E	0.1494	0.9280
Model F	0.2391	0.8872
Model G	0.4092	0.8149
Model H	0.4867	0.7839



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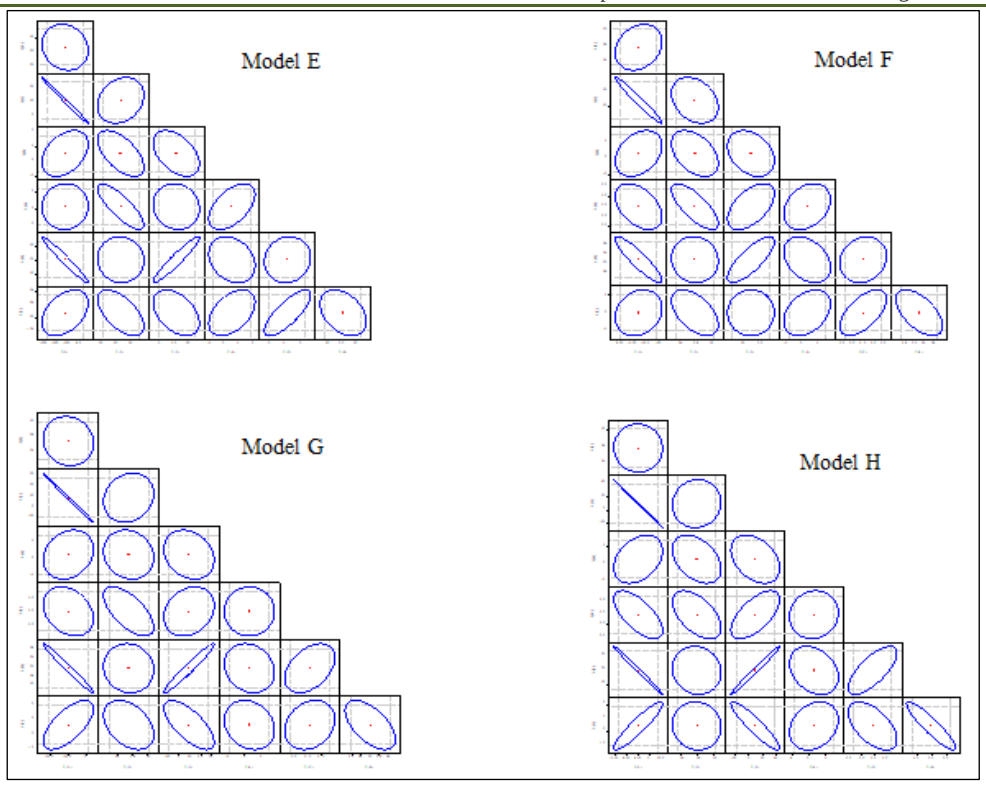

Figure 1: The results of GMM: Confidence ellipse

The coefficient diagnostics test for the GMM is given in Figure 1 which estimation considers the confidence ellipse criteria to ensure the consistency of each model at the 95% confidence interval with a 5% level of statistically significant. The results of the estimation confidence ellipse criteria confirm the suitability of each coefficient for model A-H.

4.3 The results of ARDL model for impact of FDI inflows into Laos

4.3.1 The results of ARDL bound test

The ARDL bounds test was operated to calculate the F-statistic value to the null hypothesis of no cointegration will be rejected or not. Table 5 reports the calculated joined F-statistic value (7.5737) is higher than 10%, 5%, 2.5%, and 1% of the upper bound critical in the order zero and one, respectively, rejecting the null hypothesis by suggesting the presence of cointegration among the variables have a long-run relationship.

Table 5: The especially results of the ARDL bounds test

F-Bounds Test		**Null Hypothesis: No levels relationship**		
Test Statistic	Value	Significance Level	I(0)	I(1)
F-statistic	7.5737	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

4.3.2 The results of long run relationship and error correction model

The result of ARDL shows that the positive long-run relationship among dependent and independent variables is given in Table 6. The coefficient of the key variable GDP is 2.6603, implying that an increase in GDP causes the FDI inflows into Laos to increase by 2.6603% with statistical significance at the 5% level and the T-statistic is 2.6092. There is a positive impact and statistically significant at the 5% level of the TRA, if a 1% rise in the TRA will result in to rise in the FDI inflows invested to Laos by 1.8056% in the long run with a T-statistic is 2.6384. The coefficient of PO has a positive effect and a significant 1% level the coefficient of PO is 7.4402 with T-statistic is 4.9859 meaning that a 1% increase in PO will increase in FDI by 7.4402%. In the long run impact of LA in Laos is positive and insignificant at the level.

Table 6: The particularly results of the long-run

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	2.6603**	1.0195	2.6092	0.0216
TRA	1.8056**	0.6843	2.6384	0.0205
PO	7.4402***	1.4922	4.9859	0.0002
LA	30.1448	37.2082	0.8101	0.4324
C	-168.2211	175.8789	-0.9564	0.3563

***, ** and * indicate significance at the 1, 5 and 10 percent levels, respectively

The error correction model in the form of the ARDL (1,2,2,0,0) is given in Table 7. The coefficient value of ECT (-1) is negative (-1.2453) with statistically significant at the 1% level. We strongly confirm that the variables in the short run are running to correct in the long run which speed of adjustment will be about 124.5315 percent per year.

Table 7: The specifically results of error correction model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(logGDP)	3.3860***	0.7571	4.4721	0.0006
D(logGDP(-1))	2.4854***	0.8003	3.1054	0.0084
D(logTRA)	0.1670	0.2190	0.7627	0.4592
D(logTRA(-1))	-1.5287***	0.3032	-5.0415	0.0002
ECT(-1)	-1.2453***	0.1569	-7.9322	0.0000

***, ** and * indicate significance at the 1, 5 and 10 percent levels, respectively

4.3.3 The results diagnostic, CUSUM and CUSUMSQ tests

Table 8 shows the diagnostic test of the ARDL model. We can conclude that at a 5% significant level, there is no serious heteroskedasticity problem, no serial correlation and normally distributed in the model. So, we can confirm that the both short and long-run models fit perfectly to explain the impact of FDI inflows on economic growth in Laos by using the technique CUSUM and CUSUMSQ tests to check the stability of the model at the 5% significant level in Figure 2.

Table 8: The specifically results of diagnostic tests

Types of tests	Statistical value	Prob
Jarque-Bera	0.4787	0.7871
Breusch-Godfrey Serial Correlation LM Test:	F (2,11) = 1.5694	0.2514
	Chi-Squere(2)=5.1061	0.0778
Breusch-Pagan-Godfrey	F (9,13) = 0.9043	0.5486
	Chi-Squere(9)=8.8554	0.4507
Harvey	F (9,13) = 1.6826	0.1907
	Chi-Squere(9)=12.3761	0.1929

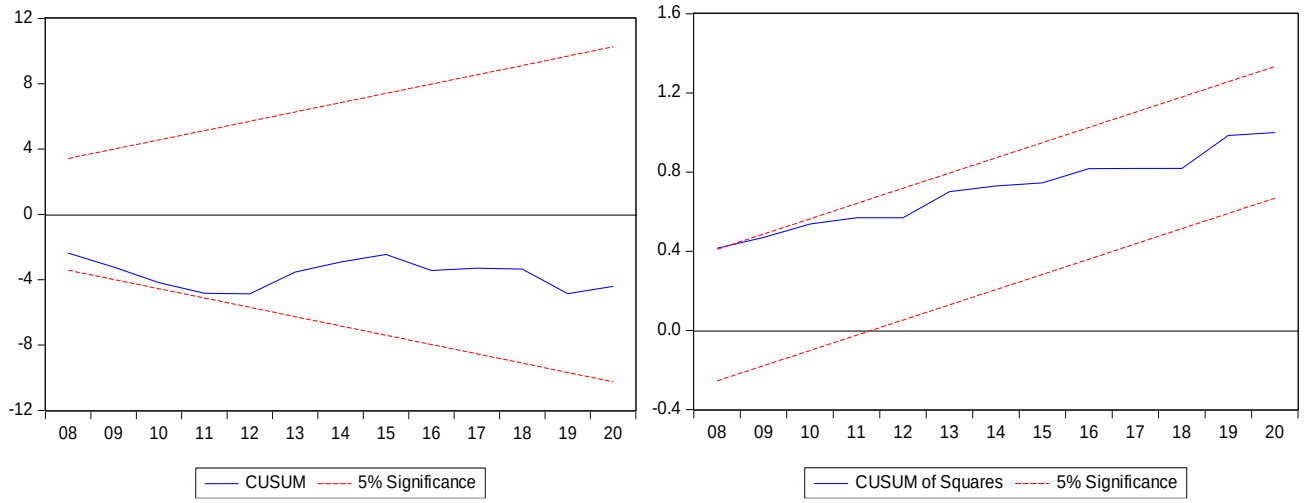

Figure 2: The results of CUSUM and CUSUMQ tests for stability of model

5. CONCLUSION AND RECOMMENDATION

This paper has investigated in two stages, the first stage of this paper analyses the dynamic impacts of economic growth, FDI, infrastructure, and other sectors of the economy by using the GMM approach. In the second stage of this paper, we have used the ARDL to investigate the long-run relationship between FDI and economic growth in Laos with time series data during 1995-2020. The unit root test to check the stationarity of all variables in this study by using the most popular technique Augment Dicky Fuller (ADF) test. The empirical results of GMM show that the FDI is a major catalyst for economic growth in Laos which has a positive impact and is statistically significant at the level. Similarly, the role of agriculture, service, and industry sectors are the main of the most important indicators in supporting the economic growth in Laos which there are positive impact and is significant at the level. In particular, the role of infrastructure as telecommunication, electricity air transport on economic growth has positive impacts and is insignificant at a level that cannot be summarized as a statistical principle. However, the study also found some variables such as labor, population growth, and life expectancy in support of economic growth which are strongly positive and significant at the level with both human capital and trade have a positive impact, but no significance at the level. The empirical results of ARDL confirm that economic growth, trade, and population growth have a positive and significant impact on FDI inflows into Laos in the long run. We, therefore, recommend that the government of Laos should attract and sustain more foreign direct investment and infrastructure development to achieve the target of sustainable economic growth in the long run.

REFERENCES

- Adhikary, B. K. (2012). Impact of Foreign Direct Investment, Trade Openness, Domestic Demand, and Exchang Rate on the Export Performance of Bangladesh: A VEC Approach. *Economics Research International*, *1*, 1-10. doi:https://doi.org/10.1155/2012/463856
- Akpan, E. S., & Eweke, G. O. (2017). Foreign Direct Investment and Industrial Sector Performance: Assessing the Long-Run Implication on Economic Growth in Nigeria. *Journal of Mathematical Finance*, *7*, 391-411. doi: https://doi.org/10.4236/jmf.2017.72021
- Ali, R., Bakhsh, K., & Yasin, M. A. (2023). Causal nexus between air transportation and economic growth in BRICS countries. *Journal of Air Transport Management,107*. doi:https://doi.org/10.1016/j.jairtraman.2022.102335
- Amos, A. K., & Jidda, D. C. (2018). Infrastructural development as a strategy for Nigeria's export promotion. *African Research Review, 12*(4), 40-49. doi: http://dx.doi.org/10.4314/afrrev.v12i4.4
- Atchike, D. W., Zhao, Z. Y., & Bao, G. (2020). The Relationship between Electricity Consumption, Foreign Direct Investment and Economic Growth: Case of Benin. *International Journal of Energy Economics and Policy*, *10*(4), 507-515. doi:https://www.researchgate.net/publication/341444923
- Baita. (2021). Impact of infrastructure on trade: an empirical assessment by the Gravity model in ECOWAS. *Young Africa Leaders Journal of Development*, *3*(20), 143-149. doi:https://digitalcommons.kennesaw.edu/yaljod/vol3/iss1/20
- Belloumi, M. (2014). The relationship between trade, FDI and economic growth in Tunisia: An application of the autoregressive distributed lag model. *Economic Systems*, *38*(2), 269-287. doi:https://doi.org/10.1016/j.ecosys.2013.09.002
- Ekeocha, D. O., Ogbuabor, J. E., & Orji, A. (2022). Public infrastructural development and economic performance in Africa: a new evdence from panal deata analysis. *Economic Change and Restructuring*, *55*, 931-950. doi:https://doi.org/10.1007/s10644-021-09334-8
- Epaphra, M., & Mwakalasya, A. H. (2017). Analysis of Foreign Direct Investment, Agricultural Sector and Economic Growth in Tanzania. *Modern Economic*, *8*, 111-140. doi: https://www.researchgate.net/publication/312599229
- Kakar, Z. K., & Khilji, B. A. (2011). Impact of FDI and Trade Openness on Economic Growth: A Comparative Study of Pakistan and Malaysia. *Theoretical and Applied Economic*, *18*, 53-58. doi:https://www.researchgate.net/publication/239804997
- Long, P. D., Ngoc, B. H., & My, D. T. H. (2018). The Relationship between Foreign Direct Investment, Electricity Consumption and Economic Growth in Vietnam. *International Journal of Energy Economics and Policy*, *8*(3), 267-274. doi:https://www.zbw.eu/econis-archiv/bitstream/11159/2122/1/1028135211.pdf
- Lydon, R., & Williams, M. (2005). Communications networks and foreign direct investment in developing countries. *Communications and Strategies*, *58*(2), 43-60. doi:https://mpra.ub.uni-muenchen.de/2492/
- Majumder, S. C., Rahman, M. H., & Martial, A. A. A. (2022). The effect of foreign direct investment on export processing zones in Bangladesh using Generalized Method of Moments Approach. *Socail Sciences &Humanities Open*, *6*(1), 1-10. doi:https://doi.org/10.1016/j.ssaho.2022.100277
- Markusen, J. R., & Venables, A. J. (1999). Foreign direct investment as a catalyst for industrial development. *European Economic Review*, *43*, 335-356. doi:https://www.researchgate.net/publication/223052299
- Masron, T. A. (2017). Relative institutional quality and FDI inflows in ASEAN countries. *Jpurnal of Economic Studies*, *44*(1), 115-137. doi:10.1108/JES-04-2015-0067
- Mousavian, S. Z., Mirdamadi, S. M., Hosseini, S. J. F., & Najafabadi, M. O. (2021). Determinants of foreign direct investment inflow to the agricultural sector: a panel-data analysis. *Journal of Economic and Administrative Sciences*, *1*, 1-22.

doi:https://www.researchgate.net/publication/354763114

- Nyiwul, L., & Koirala, N. P. (2022). Role of foreign direct investments in agriculture, forestry and fishing in developing countries. *Future Business Journal*, *8*(50), 1-12. doi:https://doi.org/10.1186/s43093-022-00164-2
- Oleyede, B. B. (2014). Impact of Foreign Direct Investment on Agricultural Development in Nigeria. *Kuwait Chapter of Arabian Journal of Business and Management Review*, *3*, 14-24. doi:http://www.arabianjbmr.com/pdfs/KD_VOL_3_12/2.pdf
- Pegkas, P. (2015). The impact of FDI on economic growth in Eurozone countries. *The Journal of Economic Asymmetries*, *12*(2), 124-132. doi:http://dx.doi.org/10.1016/j.jeca.2015.05.001
- Pereira, A. M., & Pereira, R. M. (2020). Infrastructure investment in Portugal and the traded/non-traded industry mix. *Journal of Infrastructure, Policy and Development*, *4*(1), 1-26. doi:10.24294/jipd.v4i1.1124
- Qazi, U., Alam, A., Ahad, S., & Ambreen. (2021). Impact of FDI and Electricity on the Economic Growth of Pakistan: A Long Run Cointegration and Causality Analysis. *Research in World Economy*, 273-288. doi:https://www.researchgate.net/publication/349729685
- Sahoo, P., & Dash, R. K. (2012). Economic growth in South Asia: role of infrastructure. *Journal of International Trade and Economic Development*, *21*(2), 217-252. doi:10.1080/09638191003596994
- Tashfeen, R., Shah, S. M. A., Ali, M. S., & Anis, W. (2022). Impact of Foreign Direct Investment and Information Communication Technology on Economic Growth: An Emoirical Analysis from Selected Developing Countries. *Al-Qantana*, *8*(2), 201-212. doi:https://www.researchgate.net/publication/366645679
- Tiong, K. M., Cheng, M. Y., & Choong, C. K. (2022). The Roles of ICT Telecommunication Infrastructure on Foreign Direct Investment in Malaysia. *Asian Academy of Management Journal*, *27*(2), 1-20. doi:https://doi.org/10.21315/aamj2022.27.2.1
- Tolcha, T. D., Brathen, S., & Holmgren, J. (2020). Air transport demand and economic development in sub-Saharan Africa: Direction of causality. *Journal of Transport Geography*, *86*, 1-14. doi:https://doi.org/10.1016/j.jtrangeo.2020.102771
- Umer, F., & Alam, S. (2013). Effect of Openness to Trade and FDI on Industrial Sector Growth: A Case Study for Pakistan. *The Romanian Economic Journal*, *48*, 179-197. doi:http://www.rejournal.eu/sites/rejournal.versatech.ro/files/articole/2013-06-01/1926/umer.pdf
- Williams, K. (2015). Foreign investment in Latin America and the Caribbean: An empirical analysis. *Latin American Journal of Economics*, *52*(1), 57-77. doi:10.7764/LAJE.52.1.57
- Xu, G., Yang, H., & Schwarz, P. (2022). A strengthened relationship between electricity and economic growth in China: An empirical study with a structural equation model. *Energy*, *241*, 1-11. doi:https://doi.org/10.1016/j.energy.2021.122905
- Zhang, C., H. Zhou., Yang, S., & Shao, Z. (2017). On electricity consumption and economic growth in China. *Renewble and Sustainable Energy Reviews*, *76*, 353-368. doi:https://doi.org/10.1016/j.rser.2017.03.071
- Zhang, F., & Graham, D. (2020). Air transport and economic growth: a review of the impact mechanism and causal relationships. *Transport Reviews*, *40*(4), 506528. doi:https://doi.org/10.1080/01441647.2020.1738587
- Zhao, Z., & Zhang, K. H. (2010). FDI and Industrial Productivity in China: Evidence from Panel Data in 2001-06. *Review of Development Economics*, *14*(3), 656-665. doi:10.1111/j.1467-9361.2010.00580.x