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# Foreign aid, foreign direct investment and economic growth of Lao PDR

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## Abstract

This paper investigates the impact of foreign aid and foreign direct investment on the long-run income per capita and short-run income growth of Lao PDR. We formulate a modification of Solow model; then we employ a cointegration technique to carry out the long-run relationship, and employ an error correction model to estimate the short-run growth effects. The results show that foreign aid has a strong positive impact and is the main contributor on income level and income growth of Lao PDR in the long run. Surprisingly, FDI has significant negative impact on long-run income per capita and small positive impact on income growth in the short run. We conclude that the long-run negative impact of FDI might be due to its surge and concentration on few economic sectors and due to its extreme rises and falls in some period. Therefore, the policies to promote FDI in many sectors and the policies that attract stable FDI inflows should be promulgated.

*Keywords:* Foreign aid; Foreign direct investment; Convergence; Economic growth

*JEL classification:* C22, F21, F35, O1, O4

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## **1. Introduction**

Official Development Assistance (ODA), hereafter foreign aid, and foreign direct investment (FDI) are two major forms of foreign capital hypothesized to play important roles in boosting economic growth and development of low income countries. However, for a half of century, researchers and policy makers have not been able to agree upon the effects of foreign aid and FDI on economic growth of developing nations, and the debate is still going on. In academic field, on one side, the pro-foreign-capital-growth economists claim that foreign capital can supplement to domestic savings, bring in new technology and management know-how to poor nations and can, finally, spur growth. On the other side, the opposite view argues that instead of supplementing, foreign capital might displace domestic savings, create aid-dependency behavior and widen the gap between the rich and the poor. In recent years, some studies have pointed out that foreign capital might properly work only for the country with good policy environment (Burnside and Dollar, 2000).

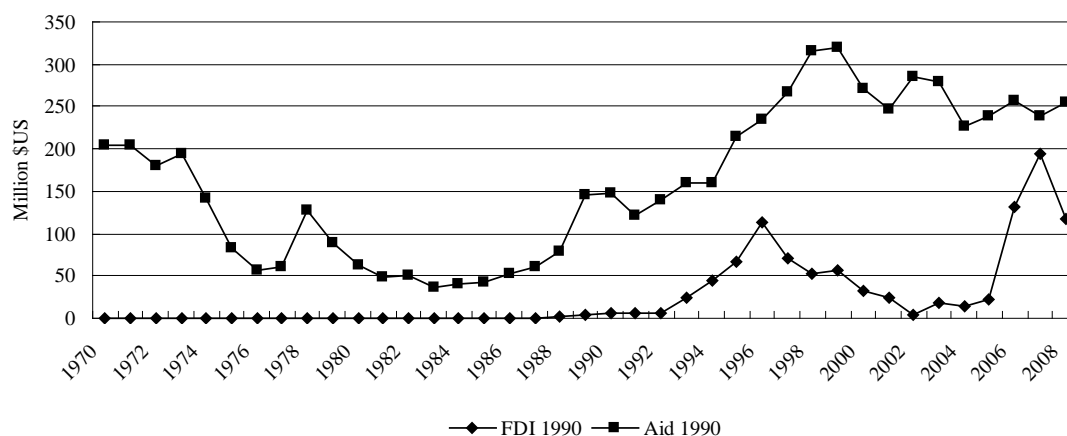
Lao People's Democratic Republic (hereafter, Lao PDR) is one of the least developed countries that have long received large amount of foreign aid for financing its infrastructure and socio-economic development. Last two decades, after the introduction of market-oriented policy, have witnessed structural adjustment, changes in many economic sectors and an expansion of public infrastructure. In general, except the period 1977-1979, during which Lao PDR experienced economic turmoil; the period 1987-1988, during which the natural disaster occurred; and 1997-1999 during which Lao PDR had been severely affected by the Asian financial crisis, the Lao economy has gained relatively satisfactory economic stability. The GDP growth rate on average is about 6% since 1990s and the falling rate of poverty from 46% in 1992 to 33.5% in 2003; the GDP per capita, in nominal term, rapidly increases from 150 US Dollars in 1988 to 837 US Dollars in 2008 (World Bank, 2011). The chronic double deficits (trade and fiscal deficit) started to decrease in past several years. In the light of this recent development of Lao PDR and the on-going debate of foreign capital effectiveness, this study attempts to provide a contribution by examining the impact of foreign aid and FDI on economic growth of Lao PDR.

## **2. Overview of foreign aid and FDI in Lao PDR**

After the revolution in 1975, the Lao People's Democratic Republic (Lao PDR) was established, and by the influence of Soviet Union, the centrally planned economic system was adopted. However, under this new regime, the Lao economy had stagnated and experienced an economic turmoil. In 1986, following the economic reform of

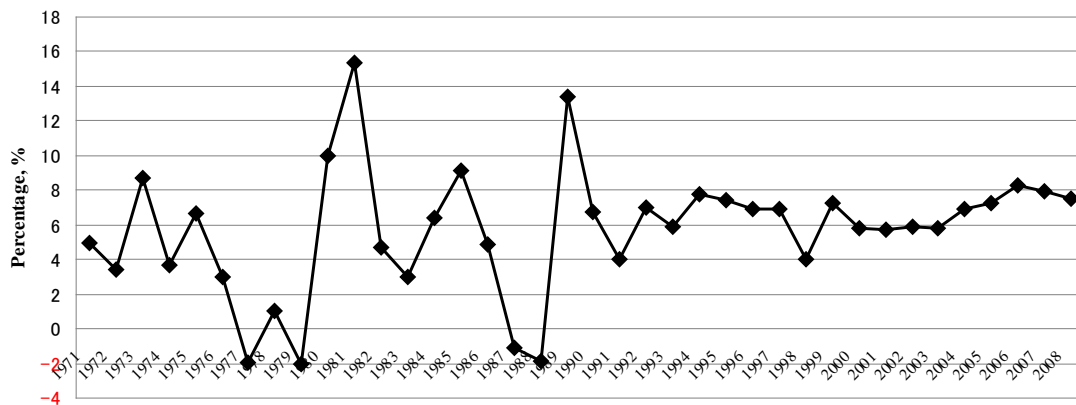
Soviet Union and its socialist allies, the Lao government introduced a New Economic Mechanism (NEM) in the hope to improve socio-economic condition and eradicate poverty. To achieve such goals, the Lao government decentralized the economic system, allowed for private transaction and resource mobilization; privatized some state-owned enterprises, restructured tax and banking system; and adopted foreign investment and trade liberalization policy.

In order to support new economic policies, the Lao government sought for more international assistance from many countries and international organizations. The amount of total aid inflows started to increase significantly from about US\$ 45 million in 1986 to US\$ 140 million in 1989. The amount of foreign aid kept increasing and reached US\$ 330 million in 1996. After 1997, the amount of foreign aid slightly declined and had been, on average, about 280 million during 1998 and 2005. Since 2006, the amount of aid had dramatically increased. It reached almost US\$ 500 million in 2008 (See Figure 1).



**Fig. 1.** Total foreign aid and actual FDI inflows to Lao PDR 1988-2008.

Source: World Development Indicators (The values are in current price).



**Fig. 2.** GDP growth of Lao PDR, 1971-2008

Source: United Nations' statistic division.

Foreign aid has played a vital role in the development of Lao PDR. It had accounted for 14% of GDP, on average, during 1988 to 2008. This share of aid to GDP implies the heavy reliance of Lao PDR on external assistance more than other South East Asian countries. For example, Thailand, Indonesia and the Philippines during the period 1970-2000 had on average aid-GDP ratio of 0.8%, 1.7% and 1.5%, respectively (Burke and Ahmadi-Esfahani, 2006). Lao PDR has received aid from many sources. The top two for bilateral-aid donors are Japan and China, for multilateral-aid donors are Asian Development Bank (ADB) and the World Bank. Foreign aid is the major part of the Lao PDR's Public Investment Programme (PIP), through which the government plans and allocates capital investment. It contributes to 60-80% to the PIP and is mainly disbursed to finance public capital outlays, such as infrastructure construction (i.e., road, bridge, irrigation, electricity transmission network, and so forth) and other soft infrastructure such as education and health care. In addition, many aid projects have engaged in humanitarian, social and environmental aspects such as food security, poverty reduction, wild life conservation and environmental protection (GoL, 2006).

Apart from foreign aid, FDI is considered by both the Lao government and its international counterparts to be an engine that plays a key role in the forefront of Lao PDR's development. In fact, during 1975-1987, private investment was not allowed. It was not until after the FDI and domestic investment promotion law were promulgated in 1988 that foreign, as well as domestic, investors could start operating their business. Initially, the FDI inflows to Lao PDR were rather small. In 1988, the value of FDI inflows was only about US\$ 2 million. Then, it started to gradually increase to around US\$ 6-7 million during 1989 and 1992. From 1993, the value of FDI inflows increased significantly. It reached US\$ 160 million in 1996. Freeman (2002) pointed out that a

boom of private capital inflows to Lao PDR was attributed to the amendment of Foreign Investment Promotion law in 1994. However, after the Asian financial crisis' outburst in 1997, foreign investment had decreased dramatically. The value is as low as \$ 4.5 million in 2002. Having seen a declining trend of actual FDI inflows, the Lao government took another step in amending the FDI promotion law in 2004 and sought for a Normal Trade Relation (NTR) with the United States and was granted in 2005. In 2006, the actual amount of FDI inflows jumped up to US\$ 180 million, which is about 570% higher than the amount in 2005, and the amount jumped to US\$ 323 million in 2007. The surge of FDI inflows since 2006 is attributed to the increase of investment in mining and hydropower sector (Bank of Lao PDR, 2009).

### **3. Literature Review**

#### *3.1 Foreign aid and economic growth*

The literature of the economic impact of foreign capital can be traced back to the work of Rosenstein-Rodan (1961), Chenery and Bruno (1962), McKinnon (1964), and Chenery and Strout (1966), among others. In fact, many studies of aid-growth literature have accredited the work of Chenery and Strout (1996) as an influential workhorse. Chenery and Strout (1966) employed a so-called two-gap model, which assumed that low-income countries face one of the two constraints – savings or foreign exchange – that prevent the economy to achieve its targeted growth rate, to determine the amount of foreign capital required by developing countries in order to achieve the targeted economic growth. However, some criticisms to this two-gap model had emerged and warned that foreign aid and other private capital inflows might cause a reverse effect on growth by displacing domestic savings. These include, for example, Griffin and Enos (1970) and Weisskopf (1972) who found a negative impact of foreign capital on domestic savings. This sparked a long debate between development economists who are in favour of and against the assumption that foreign assistance contribute to economic growth.

Papanek (1973) and Chenery and Syrquin (1975), among others, empirically examined by how much foreign aid and foreign private investment contribute to growth and displace domestic savings. They found that aid and foreign private investment have positive impact on growth and exert their negative impact on domestic savings, thus aid and foreign private investment contribute to economic growth. However, most of these works are subjected to the criticism in that they did not take into account the simultaneity of foreign capital and growth and neglected the growth effect of other factors. To tackle this criticism, Mosley *et al* (1987) included growth rate of export and

literacy and used 3-stage least squares (3SLS) method to test for aid-growth relationship for groups of developing countries; however, they found no significant effects of aid on growth. From mid-1990s onward, major studies of aid-growth relation have emphasized the importance of economic and policy environment. These include Boon (1995), Burnside and Dollar (1997, 2000), to name a few. Burnside and Dollar (2000) concluded that foreign aid works only with countries that have good economic policy environment. However, Hansen and Tarp (2000) and Lensink and White (2001), among others, argued that Burnside and Dollar's results are skeptical and subjected to criticism in various grounds. Thus, the debate of aid effectiveness has not yet found a conclusive agreement.

### *3.2 Foreign direct investment and economic growth*

Although some aid-growth studies have taken FDI into account, the literature of FDI-growth relationship has paved its own way. The literature of FDI-growth relationship is separated into macroeconomic level and firm level. For the former, the neoclassical growth theory has been widely employed to carry out the impact of FDI on growth. The theory argued that FDI is not only a supplement to domestic investment, but also provides technology transfer that generates positive spillover effects to local firms of host countries, which will ultimately spur growth. This view has been pointed out by the works of Lucas (1988), Barro (1991), and Barro and Sala-i-Martin (1995). Romer (1993) noted that foreign investment can ease transfer of technology and business know-how to the poorer countries. However, the empirical studies following this setup have produced mixed results. Some studies found that FDI can have a positive growth effect to the economy only under good economic and political condition. For example, Barasubramanyam *et al* (1996) found that FDI has a positive effect on growth in the countries that have good trade policy. Borenstein *et al.* (1998) and Noorbakhsh and Palino (2001) found that FDI is an important vehicle for technology transfer, but only with the economies that have high level of human capital stock and absorptive capacities. Alfaro *et al.* (2004, 2010) found that countries with well-developed financial market gain advantages from FDI. In contrast, the studies in the firm level mostly could not find positive spillovers of foreign firms to domestic firms. For example, Haddad and Harrison (1993) and Aitken and Harrison (1999), among others, find no evidence of positive spillovers of foreign firms to domestic firms.

## **4. Conceptual framework**

### *4.1 Foreign aid and FDI in Solow-growth model*

While most studies used static models and panel data analysis to examine the growth effects of foreign aid and FDI, in this study, we distinguish from the others by adopting the Solow-growth model and use time series analysis to study the effect of foreign aid and FDI on income per capita and economic convergence. This method has a merit in that it can use to examine a specific country (not a group of countries) and can correct the simultaneity problem of variables.

We first start off by extending the Solow model. By disaggregating capital stock into the stock of foreign aid, FDI, and domestic investment, the Cobb-Douglas production function can be express as:

$$Y_t = K_{At}^\theta K_{Ft}^\beta K_{Dt}^\gamma (A_t L_t)^{1-\theta-\beta-\gamma} \quad (1)$$

where  $Y$  is output,  $A$  is technological level assuming to grow at exogenous rate ( $A=A_0 e^{gt}$ ),  $K_A$  is stock of foreign aid,  $K_F$  is stock of FDI,  $K_D$  is stock of domestic investment, and  $L$  is labour force. Subscript  $t$  represents time. After some mathematical derivation (See Appendix B), we have:

$$\dot{k}_A = s_a y_t - (n + g + \delta)k_{At} \quad (2a)$$

$$\dot{k}_F = s_F y_t - (n + g + \delta)k_{Ft} \quad (2b)$$

$$\dot{k}_D = s_D y_t - (n + g + \delta)k_{Dt} \quad (2c)$$

where  $y=Y/AL$ ,  $k_A=K_A/AL$ ,  $k_F=K_F/AL$  and  $k_D=K_D/AL$  are income per effective unit of labor, foreign aid stock per effective unit of labor, FDI stock per effective unit of labor, and domestic capital stock per effective unit of labor, respectively.  $s_A$ ,  $s_F$ , and  $s_D$  are the share of foreign aid, FDI, and domestic investment to income, respectively.

From equation (2), (3), and (4), the steady state level of income per effective labor can be defined as

$$y^* = \frac{s_A^{\theta/(1-\theta-\beta-\gamma)} s_F^{\beta/(1-\theta-\beta-\gamma)} s_D^{\gamma/(1-\theta-\beta-\gamma)}}{(n + g + \delta)^{(\theta+\beta+\gamma)/(1-\theta-\beta-\gamma)}} \quad (3)$$

Taking logs both sides, we have the steady state of income per labor as:



$$\ln\left(\frac{Y_t}{L_t}\right)^* = \ln A_0 + gt + \frac{\theta}{1-\theta-\beta-\gamma} \ln(s_A)^* + \frac{\beta}{1-\theta-\beta-\gamma} \ln(s_F)^* + \frac{\gamma}{1-\theta-\beta-\gamma} \ln(s_D)^* - \frac{\theta+\beta+\gamma}{1-\theta-\beta-\gamma} \ln(n+g+\delta) \quad (4)$$

Using the first-order Taylor expansion to approximate around steady state of income, we can have the speed of convergence (See Appendix B) as:

$$\lambda = -(1-\theta-\beta-\gamma)(n+g+\delta) \quad (5)$$

#### 4.2 Empirical model

Equation (4) is similar to that of Solow (1965) and Mankiw *et al.* (1992). However, it cannot be estimated directly. Therefore, we follow Mallick (2002) who postulates that at steady state capital stock can be approximated by the level of investment (In fact, many other studies have used level of investment as a proxy of capital stock). This can be elaborated by assuming that

$$\begin{aligned} \dot{K}_A &= I_A - \delta K_A \\ \dot{K}_F &= I_F - \delta K_F \\ \dot{K}_D &= I_D - \delta K_D \end{aligned}$$

where  $I_A$  is aid inflows,  $I_F$  is FDI inflows, and  $I_D$  is domestic investment.

At steady state  $\dot{K}_A = \dot{K}_F = \dot{K}_D = 0$

Therefore,

$$K_A^* = \frac{1}{\delta} I_A^*, \quad K_F^* = \frac{1}{\delta} I_F^*, \quad \text{and} \quad K_D^* = \frac{1}{\delta} I_D^*$$

Substituting this in the production function (1), we have:

$$Y_t^* = \frac{1}{\delta^{\theta+\beta+\gamma}} (I_A^*)^\theta (I_F^*)^\beta (I_D^*)^\gamma (A_t L_t)^{1-\theta-\beta-\gamma}$$

Dividing both sides by  $L$  and taking logs, the model can be express as

$$\log\left(\frac{Y}{L}\right)^* = \log\left(\frac{1}{\delta^{\theta+\beta+\gamma}}\right) + \theta \log\left(\frac{I_A}{L}\right)^* + \beta \log\left(\frac{I_F}{L}\right)^* + \gamma \log\left(\frac{I_D}{L}\right)^* + (1-\theta-\beta-\gamma) \log(A_t)$$

Assume that technology  $A$  grows at exogenous rate

$$A = A_0 e^{gt}$$

$$\log\left(\frac{Y}{L}\right)^* = C + \theta \log\left(\frac{I_A}{L}\right)^* + \beta \log\left(\frac{I_F}{L}\right)^* + \gamma \log\left(\frac{I_D}{L}\right)^* + (1 - \theta - \beta - \gamma)gt \quad (6)$$

$$\text{where } C = \log\left(\frac{1}{\delta^{\theta+\beta+\gamma}}\right) + (1 - \theta - \beta - \gamma)\log A_0$$

For the empirical estimation, we write equation (5) as:

$$\log(YPC)^* = C + \theta \log(AID)^* + \beta \log(FDI)^* + \gamma \log(DI)^* + (1 - \theta - \beta - \gamma)gt \quad (7)$$

where  $YPC$  is income per capita,  $AID$  is foreign aid per capita,  $FDI$  is foreign direct investment per capita,  $DI$  is domestic investment per capita,  $g$  is exogenous growth rate of technology, and  $t$  represents time trend.

To estimate the long-run equilibrium equation, it is necessary that the employed method can provide the information of long-run relationship of variables. Fortunately, the econometric advancement provides some techniques that can be used to estimate long-run relationship of variables. The details of the methodology used are discussed in the following empirical analysis section.

## 5. Empirical analysis

### 5.1 Data source

Data used in this study are annual data of the period 1970-2008 (39 years) and are taken from two sources. Data of GDP and domestic investment are from United Nations' statistical division (UNs, 2011). The data are expressed in US dollar at constant 1990 price. The data of foreign aid, FDI, and population are from World Development Indicators (World Bank, 2011). The value of foreign aid and FDI are in US dollar (at nominal price) and are converted to constant 1990 price using GDP deflator. For FDI, during 1970-1987, its value is zero (since there were no FDI inflows during this period); therefore, in order to be able to take logs, we assume that the value during this period is \$US 1.

### 5.2 Unit root test

In econometric time series, prior to estimate the long-run relationship of variables, the knowledge of the stationary property of variables is needed. Two most prominent methods usually used to check for stationary property, in most studies, include the

Augmented Dickey-Fuller (ADF) unit root test and the Phillips-Perron unit root test (Phillips and Perron, 1998). The results of these tests are shown in Appendix A. For the ADF test, the optimal lag lengths are determined by the Schwarz Information Criteria (SIC), while for the Phillips-Perron test, the optimal bandwidths are used and are determined by the Newey and West method (Newey and West, 1987).

As can be seen in Table A1, the results of the unit root test using both ADF and Phillips-Perron methods show that the variables are not stationary at level, but stationary at first difference. Based on these results, the test of long-run relationship of variables can be estimated using cointegration techniques.

### 5.3 Long-run effects and convergence

In order to find the long-run relationship of variables, we employ the maximum likelihood estimation (MLE) method of Johansen and Juselius (1990) to test for the cointegration of the variables. The MLE is used to estimate the vector error correction model (VECM) to define the number of cointegrating ranks. Following Johansen and Juselius (1990), VAR in levels (Eq. 7) can be rewritten as a VECM (Eq. 8) as:

$$Y_t = \omega + \Pi_1 Y_{t-1} + \dots + \Pi_k Y_{t-k} + \varepsilon_t, \quad t = 1, 2, \dots, T \quad (8)$$

$$\Delta Y_t = \omega + \Gamma_1 \Delta Y_{t-1} + \dots + \Gamma_{k-1} \Delta Y_{t-k+1} - \Pi Y_{t-1} + \varepsilon_t \quad (9)$$

where  $Y = [YPC, AID, FDI, DI]$ ,  $\Gamma_i = -\mathbf{I} + \Pi_1 + \dots + \Pi_i$ ,  $i = 1, \dots, k-1$ ,

$\Pi = \mathbf{I} - \Pi_1 - \dots - \Pi_k$ ,  $\Delta$  is the first difference.

This method requires that  $Y$  should be non-stationary at levels, but be stationary at first difference. If the rank  $r$  of  $\Pi$  is greater than zero, there will exist  $r$  possible stationary linear combination of variables; thus  $r$  long-run relationship among variables exists.

Prior to test for the cointegration, we check for the order of lag length of the vector autoregressive model. We use the Akaike information (AIC) and Schwartz information criterion (SC) to define the lag length. The results of lag selection are reported in Table A2. All criteria suggest one lag to the system. Therefore, we proceed with the cointegration test. The results of cointegration test are reported in Table A3. Both trace and the maximum Eigen value statistics reject the null hypothesis of no cointegration, but fail to reject the null hypothesis of the existence of more than one cointegration; therefore, we conclude that there is one cointegration among variables.

The estimation of long-run relationship among variables is reported in Table 1. As

we can see, the estimated income share of foreign aid has positive sign and significant at 1%. Surprisingly, the estimated income share of FDI turns out to be negative, and is significant at 1%. Domestic investment shows positive effect, but insignificant. Therefore, we conclude that there is no effect of income share of domestic investment. The result indicates that while foreign aid pushes up the equilibrium level of income per capita, FDI seems to bring it down.

**Table 1**

Estimated long-run relationship of variables

$$\log(YPC) = 4.023 + 0.100\log(AID) - 0.016\log(FDI) + 0.029\log(DI)_t + 0.039trend$$

(4.357)\*\*\*                      (-5.326)\*\*\*                      (0.878)                      (10.295)\*\*\*

Note: Asterisks (\*), (\*\*), (\*\*\*) indicate significant at 10%, 5%, and 1% respectively.

**Table 2**

Estimated coefficients and the speed of convergence

$\theta$	$\beta$	$\gamma$	$n$	$g$	$\delta$	$\lambda$	$\lambda$
						With FDI	Without FDI
0.100	-0.016	0	0.023	0.042	0.050	-0.105	-0.103

Note:  $\lambda$  is the speed of convergence. The depreciation rate  $\delta$  is assumed to equal to 5%.  $g = 0.039/(1-\theta-\beta-\gamma)$ . The constant growth rate of population is estimated from  $\log(POP) = c_1 + nt$  by using OLS method (where  $POP$  is the number of population,  $n$  is the parameter reflecting the average growth rate of population, and  $t$  is time trend). Convergence rate is computed from  $-(1-\theta-\beta-\gamma)(n+g+\delta)$ .

In the speed of convergence's point of view (shown in Table 2), as explained by Solow (1956) and Mankiw *et al.* (1992), the higher the speed of convergence, the more the income level far from its potential steady state. This means that if the negative effect of FDI would be large, it can affect the speed of convergence and it would cause the economy to be far from its potential equilibrium. Nevertheless, in our case, it can be observed that with or without the inclusion of the FDI effect, the speed of convergence of Lao PDR does not change significantly. This means that the negative impact of FDI does not have large effect on the speed of convergence. The effect of domestic investment on the speed of convergence is assumed to be zero ( $\gamma = 0$ ), as its coefficient is not significant.

The negative impact of FDI seems to be, to some extent, unfavorable for the pro-FDI-led-growth economists and policy makers. Nevertheless, this result implies

how FDI affects the Lao economy. There are at least two reasons that can explain this negative effect. First, this result supports the concerns of some economists and international bodies (who have observed the process of development of Lao PDR in recent years) that the surge of FDI inflows in Lao PDR, which concentrates only on mining and hydropower sector, might not stimulate only short-run economic growth, but not sustain in the long run (UNDP, 2006). This is because the FDI inflows that go to only mining and hydropower sectors mostly do not improve labor skills, quality, and spillover effects; thus might not lead to a sustainable economic growth. Second, as pointed out by Lensink and Morrissey (2006) that unstable flows of FDI cause negative effect to long-run economic growth.

#### 5.4 Short-run dynamic effects

To find the short-run dynamic effects of the growth of aid, FDI and domestic investment per capita on the growth of income per capita, we employ the error correction model (ECM) specified by Banerjee *et al.* (1993). However, this model requires that the variables on the right hand side should be weakly exogenous. Therefore, prior to estimate the short-run dynamic impact of aid, FDI, and domestic investment, the exogeneity test is necessary.

We employ the Granger causality drawn from VECM to test for the exogeneity of the independent variables. Using the VECM specification of Eq. (9), the Granger causality is estimated and reported in Table 3.

**Table 3**  
Causality test

Dependent Variable	Short-run				Long-run
	$\Delta \ln Y$	$\Delta \ln AID$	$\Delta \ln FDI$	$\Delta \ln DI$	$ECT$
	F-statistics				t-statistics
$\Delta \ln Y$	-	8.588***	20.007***	4.019**	- 4.327***
$\Delta \ln AID$	0.869	-	1.357	1.028	1.715
$\Delta \ln FDI$	0.802	0.292	-	0.860	- 0.630
$\Delta \ln DI$	2.77	0.0047	0.015	-	- 1.609

Note: Asterisks (\*), (\*\*), (\*\*\*) indicate significant at 10% , 5%, and 1% respectively. The optimum lag length is chosen by using Akaike Information and Schwarz Information Criterion which suggest 1 lag for all variables.  $ECT$  refers to error-correction term.

Based on the results of the Granger causality test, we can see that the F-statistics of the short run effect suggest that there are impacts run from aid, FDI, and domestic investment per capita to income per capita (with the significant level of F-statistics of more than 5% in all cases) , but not vice versa. In addition, there are no simultaneity effects among independent variables. With regards to the long-run effect, the t-statistics of error-correction term also confirm that there is only one-direction impact, which runs from aid, FDI, and domestic investment per capita to income per capita (the t-statistics is significant at 1%). These results assure that aid, FDI, and domestic investment per capita are exogenous.

We now proceed with the test of the error-correction model for the single equation model. Following Banerjee *et al.* (1993) the representation of the error correction model used in our study can be written as

$$\Delta \log(YPC) = C' + \sum_{i=1}^m \theta_i \Delta \log(YPC)_{t-i} + \sum_{j=0}^n \alpha_j \Delta \log(AID)_{t-j} + \sum_{k=0}^p \beta_k \Delta \log(FDI)_{t-k} + \sum_{h=0}^q \gamma_h \Delta \log(DI)_{t-h} + \phi EC_{t-1} \quad (10)$$

where  $C'$  is an intercept,  $\theta$  is lag effects of GDP per capita itself,  $\alpha_j$ ,  $\beta_k$ , and  $\gamma_h$  are short-run dynamic effects of growth of aid, FDI, and domestic investment per capita on growth of GDP per capita, respectively.  $\phi$  is the adjustment coefficient, and  $EC$  is the error-correction term. We use the information of long-run relationship reported in Table 1 to find the error-correction term.

To make our short-run dynamic model consistent with the long-run relationship estimation, we use one-year lag for all variables. Table 3 shows the results of the estimation of the error-correction model. In overall, the model shows no sign of misspecification. The adjusted R-squared is high enough to ensure that the model can explain the behavior of the data. The Durbin-Watson statistics is close to 2. All other statistics of diagnostic tests, such as the Breusch-Godfrey serial correction test, the ARCH test for heteroskedasticity, the Ramsey RESET test for model specification, and the Jarque-Bera normality test, are all well below their critical values. The stability test such as CUSUM and CUSUM of squares also assure that the movement of the error term is within the 5% confidence interval of the critical region.

**Table 4**

Estimated short-run effects of aid, FDI and domestic investment on growth

Dependent variable:  $\Delta \log(YPC)$ 

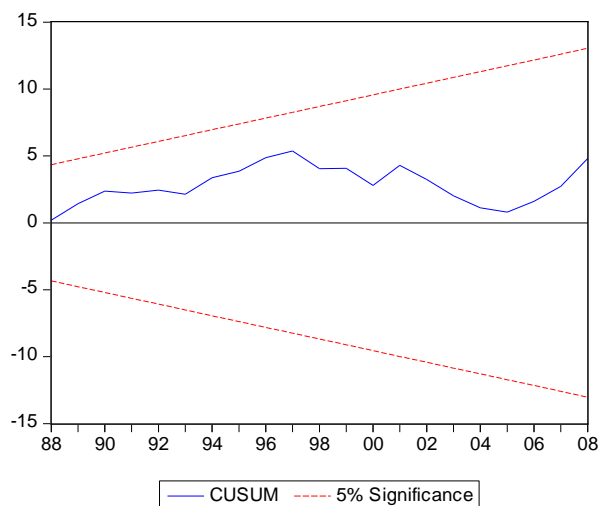
(No. of Sample: 37 after adjustment)

Variables	Coefficients	t-statistics
<i>Intercept</i>	0.052***	8.213
$\Delta \log(YPC)_{t-1}$	0.262**	2.055
$\Delta \log(AID)$	0.036***	2.579
$\Delta \log(AID)_{t-1}$	- 0.049***	- 3.545
$\Delta \log(FDI)$	- 0.001	- 0.516
$\Delta \log(FDI)_{t-1}$	0.006***	4.047
$\Delta \log(DI)$	0.007	0.337
$\Delta \log(DI)_{t-1}$	- 0.051***	- 2.441
$D_{1977-79}$	- 0.050***	- 3.976
$D_{1987-88}$	- 0.078***	- 4.037
$EC_{t-1}$	- 0.382***	- 4.773
Adjusted R <sup>2</sup>	0.746	
Durbin-Watson stat	2.298	
Serial correlation (LM) test	F(2,24) = 1.288 [4.494]	
Heteroskedasticity (ARCH) test	F(2,32) = 1.927 [4.279]	
Specification error (RESET) test	F(2,24) = 0.340 [4.494]	
Normality (Jarque-Bera) test	$\chi^2(2) = 1.625 [5.99]$	

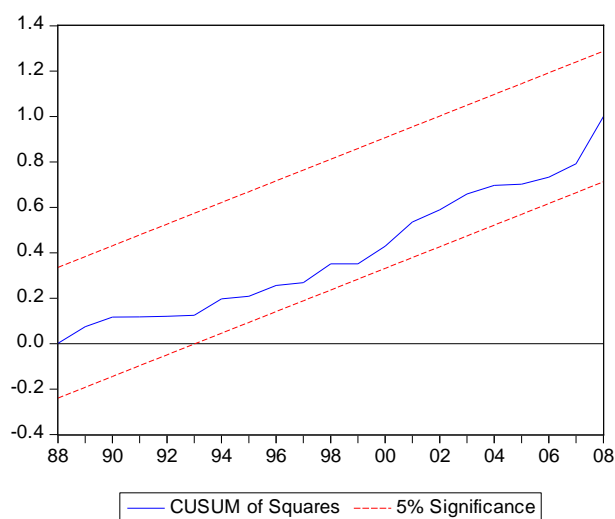
Note: Asterisks (\*), (\*\*), (\*\*\*) indicate significant at 10% , 5%, and 1% respectively.  $D_{1977-79}$  is the dummy variable that captures the effects of economic turmoil after the centrally-planned regime was introduced in 1975; it takes the value of 1 during 1977-79 and 0 elsewhere.  $D_{1987-88}$  is the dummy variable that captures the effects of natural disasters in 1987 and 88; it takes the value of 1 in 1987-88 and 0 elsewhere.

The results of the short-run dynamic indicate that the instant growth of foreign aid per capita has strong positive and significant effect on growth of income per capita. One percent point increase in growth of foreign aid per capita increases growth of income per capita by 0.036 percent point. However, the one-year-lag effect of aid shows negative impact and significant at 1% (One percent point increase in growth of foreign aid per capita decreases growth of income per capita by 0.049 percent point). The instant effect of foreign aid implies that, as most aids go to government budget, when receives aid, the government has financial confidence and can boost the economy by

increasing public spending, especially for improving infrastructures.



**Fig. 4.** CUSUM test on short-run dynamic model.



**Fig. 5.** CUSUM squares test on short-run dynamic model

However, the overspending of aid might cause the distortion in prices (a Dutch disease effect), thus causes a one-year lagged negative effect. Contrasting to foreign aid, FDI shows a negative instant effect to growth, but insignificant. Nevertheless, the one-year-lagged effect of FDI shows a significant impact on growth of income per capita. One percent point increase in growth of FDI per capita increases growth of



income per capita by 0.006 percent point. These effects might be explained in the sense that it will take FDI, which is the private foreign capital, at least one-year to effectively operate their business and be productive. However, the magnitude of the FDI's coefficient is very small compared to that of foreign aid. Unfortunately, we cannot see the significant instant effect of domestic investment, but the significant one-year lagged effect. It is quite difficult to find an exactly correct explanation of this negative effect. It should be noted that this domestic investment includes both public (excluding aid) and private investment; and for more than two decades (since 1975) most of major private enterprises are state-owned, who have always been the cause of non-performing loans, and have been the source of financial instability (IMF, 1998).

The dummy variables that capture the effects of economic turmoil (during 1977 and 1978) and the natural disaster occurred during 1987 and 1988 show strong significant negative effect (at 1%) on growth. The error correction coefficient also has correct negative sign. The magnitude of 0.328 implies that it will take about three years for independent variables to adjustment to equilibrium if any shock would occur.

## **6. Conclusion and policy implication**

This study empirically investigates the impact of foreign aid and foreign direct investment on long-run income per capita and short-run economic growth of Lao PDR. The empirical results strongly support the argument that foreign aid has a strong contribution to long-run income per capita income and it leads to instantaneous growth in the short run. On the other hand, our study found a strong negative impact of FDI on long-run income per capita and find that in the short run, it might take at least one year for FDI to have its growth effect. In addition, we found that domestic investment does not have a long-run effect on income. We conclude foreign aid plays a significant role in contributing to the sustainable economic growth to Lao PDR. For FDI, its negative impact might be due to its concentration only on mining and hydropower sector, which create less spillover effects; and might be due to its raises and falls in some periods.

In this respect, the policy implication is that the Lao government should also promote FDI to other sectors, especially those that provide spillover effects (i.e., manufacturing) and the government still needs to put efforts to carry out the policies that attract more stable flows of FDI. Also, the policy to promote private domestic investment is indispensable in order to increase a strong positive contribution in both long run and short run.

## Appendix A

Table A1

Augmented Dickey-Fuller (ADF) and Phillip-Perron unit root test

Variable	ADF test			Phillip-Perron test		
	Lag	Computed t-statistics	Critical t-statistics	Bandwidth	Computed t-statistics	Critical t-statistics
<u>At level</u>						
<i>log(YPC)</i>	2	1.707	-2.946	2	1.680	-3.533
<i>log(AID)</i>	1	-2.146	-2.946	1	-1.913	-3.533
<i>log(FDI)</i>	0	-0.853	-2.946	0	-0.853	-3.533
<i>log(DI)</i>	0	1.075	-2.946	2	1.225	-3.533
<u>At first difference</u>						
$\Delta \log(YPC)$	1	-5.019***	-2.946	2	-4.808***	-3.533
$\Delta \log(AID)$	0	-4.683***	-2.946	1	-4.712***	-3.533
$\Delta \log(FDI)$	0	-5.892***	-2.946	0	-5.892***	-3.533
$\Delta \log(DI)$	0	-5.589***	-2.946	2	-5.576***	-3.533

Note: Asterisks (\*), (\*\*), (\*\*\*) indicate significant at 10%, 5%, and 1% respectively. Critical values are from McKinnon (1991) at the 5% significant level.  $\Delta$  refers to first difference.

Table A2

Lag structure of the system

Lags	AIC	SC
0	7.548	8.076
1	-1.394*	-0.162*
2	-0.971	0.964
3	-0.961	1.677

Note: \* indicates lag order selected by the criterion. AIC refers to Akaike information criterion. SC refers to Schwarz information criterion.

Table A3

Johansen's cointegration test

Null Hypothesis for No. of CE(s)	Trace test		Maximum Eigen value test	
	Trace Statistics	Critical value (at 5%)	Max-Eigen value	Critical value (at 5%)
None	64.514**	63.876	34.480**	32.118
More than 1	30.033	42.915	13.043	25.823
More than 2	16.990	25.872	12.212	19.387
More than 3	4.777	12.518	4.777	12.518

Note: Asterisks (\*), (\*\*), (\*\*\*) indicate rejecting the null hypothesis at 10% , 5%, and 1% respectively.

## Appendix B

### B1. Derivation of foreign aid and FDI in Solow model

We assume a Cobb-Douglas production function, which disaggregates foreign aid, FDI, and domestic capital:

$$Y_t = K_{At}^\theta K_{Ft}^\beta K_{Dt}^\gamma (A_t L_t)^{1-\theta-\beta-\gamma} \quad (\text{B.1})$$

Then define

$y=Y/AL$ ,  $k_A=K_A/AL$ ,  $k_F=K_F/AL$  and  $k_D=K_D/AL$ , which are income per effective unit of labor, foreign aid stock per effective unit of labor, FDI stock per effective unit of labor, and domestic capital stock per effective unit of labor, respectively.

Eq.(1) can be written as

$$y_t = k_{At}^\theta k_{Ft}^\beta k_{Dt}^\gamma \quad (\text{B.2})$$

Differentiate  $k_A=K_A/AL$ ,  $k_F=K_F/AL$  and  $k_D=K_D/AL$  with respect to time, we have:

$$\frac{\dot{K}_A}{K_A} = \frac{\dot{k}_A}{k_A} + n + g; \quad \frac{\dot{K}_F}{K_F} = \frac{\dot{k}_F}{k_F} + n + g; \quad \text{and} \quad \frac{\dot{K}_D}{K_D} = \frac{\dot{k}_D}{k_D} + n + g \quad (\text{B.3})$$

where  $n$  is population growth rate,  $g$  is technological growth rate.

Assume that

$$\dot{K}_A = s_A Y - \delta K_A; \quad \dot{K}_F = s_F Y - \delta K_F; \quad \text{and} \quad \dot{K}_D = s_D Y - \delta K_D \quad (\text{B.4})$$

where  $\delta_A = \delta_F = \delta_D = \delta$  is depreciation rate,  $s_A$ ,  $s_F$ , and  $s_D$  are the share of foreign aid, FDI, and domestic investment to income, respectively.

Substitute (B.4) into (B.3) we have

$$\dot{k}_A = s_A y_t - (n + g + \delta)k_{At} \quad (\text{B.5a})'$$

$$\dot{k}_F = s_F y_t - (n + g + \delta)k_{Ft} \quad (\text{B.5b})'$$

$$\dot{k}_D = s_D y_t - (n + g + \delta)k_{Dt} \quad (\text{B.5c})'$$

From (B.5a), (B.5b), and (B.5c), solving for  $k_A$ ,  $k_F$ , and  $k_D$  at steady state and put into (B.2), we can write the steady state income per productive labor as:

$$y^* = \frac{s_A^{\theta/(1-\theta-\beta-\gamma)} s_F^{\beta/(1-\theta-\beta-\gamma)} s_D^{\gamma/(1-\theta-\beta-\gamma)}}{(n + g + \delta)^{(\theta+\beta+\gamma)/(1-\theta-\beta-\gamma)}} \quad (\text{B.6})$$

Expressing  $y$  as income per labor and taking logs both sides, we have

$$\begin{aligned} \ln\left(\frac{Y_t}{L_t}\right)^* &= \ln A_0 + gt + \frac{\theta}{1-\theta-\beta-\gamma} \ln(s_A)^* + \frac{\beta}{1-\theta-\beta-\gamma} \ln(s_F)^* + \frac{\gamma}{1-\theta-\beta-\gamma} \ln(s_D)^* \\ &\quad - \frac{\theta + \beta + \gamma}{1-\theta-\beta-\gamma} \ln(n + g + \delta) \end{aligned} \quad (\text{B.7})$$

where  $A = A_0 e^{gt}$

## B2. Speed of convergence

We turn Eq. (B.5a), (B.5b), and (B.5c) into the form

$$\dot{k}_A / k_A = s_A e^{(\theta-1)\ln k_A} \cdot e^{\beta \ln k_F} \cdot e^{\gamma \ln k_D} - (n + g + \delta) \quad (\text{B.8a})'$$

$$\dot{k}_F / k_F = s_F e^{\theta \ln k_A} \cdot e^{(\beta-1)\ln k_F} \cdot e^{\gamma \ln k_D} - (n + g + \delta) \quad (\text{B.8b})'$$

$$\dot{k}_D / k_D = s_D e^{\theta \ln k_A} \cdot e^{\beta \ln k_F} \cdot e^{(\gamma-1)\ln k_D} - (n + g + \delta) \quad (\text{B.8c})'$$

Using first-order Taylor expansion to approximate around steady state, and substituting

into  $\dot{y}/y = \theta(\dot{k}_A/k_A) + \beta(\dot{k}_F/k_F) + \gamma(\dot{k}_D/k_D)$ , we have

$$\dot{y}/y = -(1-\theta-\beta-\gamma)(n + g + \delta)[\theta(\ln k_A - \ln k_A^*) + \beta(\ln k_F - \ln k_F^*) + \gamma(\ln k_D - \ln k_D^*)]$$

or

$$\ln y - \ln y_{t-1} = -(1 - \theta - \beta - \gamma)(n + g + \delta)(\ln y - \ln y^*) \quad (\text{B.9})$$

The speed of convergence is defined as

$$\lambda = -(1 - \theta - \beta - \gamma)(n + g + \delta) \quad (\text{B.10})$$

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