Causality Relationship between Education, Health and Economic Growth in Laos and Thailand*

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Abstract

The intention of this study is to investigate the causal relationship between three different levels of education enrollment (primary, secondary and higher education), health (life expectancy) and RGDP in Laos and Thailand. The causal relationship was tested by using ARDL and VECM Granger Causality for the period 1996 to 2016. The empirical results show the same and the difference in 2 case Laos and Thailand. The unidirectional causality running from health and higher education enrollment to real GDP was found in two cases. The empirical estimation also found the unidirectional running from real GDP and health to secondary school enrollment in these two countries. The difference is that is unidirectional running from real GDP and health to higher education enrollment in case of Laos while we did not find these relationships in the case of Thailand. This might be benefit for policy maker to develop their economy.

Keywords: Causality; Relationship; Education; Health; Economic Growth**.**

Introduction

In this study we aimed to find the relationship between education, health and economic growth in the case of Laos and Thailand, according to UNDP we know that Laos is least developing country and Thailand is developing country. By following the idea of Solow Growth Model that labor is a factor of output, so our ideas is education and health are human capital that play an important role on economy. We can see in any kind of job will have human or labor are doing that job or in some kind of jobs that they are using machines they still need human to control the machines. Even though, the controller is not require for some machines to keep doing their jobs but there would not have machines if there are no human because human are the originator and creator. These mean human or labor are very important and to be a quality labor they must get an education to improve their skills, knowledge and critical thinking. In 2009 the research paper of Li. H and Huang. L was published. The research took place in China. They found the positive significant effects of health on economic growth. By dividing the education into different level they found that education has positive significant effect on economic growth. The estimation results also indicate that health and education will not reduce their impact on economic growth. They said perhaps

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there is a trade-off between these two forms of human capital investment. Moreover, the research of Afzal et al (2011) had found the unidirectional causality running from education to economic growth in Pakistan by using Granger causality test.

This research paper we used RGDL (real gross domestic product) as an economic growth, use three different levels of education enrollment and life expectancy in form of health. The assumption of the study is there are bidirectional causality between education and economic growth, bidirectional causality between health and economic growth, and bidirectional causality between health and education. As you know labor is the important factors that drive economy, therefore labor must have abilities to drive the economy and they should be healthy to keep doing their jobs. We assume that education and health would stimulate economic growth in positive way. While economic growth was affect by education and health, it would effects back to increase education and health. Moreover, we assume that health would cause the education to increase because if people are not healthy or sick they will miss a chance to go to school or miss a chance to learn. Furthermore, in countryside children might die by some disease because there are no public health supports and if they are intelligence that means we lost the very important labor force.

The rest of this paper has the following structure. In Section 2 provide the literatures review. Section 3 includes the methodology and data. Section 4 reports the result. Section 5 offers conclusion and compare the result of Laos and Thailand.

Literature review.

There are extensive empirical studies on the relationship between education, health and economic growth in developing and developed countries. However, the empirical results of the three variables are mixed and their result depends on country context, methodology and time spans.

Many recent empirical studies indicate the directional causality relationship between health and economic growth. By using VECM Granger Causality, Elmi and Sadeghi (2012) had found that economic growth got unidirectional causality from health in developing countries over the period of 1990 - 2009. French (2012) had run a research in OECD countries and found bidirectional between life expectancy and economic growth in time period of 1960 to 2007. Furthermore, there are many researches that found this relationship such as Hartwig (2009) found unidirectional causality from health capital to economic growth, Alhowaish (2014) found unidirectional causality running from economic growth to health care.

In addition, some research found the directional causality relationship between education and economic growth. Mariana (2015) used methodology of Granger causality to estimate the relationship between higher education and economic growth in Romania over the period 1980 to 2012. The estimate empirical shows that there is bidirectional causality between economic growth and higher education. Pegkas (2014) found the bidirectional causality between secondary education and economy in Greece by using Granger causality test. Moreover some research use different methodology such as Qazi et.al (2014) found the bidirectional causality between higher education and real income growth by using Toda-Yamamoto causality test. Fidlizan and Hussin (2012) used VAR to evaluate the relationship between economic growth and education in Malaysia. The result indicates that there is unidirectional causality between these two variables.

For more details about literature reviews we show it in the tables below. Table 1 provides literature of the causal relationship between health and economic growth. Table 2 shows Literature of the causal relationship between education and economic growth.

Table 1: literature of the causal relationship between health and economic growth.			
Growth hypothesis (Health Granger cause economic growth)			
Authors	Countries	Time period	Mothodology
Bloom et al (2001)	countries observed every 10 years	1960-1999	Panel cointegration, Nonlinear
Elmi and Sadeghi (2012)	Developing countries	1990-2009	Panel cointegration; Granger causality-VECM
Hartwig (2009)	OECD countries	1970-2005	Granger causality test
Mayer (2011)	Latin American	1950-1990	Granger causality test
Conservation hypothesis (economic growth Granger cause Health)			
Alhowaish (2014)	Saudi Arabia	1981-2013	Granger causality test
Asghar et al (2012)	Pakistan	1974-2009	Johansen cointegration; Granger causality test-VECM
Feedback hypothesis (Bi-directional causality between two variables)			
Erdil and Yetkiner (2009)	75 countries	1990-2000	Granger causality test-VAR
French (2012)	OECD countries	1960-2007	Panel cointegration, PANIC
Bédia (2008)	USA	1929-1996	Johansen cointegration ; Granger causality test-ECM
Hassan and Kalim (2012)	Pakistan	1972-2009	ARDL bounds test ; Granger causality
Neutrality hypothesis (No-directional causality between two variables)			
Ogungbenle et al. (2013)	Nigeria	1986-1990	Granger causality test-VAR

Table 2: literature of the causal relationship between education and economic growth.			
Growth hypothesis (Education Granger cause economic growth)			
Authors	Countries	Time period	Methodology
Alfândega and Lupi (2004)	Portugal	1960-2001	Johansen cointegration; Granger causality test
Afzal et al (2011)	Pakistan	1970-2009	Autoregressive Distributed Lag (ARDL); Granger causality test
Fidlizan and Hussin (2012)	Malaysia	1970-2010	Granger causality test-VAR
Katircioglu et al.(2012)	North Cyprus	1980-2010	error correction and Granger causality tests
Self and Grabowski (2004)	India	1966-1996	Granger causality test
Tsamadias and Prontzas (2011)	Greece	1960-2000	Granger causality test
Conservation hypothesis (economic growth Granger cause Education)			
Chuang (2000)	Taiwan	1952-1995	Granger causality test
Chaudhary et al (2009)	Pakistan	1972-2005	Johansen cointegration; Toda &

			Yamamoto test
Asghar et al (2012)	Pakistan	1974-2009	Johansen cointegration; Granger causality test-VECM
Feedback hypothesis (Bi-directional causality between two variables)			
Al-Yousif (2008)	GCC countries	1977-2004	Granger causality test
Mariana (2015)	Romania	1980-2012	Johansen cointegration; Granger causality test
Pegkas (2014)	Greece	1960-2009	Johansen cointegration; Granger causality test
Qazi et al (2014)	Pakistan	1980-2011	ARDL estimations; Granger causality test, Toda and Yamamoto
Tariq, S. I., Md Abdul, W., and Qamarullah, B. T. I. (2007)	Bangladesh	1976-2003	Johansen cointegration and Granger causality test
Bédia (2008)	USA	1929-1996	Johansen cointegration ; Granger causality test-ECM
Hassan and Kalim (2012)	Pakistan	1972-2009	ARDL bounds test ; Granger causality
Neutrality hypothesis (No-directional causality between two variables)			
Omojimite (2010)	Nigeria	1980-2005	Johansen cointegration; Granger causality test

Data and Methodology.

To investigate the relationship between education, health and growth we begin by following Cobb-Douglas production function:

$$Y = AK^{\alpha_1}L^{\alpha_2}$$

Where Y is Real GDP, A is technology and e is error term assumed, K is Capital, L is Labor composite as health and education (Narayan. S, Narayan. P. S and Mishra. S (2010)). We get constant return to scale when Cobb-Douglas technology is restricted to ($\alpha_1 + \alpha_2 = 1$). Then we write the empirical equation by transform each series to natural-log form for empirical purpose.

$$lnY_t = \beta_0 + \beta_1 lnK_t + \beta_2 lnH_t + \beta_3 lnE_t + u_t$$

Where Y is Real GDP represent to economic growth, H is life expectancy in form of health and E is education. For education we use three indicators as primary school enrollment (E1), secondary school enrollment (E2) and higher education enrollment (E3). We split empirical model into three models according to education indicators:

Model 1: $lnY_t = \beta_0 + \beta_1 lnK_t + \beta_2 lnH_t + \beta_3 lnE1_t + u_t$

Model 2: $lnY_t = \beta_0 + \beta_1 lnK_t + \beta_2 lnH_t + \beta_3 lnE2_t + u_t$

Model 3: $lnY_t = \beta_0 + \beta_1 lnK_t + \beta_2 lnH_t + \beta_3 lnE3_t + u_t$

We use these three models to evaluate the relationship in each country Laos and Thailand. The studies use annual time series data for the period 1996 to 2016.

Follow Qazi.W and Raza.S.A and Jawaid.S.T (2013) we used an Augmented Dickey–Fuller test (ADF) to examine to unit root test to find stationary for our time series data. We followed an equation below for Augmented Dickey–Fuller test (ADF)

$$\Delta Y_t = \alpha_{0+} + \alpha_1 Y_{t-1} + \sum_{j=1}^{k} d_j \Delta Y_{t-j} + \varepsilon_t$$

Where, ε_t is pure white noise error term, Δ is first difference operator, Y_t is a time series, α_0 is the constant and k is the optimum numbers of lags of the dependent variable. The variables be stationary if t-statistic of ADF is less than test critical values.

To find cointegration between economic growth, health and education we used Autoregressive Distributed Lag (ARDL) bounds test developed by Pesaran, M.H., Shin, Y., Smith, R.J (2001). This helps us find short run and long run relation in each model.

$$\Delta lnY_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta Y_{t-i} + \sum_{i=1}^{q} \alpha_2 \Delta K_{t-i} + \sum_{i=1}^{r} \alpha_3 \Delta H_{t-i} + \sum_{i=1}^{s} \alpha_4 \Delta E_{t-1} + \beta_1 Y_{t-1} + \beta_2 K_{t-1} + \beta_3 H_{t-1} + \beta_4 E_{t-1} + \mu_t$$

Where, α_0 is constant, Δ is the first difference operator and μ_t is an error term. The null hypothesis is there is no cointegration (H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$), if F-statistic is less than lower bound critical value or if it is between lower and upper bound critical values we accept null hypothesis. We can reject null hypothesis and accept H_1 (H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$) if F – statistic exceed the upper bound critical value. This mean there is no cointegration. In the equation $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ are short run coefficients and $\beta_1, \beta_2, \beta_3, \beta_4$ are long run coefficients. For the short run we follow the equation below.

$$\Delta lnY_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta Y_{t-i} + \sum_{i=1}^{q} \alpha_2 \Delta K_{t-i} + \sum_{i=1}^{r} \alpha_3 \Delta H_{t-i} + \sum_{i=1}^{s} \alpha_4 \Delta E_{t-1} + \beta ECT_t + \mu_t$$

In short run relationship ECT_t is a speed adjustment from short run equilibrium to long run term equilibrium. The coefficient of ECT_t must lower than zero and be significant to indicates the speed of adjustment.

After we found the cointegration by using ARDL Bounds Test we continue to investigate the causality relationship. VCEM (vector error correction model) Granger Causality was used to examine the short run and long run direction of causality relationship between economic growth, health and education. The VCEM (vector error correction model) is as given below:

$$(1-L)\begin{bmatrix} lnGDP \\ K \\ H \\ E \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} a_{11,i} & a_{12,i} & a_{13,i} & a_{14,i} \\ a_{21,i} & a_{22,i} & a_{23,i} & a_{24,i} \\ a_{31,i} & a_{32,i} & a_{33,i} & a_{34,i} \\ a_{41,i} & a_{42,i} & a_{43,i} & a_{44,i} \end{bmatrix} \times \begin{bmatrix} lnGDP_{t-1} \\ K_{t-1} \\ H_{t-1} \\ E_{t-1} \end{bmatrix} + \begin{bmatrix} lnGDP_{t-1} \\ K_{t-1} \\ H_{t-1} \\ E_{t-1} \end{bmatrix} + \begin{bmatrix} \vartheta_1 \\ \vartheta_2 \\ \vartheta_3 \\ \vartheta_4 \end{bmatrix} \times (ECT_{t-1}) + \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \\ \mu_4 \end{bmatrix}$$

Where, $(1-L)$ is the lag operator and $\vartheta_1, \vartheta_2, \vartheta_3, \vartheta_4$ are the coefficients of ECT_{t-1}, the significant and T – Statistic of these coefficients are refer to the long run causality relationship. ECT_{t-1} is the lag residual that obtain from the long run ARDL relationship. For short run term the hypothesis is if $a = 0$ means there is no short run causality but if $a \neq 0$ means there is short run causality.

Estimation Results.

(1) Unit Root Test.

We applied Augmented Dickey-Fuller (ADF) unit root test to inspect the variables are stationary or non-stationary. In Table 3 show the results of unit root test of variables in case of Laos and Table 4 show the results of unit root test of variables in case of Thailand. All variables were tested at intercept and trend and there are stationary. Some variables are stationary at first difference and some variables are stationary at level. This allowed us to use ARDL for testing cointegration in the next step. Lao's result indicate that LnY, LnK, LnH and LnE2 are stationary at first difference with insignificance at 1%, 5%, 1%, 1% level respectively while LnE1 and LnE3 are stationary at Level with significance at 1% and 5% level, respectively. Also, all variables of Thailand are stationary at first difference except LnH. Variables LnY, LnH, LnE2 and LnE3 are stationary with significant level at 1% while LnK and LnE1 are stationary with significant level at 5%.

Table 3: Laos: Unit Root Test (Augmented Dickey Fuller (ADF) Test).

Variable	Level		First Difference	
	Intercept	Trend	Intercept	Trend
LnY	3.020666	-1.492697	-2.516561	-4.698616*
LnK	-1.314996	-2.030277	-3.797090**	-4.022270**
LnH	-5.637609*	-0.121165	-4.114432*	-5.592134*
LnE1	-3.196004**	-1.660270	-0.881169	0.076527
LnE2	-0.209327	-2.523995	-2.036229	-5.597599*
LnE3	-4.913102*	-0.804848	-0.812003	-3.285156

Table 4: Thai: Unit Root Test (Augmented Dickey Fuller (ADF) Test).

Variable	Level		First Difference	
	Intercept	Trend		Intercept
LnY	0.370808	-3.322046***	-3.629965**	-3.467116***
LnK	-2.029774	-3.980230**	-3.779696**	-3.669665***

LnH	2.441217	-3.777540**	-1.771822	-2.296055
LnE1	-2.203500	-2.312263	-3.756558**	-3.146954
LnE2	0.995650	-2.967303	-4.605351*	-4.840367*
LnE3	-4.792051*	-4.120672**	-3.044189**	-3.760519**

(2) VAR Lag Order Selection Criteria.

The selection of optimum lag is very important for estimation. We followed the literature in order to estimate the optimum lag.

Table 5: Lag section for case of Laos.

Model 1: LnY LnK LnH LnE1

Lag	LogL	LR	FPE	AIC	SC	HQ
0	115.1070	NA	1.09e-11	-13.88837	-13.69522	-13.87848
1	225.3644	151.6040*	9.10e-17*	-25.67055*	-24.70481*	-25.62109*

Model 2: LnY LnK LnH LnE2

Lag	LogL	LR	FPE	AIC	SC	HQ
0	98.95808	NA	8.23e-11	-11.86976	-11.67661	-11.85987
1	205.5652	146.5848*	1.08e-15*	-23.19565*	-22.22992*	-23.14620*

Model 3: LnY LnK LnH LnE3

Lag	LogL	LR	FPE	AIC	SC	HQ
0	88.35988	NA	3.10e-10	-10.54498	-10.35184	-10.53509
1	193.2989	144.2912*	5.01e-15*	-21.66237*	-20.69663*	-21.61291*

* indicates lag order selected by the criterion

Table 6: Lag section for the case of Thailand.

Model 1: LnY LnK LnH LnE1

Lag	LogL	LR	FPE	AIC	SC	HQ
0	154.7945	NA	3.32e-12	-15.07945	-14.88030	-15.04057
1	257.4334	153.9584*	5.99e-16*	-23.74334*	-22.74760*	-23.54896*

Model 2: LnY LnK LnH LnE2

Lag	LogL	LR	FPE	AIC	SC	HQ
0	120.2869	NA	1.05e-10	-11.62869	-11.42954	-11.58981
1	219.9115	149.4369*	2.55e-14*	-19.99115*	-18.99541*	-19.79677*

Model 3: LnY LnK LnH LnE3

Lag	LogL	LR	FPE	AIC	SC	HQ
0	126.5001	NA	5.63e-11	-12.25001	-12.05086	-12.21113
1	237.1891	166.0336*	4.53e-15*	-21.71891*	-20.72318*	-21.52454*

* indicates lag order selected by the criterion

It is important to note that: LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion. The table above shows the lag order selection criteria. Our estimation uses lag from AIC.

(3) **ARDL Cointegration Test.**

ARDL Bounds Test was used to examine the cointegration in each model. Tells cointegration test in case of Laos. The result of bounds Test show that there is cointegration among real GDP, capital, health and education in Table 7. model 1, Table 8. model, 2 and Table 9. model 3 at 1% significance. Model 1 and Model 2 indicate 1% increasing of health could affect real GDP to increase by 9.63% - 12.12% in long run with 1% significance. In addition, the result in model 1 tells that in short run real GDP will grow up 0.92% when health increases 1% with 5% significance. Besides, there are no statistical significances for the impact running from capital and education to real GDP in these two models. The last model is model 3, it indicates that the coefficient of all variables are not statistical significance. The reported that higher education enrollment has a positive effect on real GDP, real GDP will increase 0.19% if higher education enrollment increases 1% but there is no statistical significance. ECT_{t-1} value is negative and significant in model 1 and 2 but it is not significant in model 3, -0.0962**, -0.0804* and -0.0704 respectively. The diagnostic test in Table 10 shows that all model clear off serial correlation and heteroskedasticity. The model 3 is normally distributed but model 1 and model 2 is not. In addition, all models are stable by testing stability diagnostic CUSUM and CUSUM of square developed by Brown, R.L., Durbin, J., Ewans, J.M.(1975), in the graphs of CUSUM and CUSUM of square the blue lines is lie within 5% significance.

Table 7: Results of ARDL Cointegration Test, Long run and Short run results in Laos (model 1).

Dependent variables	F-Test	Critical Value	1%	5%	10%
		Lower bounds	5.15	3.79	3.17
LnY	13.29712*	Upper bounds	6.36	4.85	4.14
Long run results					
Variables	**Constant**	**LNK**	**LNH**	**LNE1**	
Coefficient	-20.4724*	0.0067	9.6361*	0.7593	
T-Statistic	-5.4864	0.0606	5.9794	1.0871	
Short run results					
Variables	**D(LNK)**	**D(LNH)**	**D(LNE1)**	**ECT(-1)**	
Coefficient	0.0006	0.9275***	-0.0499	-0.0962**	
T-Statistic	0.0614	1.9916	-0.7220	-2.5400	
R^2	**Adjusted R^2**	**F-Statistic**	**P-Value**	**Durbin-Watson stat**	
0.841899	0.762848	10.65011	0.000938	2.291968	
Note:*, ** and *** denote the statistical significance at 1%, 5% and 10% level respectively					

Table 8: Results of ARDL Cointegration Test, Long run and Short run results in Laos (model 2).

Dependent variables	F-Test	Critical Value	1%	5%	10%
		Lower bounds	5.15	3.79	3.17
LnY	9.667874*	Upper bounds	6.36	4.85	4.14
Long run results					
Variables	**Constant**	**LNK**	**LNH**	**LNE2**	
Coefficient	-24.9387*	-0.0187	12.1241*	-0.3740	
T-Statistic	-4.1995	-0.1490	5.9512	-1.2464	
Short run results					
Variables	**D(LNK)**	**D(LNH)**	**D(LNE2)**	**ECT(-1)**	
Coefficient	-0.0015	-0.3916	-0.0300	-0.0804*	
T-Statistic	-0.1464	-0.7456	-1.6157	-3.1680	
R^2	**Adjusted R^2**	**F-Statistic**	**P-Value**	**Durbin-Watson stat**	
0.838108	0.757161	10.35388	0.001050	2.274415	
Note:*, ** and *** denote the statistical significance at 1%, 5% and 10% level respectively					

Table 9: Results of ARDL Cointegration Test, Long run and Short run results in Laos (model 3).

Dependent variables	F-Test	Critical Value	1%	5%	10%
		Lower bounds	5.15	3.79	3.17
LnY	10.68032*	Upper bounds	6.36	4.85	4.14
Long run results					
Variables	**Constant**	**LNK**	**LNH**	**LNE3**	
Coefficient	-4.1381	0.0667	6.2232	0.1959	
T-Statistic	-0.2603	0.4573	1.4951	0.6916	
Skort run results					
Variables	**D(LNK)**	**D(LNH)**	**D(LNE3)**	**ECT(-1)**	
Coefficient	0.0047	0.4387	-0.0201	-0.0704	
T-Statistic	0.4607	0.7772	-0.9538	-1.5101	
R^2	**Adjusted R^2**	**F-Statistic**	**P-Value**	**Durbin-Watson stat**	
0.852799	0.779199	11.58688	0.000666	1.913625	
Note:*, ** and *** denote the statistical significance at 1%, 5% and 10% level respectively					

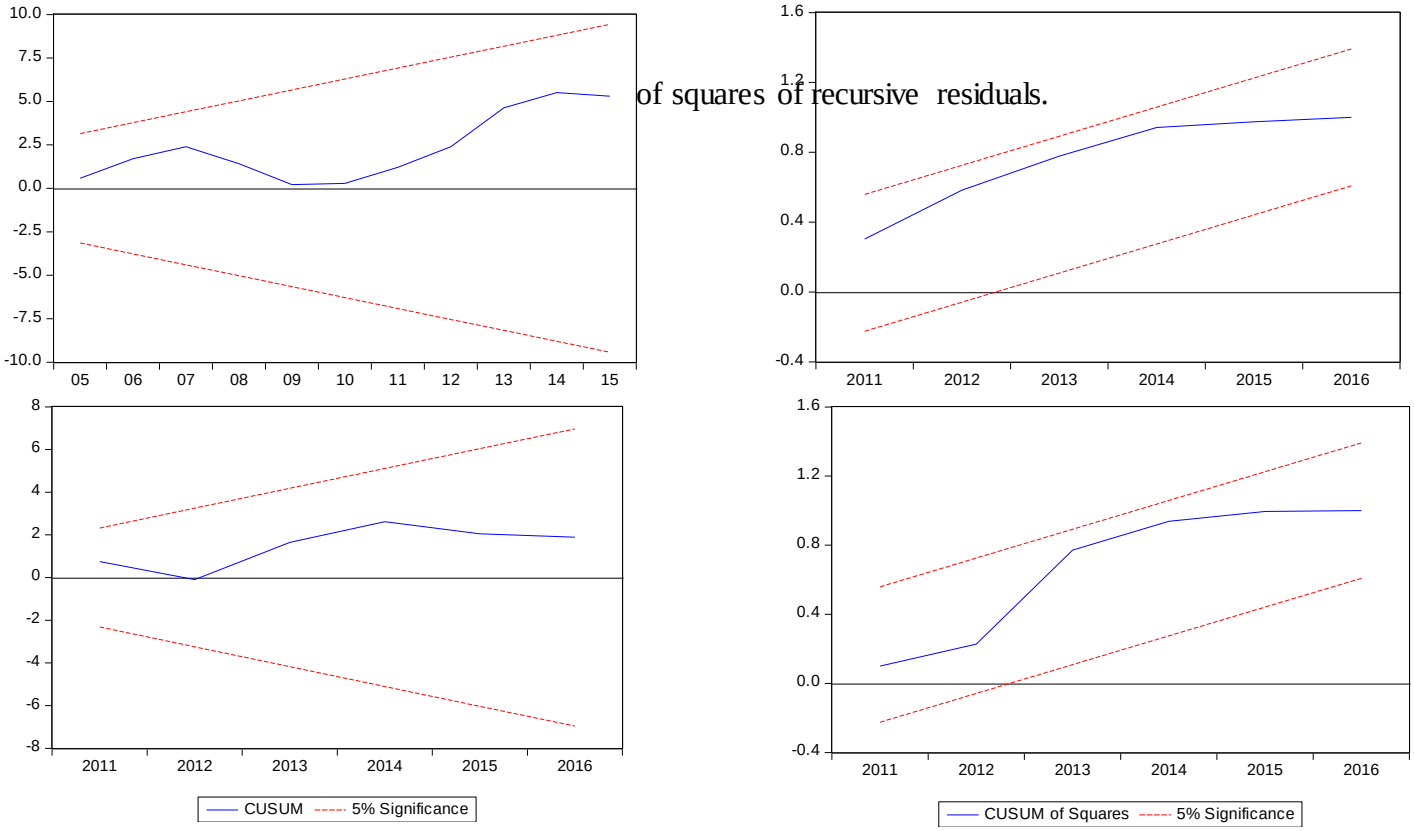
In order to check the robustness of our model, we did diagnostic test (table 10), and we also did the stability test by using the cusum and cusum of squares of recursive residuals (figure 1and 2).

Table 10: Residual Diagnostic Test

	Model 1: LnY LnK LnH LnE1		**Model 2**: LnY LnK LnH LnE2		**Model 3**: LnY LnK LnH LnE3	
	F - Statistic	P – Value	F - Statistic	P – Value	F - Statistic	P – Value
Serial	0.465617	0.3845	0.105661	0.6733	0.2312	0.5353

Correlation					65	
Normality	12.10060	0.00235 7	14.51980	0.000703	2.0486 85	0.359032
Heteroskedasticity						
Breusch-Pagan-Godfrey	0.587718	0.6107	0.443088	0.7231	1.7437 84	0.1850
ARCH Test	0.279749	0.5756	0.283024	0.5734	0.1160 23	0.7169

Model 1



of squares of recursive residuals.

Fig.2. Plot of cusum and cusum of squares of recursive residuals.

Model 3

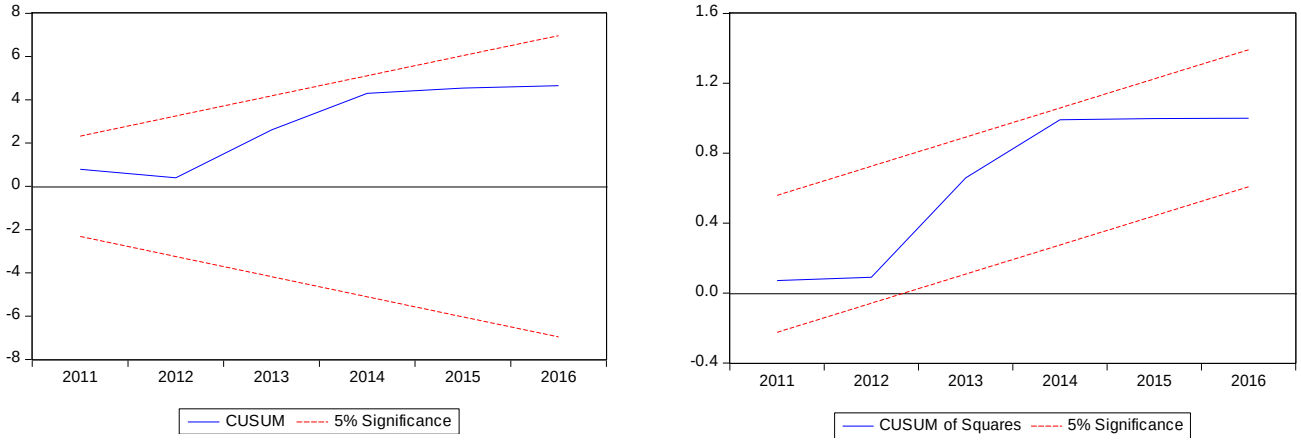


Fig.3. Plot of cusum and cusum of squares of recursive residuals.The results of ARDL cointegration in case of Thailand. The bounds testing indicate that there in cointegration in each model with statistical significance 5% and 1% level. The estimation finds the positive effect running form capital, health and education to real GDP in the term of long run. The result shows that 1% increasing of capital raises real GDP by 0.12%-0.18%. Health stimulates real GDP to growth 6.03%-8.89% when heath increases 1% with statistical significance at 1% level. Primary school enrollment and higher education enrollment have positive effect on real GDP. 1% growth of higher education enrollment stimulates real GDP to increase 0.22% and the increasing of real GDP will grow by 0.64% when primary school enrollment increases 1%. This mean education is important to real GDP and supported it to grow up. Even though the result of Table 11. Model 1 and Table 12. Model 2 indicate that education stimulate real GDP in positive way but in model 2 the result is so different. Model 2 shows the negative effect of secondary school enrollment on real GDP but it is no statistical significance.

The short run result is reported. The result is quite same as the long run term. The impact of capital, health and education on real GDP is positive expect in model 2 shows that secondary school enrollment has a negative effect on real GDP but there is no significance. 1% increasing of capital raise real GDP by 0.13% - 0.17% at 1% significance. The coefficient of health also indicate the positive effect running to real GDP, 1% increasing of health stimulate real GDP to increase by 6.03% - 8.85%. Primary school enrollment and higher education enrollment also have positive effect to increase real GDP 0.68% and 0.19%, respectively. For ECT_{t-1} the coefficient in each model is negative and significance expect model 2. The diagnostic test in Table 14 shows that there is serial correlation in model 1 and model 2 expect Table 13. Model 3. The error term of all models is normally distributed and there is no heteroscedasticity. The graph of CUSUM and CUSUM of square confirm stability of parameters because the blue lines lie with in the 5% critical bounds.

Table 11: Results of ARDL Cointegration Test, Long run and Short run results in Thailand (Model 1).

Dependent variables	F-Test	Critical Value	1%	5%	10%
		Lower bounds	5.15	3.79	3.17
LnY	5.772120**	Upper bounds	6.36	4.85	4.14

Long run results				
Variables	**Constant**	**LNK**	**LNH**	**LNE1**
Coefficient	-13.5400*	0.1667*	7.6579*	0.6424**
T-Statistic	-12.3331	4.7946	16.5510	2.1235

Short run results				
Variables	**D(LNK)**	**D(LNH)**	**D(LNE1)**	**ECT(-1)**
Coefficient	0.1784*	8.1933*	0.6874*	-1.0699
T-Statistic	3.9709	4.2540	2.4396	-4.7337

R^2	**Adjusted R^2**	**F-Statistic**	**P-Value**	**Durbin-Watson stat**
0.606180	0.501161	5.772120	0.005114	2.414762

Note:*, ** and *** denote the statistical significance at 1%, 5% and 10% level respectively

Table 12: Results of ARDL Cointegration Test, Long run and Short run results in Thailand (Model 1).

Dependent variables	F-Test	Critical Value	1%	5%	10%
		Lower bounds	5.15	3.79	3.17
LnY	6.125336*	Upper bounds	6.36	4.85	4.14
Long run results					
Variables	**Constant**	**LNK**	**LNH**	**LNE2**	
Coefficient	-14.4586*	0.1243*	8.8565*	-0.0489	
T-Statistic	-5.5413	3.3723	11.2785	-0.7552	
Short run results					
Variables	**D(LNK)**	**D(LNH)**	**D(LNE2)**	**ECT(-1)**	
Coefficient	0.1342*	9.5592**	-0.0528*	-1.0793	
T-Statistic	2.5712	4.2771	-0.7825	-4.1169	
R^2	**Adjusted R^2**	**F-Statistic**	**P-Value**	**Durbin-Watson stat**	
0.620266	0.519004	6.125336	0.003965	2.426873	
Note:*, ** and *** denote the statistical significance at 1%, 5% and 10% level respectively.					

Table 13: Results of ARDL Cointegration Test, Long run and Short run results in Thailand (Model 3).

Dependent variables	F-Test	Critical Value	1%	5%	10%
		Lower bounds	5.15	3.79	3.17
LnY	6.605352*	Upper bounds	6.36	4.85	4.14
Long run results					
Variables	**Constant**	**LNK**	**LNH**	**LNE3**	
Coefficient	-4.8766***	0.1827*	6.0346*	0.2255*	
T-Statistic	-1.9073	5.6670	7.7228	3.1504	
Short run results					
Variables	**D(LNK)**	**D(LNH)**	**D(LNE3)**	**ECT(-1)**	
Coefficient	0.1545*	5.1057*	0.1908*	-0.8460*	
T-Statistic	5.0315	3.2673	5.1110	-5.0292	
R^2	**Adjusted R^2**	**F-Statistic**	**P-Value**	**Durbin-Watson stat**	
0.637868	0.541300	6.605352	0.002843	2.539472	
Note:*, ** and *** denote the statistical significance at 1%, 5% and 10% level respectively.					

Table 14: Residual Diagnostic Test

	Model 1: LnY LnK LnH LnE1		**Model 2**: LnY LnK LnH LnE2		**Model 3**: LnY LnK LnH LnE3	
	F - Statistic	P – Value	F – Statistic	P – Value	F - Statistic	P – Value
Serial Correlation	8.598206	0.0058	24.80051	0.0003	0.402890	0.4545
Normality	1.297346	0.2732	2.929360	0.0671	0.318923	0.8146
Heteroscedasticity						
Breusch-Pagan-Godfrey	1.297346	0.2732	2.929360	0.0671	0.318923	0.8146
ARCH test	0.616807	0.4147	0.073614	0.7747	0.131821	0.7022

Model 1:

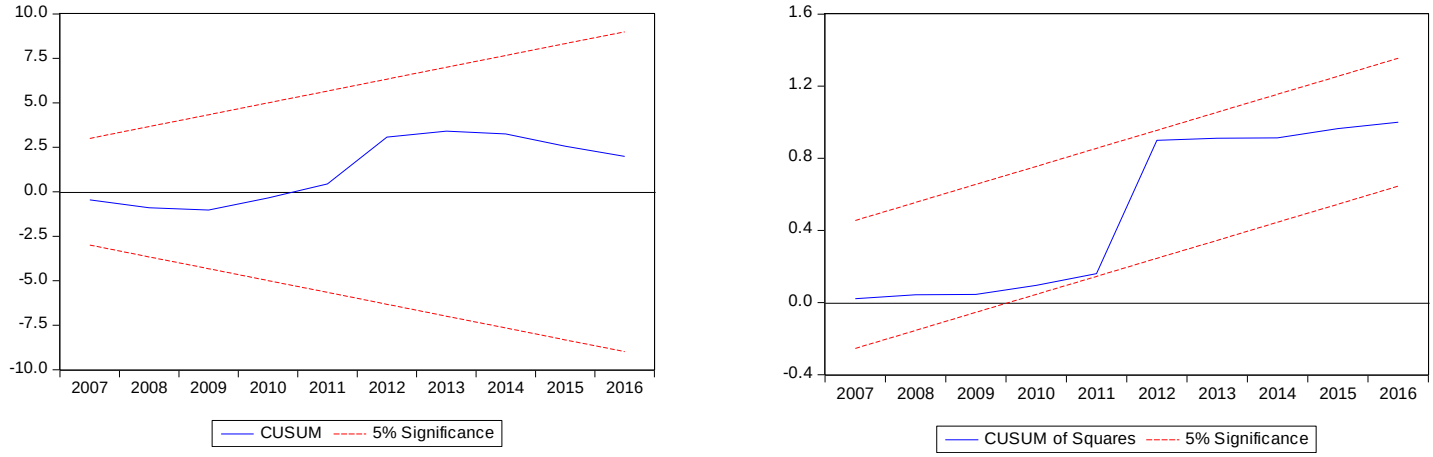


Fig.1. Plot of cusum and cusum of squares of recursive residuals.

Model 2:

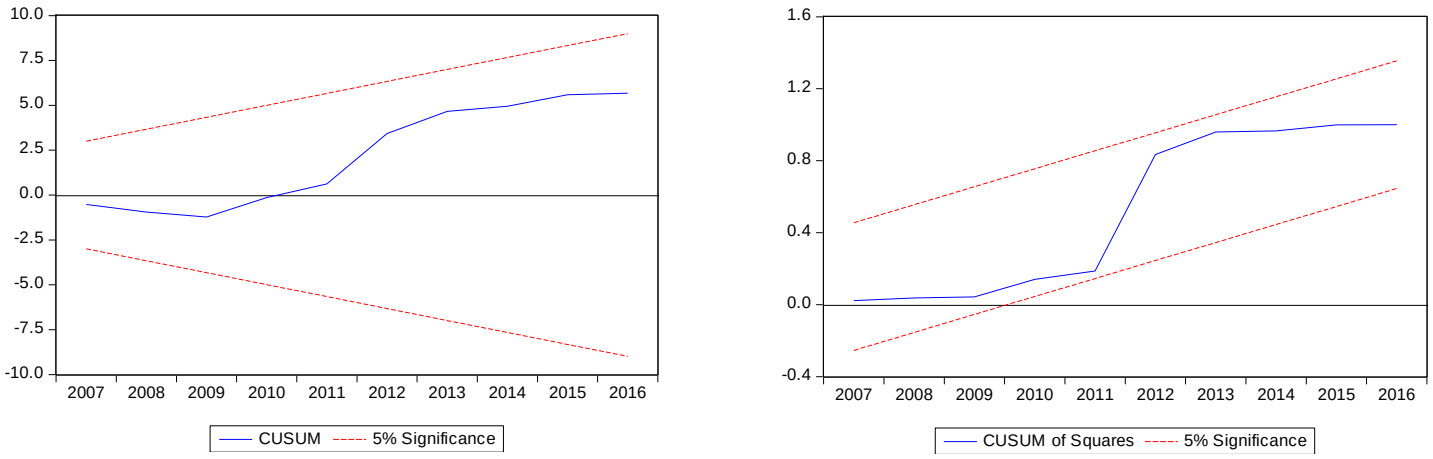


Fig.2. Plot of cusum and cusum of squares of recursive residuals.

Model 3

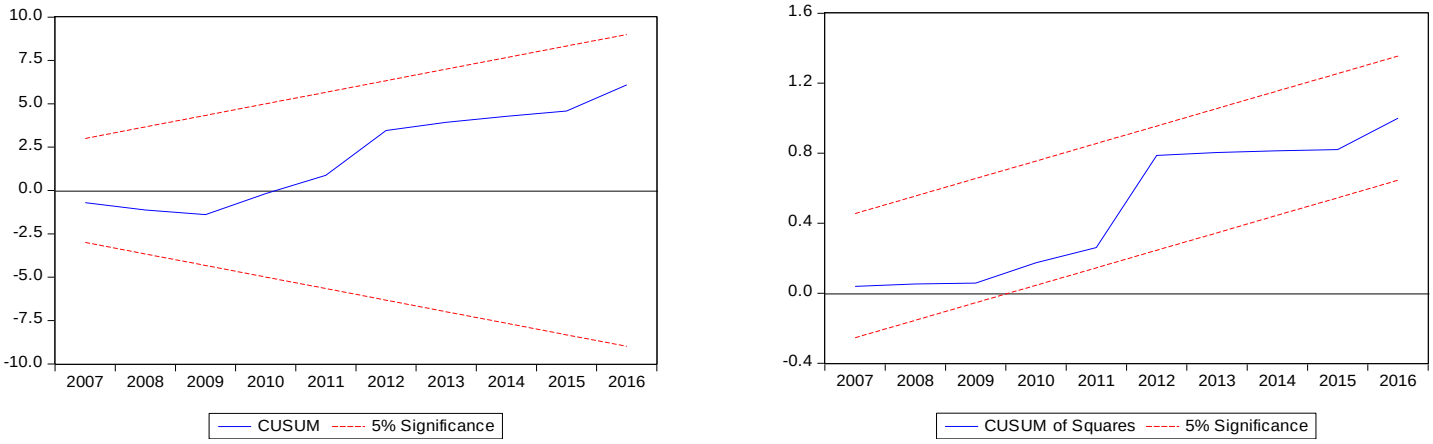


Fig.3. Plot of cusum and cusum of squares of recursive residuals.

(4) The VECM Granger causality analysis.

The result in Table 15 indicates the granger causality relationship in case of Laos. Model1 shows that there is no Granger causality running from health and capital to real GDP. Capital got unidirectional causality from real GDP, health and primary school enrollment in long run. Also, in the short run there is unidirectional causality running from real GDP and primary school enrollment to capital and there is unidirectional causality running from primary school enrollment to real GDP. The model 2 indicates the unidirectional causality running from real GDP, capital and Health to secondary school enrollment in long run. The model 2 also indicates the unidirectional causality running from real GDP, health and secondary school enrollment to capital. In addition, in model 3 there is bidirectional causality between higher education enrollment and real GDP in long run term. The unidirectional causality running from health to real GDP and Higher education enrollment was found in short run. Besides, in the short run we found the unidirectional running from health to real GDP.

Table 15: The VECM Granger Causality Analysis in Laos (Model 1)

Dependent Variables	**Short run**				**Long run**
	LnY	LnK	LnH	LnE1	ECT_{t-1}
LnY	–	0.399251 (0.5275)	1.537847 (0.2149)	3.144766*** (0.0762)	-0.925689 (0.3788)
LnK	19.24564* (0.0000)	–	1.826236 (0.1766)	11.32054* (0.0008)	-2.978944** (0.0155)
LnH	0.032538 (0.8569)	0.009520 (0.9223)	–	0.702488 (0.4019)	1.489134 (0.1706)
LnE1	0.003266 (0.9544)	0.062039 (0.8033)	0.248648 (0.6180)	–	-0.682461 (0.5121)

Model 2: The VECM Granger Causality Analysis in Laos (Model 2)

Dependent Variables	**Short run**				**Long run**
	LnY	LnK	LnH	LnE2	ECT_{t-1}
LnY	–	0.089019 (0.7654)	0.000188 (0.9891)	1.149517 (0.2837)	0.158589 (0.8775)

LnK	2.227640 (0.1356)	–	8.815094* (0.0030)	4.551291 (0.0329)	-3.181368** (0.0112)
LnH	0.405943 (0.5240)	0.116579 (0.7328)	–	2.004720 (0.1568)	1.558508 (0.1535)
LnE2	0.699776 (0.4029)	0.153804 (0.6949)	3.924166** (0.0476)	–	-1.977874*** (0.0793)

Model 3: **The VECM Granger Causality Analysis in Laos (Model 3)**

Dependent Variables	**Short run**				**Long run**
	LnY	LnK	LnH	LnE3	ECTt-1
LnY	–	0.677566 (0.4104)	17.76122* (0.0000)	18.72992* (0.0000)	-3.792429* (0.0043)
LnK	0.127015 (0.7215)	–	0.030162 (0.8621)	1.878826 (0.1705)	-0.644763 (0.5352)
LnH	1.233816 (0.2667)	0.095006 (0.7579)	–	0.033228 (0.8554)	-1.150847 (0.2795)
LnE3	6.8605 (0.9934)	0.049710 (0.8236)	6.540897** (0.0105)	–	1.837423*** (0.0993)

Note:*, ** and *** denote the statistical significance at 1%, 5% and 10% level respectively.

Table 16 reported the directional relationship between real GDP, capital, health and education enrollment in case of Thailand. Model 1 shows the unidirectional causality running from real GDP, capital and health to primary in short run and long run. In short run real GDP, capital and primary school enrollment unidirectional causality to health. The empirical estimation also found the bidirectional between real GDP and capital in short run. Furthermore, there is unidirectional running from health to real GDP in short run. The result of model 2 found the bidirectional between health and secondary school enrollment. The unidirectional causality running from real GDP to capital was found in short run. The result also indicates the unidirectional running from real GDP and capital to health and secondary school enrollment in long run. Model 3 reported the unidirectional causality running from capital, health and higher education enrollment to real GDP was found in long run. The capital got unidirectional causality from real GDP, health and higher educational enrollment. Moreover, capital also got unidirectional causality running from higher education enrollment in the short run.

Table 16: The VECM Granger Causality Analysis in Thailand (Model 1)

Dependent Variables	**Short run**				**Long run**
	LnY	LnK	LnH	LnE1	ECT_{t-1}
LnY	–	3.999413** (0.0455)	4.918245** (0.0266)	0.341642 (0.5589)	-1.663857 (0.1200)
LnK	3.558108** (0.0593)	–	2.468084 (0.1162)	0.236008 (0.6271)	0.571451 (0.5774)
LnH	7.244169* (0.0071)	4.211890** (0.0401)	–	11.40365* (0.0007)	3.439767 (0.0044)
LnE1	7.234362* (0.0072)	4.282166** (0.0385)	20.51843* (0.0000)	–	-4.599070* (0.0005)

Table 16: The VECM Granger Causality Analysis in Thailand (Model 2)

Dependent Variables	Short run				Long run
	LnY	LnK	LnH	LnE2	ECT_{t-1}
LnY	–	1.315637 (0.2514)	1.593726 (0.2068)	0.000150 (0.9902)	-0.384829 (0.7066)
LnK	5.252173** (0.0219)	–	1.822693 (0.1770)	1.231584 (0.2671)	1.185487 (0.2570)
LnH	0.529963 (0.4666)	0.032416 (0.8571)	–	33.98316 (0.0000)	-7.374869* (0.0000)
LnE2	0.044728 (0.8325)	2.970005 (0.9957)	0.016421 (0.8980)	–	-1.940329*** (0.0743)

Model 3: **Table 16: The VECM Granger Causality Analysis in Thailand (Model 3)**

Dependent Variables	Short run				Long run
	LnY	LnK	LnH	LnE3	ECTt-1
LnY	–	0.367689 (0.5443)	0.679634 (0.4097)	1.976249 (0.1598)	3.772412* (0.0023)
LnK	0.428375 (0.5128)	–	1.393033 (0.2379)	5.184610** (0.0228)	-5.290080* (0.0001)
LnH	0.038892 (0.8437)	0.008250 (0.9276)	–	0.677133 (0.4106)	-0.516446 (0.6142)
LnE3	0.852460 (0.3559)	1.320264 (0.2505)	0.148016 (0.7004)	–	-1.674468 (0.1179)

Note:*, ** and *** denote the statistical significance at 1%, 5% and 10% level respectively.

Conclusion.

This paper estimates the short run and long run directional causality relationship between real GDP, capital, Life expectancy, primary school enrollment, secondary school enrollment and higher education enrollment in case of Laos and Thailand, period 1996 to 2016. We used ARDL Bounds test to find the cointegration and used VECM Granger causality find the direction causality relationship among the variables. The result of Laos confirms that there is bidirectional between real GDP and higher education enrollment in the long run. There is unidirectional causality running from real GDP and health to secondary school and higher education enrollment. The result also indicates the positive effect and unidirectional causality running from health to real GDP.

In case of Thailand is a slightly different from Lao case. We found bidirectional between primary school enrollment and health in the short run. The result also found bidirectional between secondary school enrollment and health.

Higher education enrollment gave a positive effect on real GDP in long run term. Real GDP got directional causality from higher education enrollment in the long run while the estimation did not found directional causality running from real GDP to higher education enrollment. Moreover, the empirical estimation indicates the unidirectional running from real GDP to health, primary school and secondary school enrollment.

To sum up, the empirical estimation in case of Laos and Thailand indicates that there is unidirectional causality running from health and higher education enrollment to real GDP. We also found the unidirectional running from real GDP and health to secondary school enrollment. The difference is there is unidirectional running from real GDP and health to

higher education enrollment in case of Laos but we did not find these relationships in the case of Thailand. This study might benefit for policy makers to formulate policies for developing economy and increasing economic growth.

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