Diseases and Economic Performance: Evidence from Panel Data

Norashidah Mohamed Nor[1], Abdalla Sirag[1], Wency Bui Kher Thinng[1] & Salisu Ibrahim Waziri[1,2]

[1] Department of Economics, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

[2] Department of Economics, Bauchi State University, Gadau, Bauchi State, Nigeria

Correspondence: Abdalla Sirag, Department of Economics, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia. E-mail: abdallasirag87@yahoo.com

Abstract

The current study aims to estimate to what extent economic performance is affected by different types of diseases. Particularly, we intend to examine the impact of diseases such as dengue, TB and HIV on GDP per capita in selected Southeast Asian countries. The panel data analysis and cointegration estimation technique are adopted to achieve the objectives of the study. The findings reveal that the variables move together in the long-run, and the results confirmed by three cointegration tests: Johansen-Fisher, Kao and Pedroni. Additionally, the coefficients estimated using FMOLS and confirmed by DOLS. Most importantly, it has been shown that shocks to human capital (diseases) have a large adverse impact on economic performance, especially; dengue, TB and HIV. The second major finding was that the role of human capital is found to be very crucial expressed by education and labor. The findings of this study suggest that reduction of diseases can lead to considerable improvement in economic performance.

Keywords: economic performance, human capital, communicable diseases, cointegration, Southeast Asia

1. Introduction

The prevalence of communicable and non-communicable diseases remain the global health challenges, this pandemic has adverse effect on life expectancy, workers' productivity and economic growth in general. Most importantly, communicable diseases such Dengue fever, tuberculosis TB and HIV/AIDS are from the major diseases that pose a real threat and contribute to mortality and morbidity in the world. The Southeast Asia region contributes by 27% of the global burden of infectious and parasitic diseases, particularly by 52% for dengue and 36% for TB (Gupta & Guin, 2010). These diseases are considered to have large impact on the economic performance all around the world especially in this region (Coker, Hunter, Rudge, Liverani, & Hanvoravongchai, 2011). Considerable amount of economic literatures have tested the impact of diseases on economic growth focusing more on HIV/AIDS, however; the effect of other diseases such dengue and TB are not considered much. Basically, diseases influence economic performance through the productivity of the labor force and human capital accumulation (Veenstra & Whiteside, 2005; Couderc & Ventelou, 2005). The main outcome of the reduction on productivity and capital accumulation is immediate decline in country's output (Goenka & Liu, 2010). The aforementioned diseases have main impact in reducing infected persons' ability to work effectively and thus, reduce their productivity, which may have major economic consequences.

This paper intends to examine the extent to which economic performance is affected by diseases in Southeast Asia. The endogenous growth theory and recent extensions to "learning by doing" model by Ouattara (2004) is adopted as an appropriate theoretical framework in order to address the objectives. The study uses panel cointegration approach for six countries chosen based on the availability of long data set covers the period 1990 to 2011. Three models will be estimated separately using fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS). The remainder of this study is organized as follows. Section 2 discusses the empirical literature on the impact of diseases prevalence on economic performance, followed by the theoretical framework. Section 3 presents the data and methodology used in the study. Section 4 discusses the empirical findings, and the conclusion and policy implications are included in Section 5.

2. Literature Review

Economic growth theoretical or empirical interpretations on literatures mostly expect that the diseases to be negatively related to economic growth. On the same concept, Lucian et al. (2007) examine whether economic

growth is related to the growth rates of different diseases in European countries. The results reveal a negative insignificant relationship between mental illness and economic growth for only 11 countries due unavailability of data. Interestingly, circulatory system diseases, which consider as a kind of heart diseases found to be positively related to GDP per capita. While there is no relationship found between ischemic heart disease and economic growth. They argue that countries with higher growth rate offer more hospital services than countries with lower economic growth. Further analysis of causality showed that economic growth rate causes the growth rate of diseases in European countries, they interpret that by; higher economic growth rate may lead to higher usage of hospital and medical care.

Many studies have emphasized that the impact of diseases such as HIV on economic growth take place in the short-run through the channel of labor only. In study done by Couderc and Ventelou (2005) using macroeconomic approach, particularly the endogenous growth theory they argue that the HIV/AIDS has a long-term negative impact on productivity of human capital, and physical capital through reducing saving rate. The estimated model for the selected four African countries has confirmed the theoretical prediction made by the authors. They suggested that governments should take into account the long-run impact of diseases on human capital by spending more on health and education. In addition, some countries may suffer from lack of resources and they cannot sustain their expenses, thus; the international intervention (aid) is required in such countries. The reduction of diseases is shown to be a crucial factor that contributes substantially to improve human capital. Bleakley and Lange (2009) Show that eradication of chronic diseases such as hookworm in the American South led to increase school enrollment and reduce illiteracy rate. Additionally, the study explains that the increase in human capital is also accompanied by a decrease in fertility rate, particularly 20% reduction in hookworm-infection rate associated with a 40 % decline in fertility rate.

There are some opinions believe that some diseases such as HIV has serious multiple economic consequences, but it may take long time to unfold. Veenstra and Whiteside (2005) investigate the economic impact of HIV in some African countries. They argue that HIV leads to impoverishment of households by two things; paying for the high cost of treatment, and income earned by individuals is reduced due to the illness. In firms level the impact of HIV disease rises the cost of doing business due to the potential increase in taxes in order to finance health expenses, that besides, the low productivity of workers infected by HIV. On a macro level economic growth is largely affected by disease infection due to the reduction on national saving, specifically; GDP growth will be reduced between 0.5 to 2.6% annually. Further evidence shows that diseases tend to increase demand for health and medical care, which require strong financial capability in order to maintain these needs.

A recent study by Afawubo and Mathey (2014) try to estimate the impact of employment and education level on the HIV prevalence and GDP growth rate in the short and long run by using panel cointegration for 15 West African countries. The results of the Pedroni cointegration test reveal that all the variables move together in the long-run. The DOLS estimator shows that economic growth tends to increase HIV prevalence, but secondary school enrollment reduces HIV infection. The most striking result emerged from their study; HIV is positively correlated to economic growth in the same line with Young (2005). In addition, the findings emphasize the role played by education in rising human capital level, which cause economic growth to improve, similarly; employment also found to be a very critical factor that may reduce HIV prevalence rate and increase the growth rate. However, the outcomes of this study mainly suggest that HIV prevalence improves economic growth, which may sound very strong result lacks to theoretical and empirical support. The empirical evidence of the impact of HIV infection rate on economic growth in the developing countries, in various regions, such as Honduras from South America and Mozambique from Sub-Saharan Africa reveals quite similar findings about the negative influences of HIV on economic growth (Cuesta, 2010; Arndt, 2006). On the other hand, most of studies on the economic burden of dengue and TB tried to estimate the direct or indirect costs initiated with treatment of patients and loss to labor productivity mostly in South-East Asian countries. The findings of these studies enhance our understanding of the considerable loss of economic resources due to the high cost of dengue and TB treatment in the region of South-East Asia (Rajeswari et al., 1999; Garg, Nagpal, Khairnar, & Seneviratne, 2008; Han et al., 2010; Shepard, Undurraga, & Halasa, 2013).

It can be seen most of pervious empirical works especially those from macroeconomics prospective, emphasized much on the impact of HIV rather than other diseases. The lack of appropriate theoretical foundations, besides, not using robust econometrics technique since most of studies rely on time series analysis or just calculate the direct or indirect costs of diseases. In addition, the South-East Asian region is one of the highest contributors to the total global burden of diseases then such studies are needed to make the right decision by policy makers.

2.1 Theoretical Framework

Based on endogenous growth theory "learning by doing model" and Ouattara (2004) the relationship between health shocks (diseases) and economic growth can be specified by the following production function:

$$y = AK^{\alpha} L^{1-\alpha} E^{\beta}$$
$$A = BK^{\theta}$$

where y is the output, K is physical capital, A is knowledge, which is function of capital, L is the active population, and E is the gained experience.

Since the active labor force:

$$L = (1 - S)^e P, e \geq 1$$
$$P = P_0 e^{\int_0^t n[S(x)]dx}, P_0 = 1$$

where, S represents the shock or disease infection of active labor force as a share of total.

The learning by doing process is described as:

$$E = K$$
$$\beta = 1 - \alpha$$

The theory assumes that more experience is gained by physical capital, and constant return to scale.

Other assumptions are made to ensure that the equilibrium in the goods market will take place:

$$Y = C + D + K$$

where C is consumption, D denotes medical expenditure to combat the infection of diseases, and K is stock of capital. It is expected that D is proportional to the country's income level, as shown in the following Equation:

$$D = N K$$

Where N indicate other controlling variables, since the capital depreciation rate is constant.

Ouattara (2004) argues that the policies to stabilize health shocks in order to maintain the growth rate of the economy are exist in the form of health expenditure and capital accumulation. However, the absence of these policies can unambiguously lead to decline economic growth rate. More importantly, economic growth is expected to decrease in response to the increase in disease infection rate.

3. Data and Methodology

3.1 Estimation Methods

To estimate the impact of communicable diseases such as dengue, TB and HIV and how it can influence economic performance in selected Southeast Asian countries, this paper adopts from human capital and economic growth literatures the following models:

$$LGDP_{it} = \alpha_{1i} + \gamma_{1i}t + \beta_1 LH_{it} + \beta_2 LX_{it} + \mu_{it} \tag{1}$$

where α_{1i} and γ_{1i} are country specific effect and time trend respectively, LGDP is GDP per capita constant price, LH represents health expressed by three diseases, which are dengue cases as a percentage of population, tuberculosis out of total population, and the prevalence of HIV among productive age between 15-49 year as a percentage of total the population. LX refers to others controlling variables and µ is the error term. The controlling variables are education level represented by secondary school enrollment LSER, gross capital formation LCF as proxy of physical capital, total labor force LLF, and population growth LPG.

3.2 Data

The sample of the study contains five Southeast Asian countries, which have complete dataset: Indonesia, Malaysia, Singapore, Philippines and Thailand from 1990 to 2011. The main source of dengue reported cases data is World Health Organization, secondary school enrollment and prevalence HIV for Singapore are obtained from ministry of education and ministry health, respectively, and the other variables source's is World Development Indicator of World Bank Database.

3.3 Panel Unit Root Test

Most of time series data and especially macroeconomic variables contain stochastic time trend and thus; they tend to have unit root and regressing stationary and non-stationary might lead to a spurious outcome (Engle & Granger, 1987). Therefore, the current study uses panel unit root test in order to determine the order of integration among the variables in the models above. Previous studies have used traditional Dickey Fuller and Augmented Dickey Fuller, which have low power tests. Levin Lin and Chu (2002) proposed powerful panel unit

root test preforms better than individual unit root test, the null hypothesis indicates non-stationary of all individuals, but the alternative shows that all cross-section are stationary, which is quite strong assumption. As a result, this study is also adopting more powerful and reliable test developed by Im, Pesaran and Shin (2003). The IPS test allows for heterogeneity across individual units which every cross section has a separate non-stationary process; the null hypothesis assumes the presence of unit root.

$$\Delta y_{it} = \alpha_i + \beta_i y_{it-1} + \sum_{i=1}^{pi} \rho_{ij} \Delta y_{it-j} + \mu_{it} \tag{2}$$

According to Im et al. (2003), the ADF regression will be estimated for each cross section unit separately, and different orders of serial correlation allowed. The null hypothesis is $\alpha_i = 0$ for all cross sections, and alternative hypothesis $\alpha_i \neq 0$ for i= 1,2,…,N_1 where $N_1 < N$, and $\alpha_i < 0$ for i= N+1, N+2,…,N. The rejection of the null hypothesis of unit root does not imply for all the cross section units due to the heterogeneity of the alternative hypothesis (Im et al., 2003).

3.4 Panel Cointegration Test

The following step after the order of integration being determined is to test for the existence of the long-run cointegration relationship among variables. In order to do so, the study uses Kao (1999) cointegration test, which is based on Engle Granger-two step, Johansen Fisher Panel Cointegration test developed by Maddala and Wu (1999), and Pedroni (2004) panel cointegration test to examine the long-run equilibrium relationship among variables. Kao (1999) test is calculated as follows:

$$y_{it} = \alpha_i + x_{it} \beta + \varepsilon_{it} ; \quad i=1,2,….,N; t=1,2,….,T \tag{3}$$

where α_i individual intercept, y_{it} and x_{it} are integrated process of order 1 for all cross section units, β the slope parameter, and ε_{it} is stationary error term. Kao's (1999) Augmented Dickey-Fuller (ADF) test can be calculated as follow:

$$\acute{\varepsilon}_{it} = \rho \acute{\varepsilon}_{it-1} + \sum_{j=1}^{p} \theta_{it} \Delta \acute{\varepsilon}_{it-j} + \upsilon_{it} \tag{4}$$

where $\acute{\varepsilon}_{it}$ is the estimated residual from Equation (3). Thus, the null hypothesis of no cointegration against the alternative can be specified as:

$$H_0: \rho = 1, \quad H_1: \rho < 1$$

The second test Johansen-Fisher of Cointegration developed by Maddala and Wu (1999) is panel version of Johansen (1988) cointegration test. The test takes the sum of the p-value of cross section Johansen trace statistics and maximum eigenvalue. Let assume that Π_i is the p-value of individual cointegration test for cross section i, and the null hypothesis test of the panel is:

$$-2 \sum_{i=1}^{n} log (\Pi_i) \sim X_{2n}^2 \tag{5}$$

Johansen-Fisher panel cointegration test depends on the number of lag order on the VAR system. The findings shown in Table (2a) use one lag to indicate the existence of one cointegrating vector.

Pedroni (2004) proposed many tests under the null of no cointegration and the test allows for heterogeneity among cross-sections which can consider an improvement in testing for panel cointegration.

$$y_{it} = \alpha_i + \sum_{m=1}^{M} \beta_{mi} x_{it} + \varepsilon_{it} ; \quad i=1,2,….,N; t=1,2,….,T \tag{6}$$

where N is the number of cross sections, T is the number of time observation, α_i allows for country specific effects, and β_{mi} represents the heterogenous slope of different individuals, allowing for heterogeneous cointegrating vectors across countries. Pedroni (2004) suggested seven test statistics for the null hypothesis of no cointegration. The tests are panel v-statistic, panel r-statistic, panel PP-statistic, panel ADF-statistic, group rho-statistic, group PP-statistic, and group ADF-statistic. The first four statistics based on within-group approach, while the three statistics are based on the between-group approach. The seven tests statistics are normally distributed. Under the null of no cointegration, the panel cointegration test is basically a test of unit roots in the estimated error terms of the panel: the stationarity of the residuals indicates the presence of a cointegrating relation. The seven tests tend to reject the null when they have high negative values excluding panel-v test, which rejects the null when it has high positive value. On the other hand, r-statistics and PP-statistics tend to under reject the null especially in case of small samples, and ADF-statistics within or between groups appear to be more reliable (Pedroni, 2004).

$$\hat{\varepsilon}_{it} = \hat{\rho}_i \hat{\varepsilon}_{i,t-1} + \hat{\mu}_{it}, \qquad \hat{\varepsilon}_{it} = \hat{\rho}_i \hat{\varepsilon}_{i,t-1} + \sum_{j=1}^{ki} \hat{\rho}_{ik} \Delta \hat{\varepsilon}_{i,t-1} + \hat{\mu}_{it}^*, \qquad \Delta y_{it} = \sum_{m=1}^{M} \hat{\gamma}_{mi} \Delta x_{mit} + \hat{\eta}_{it}$$

The error terms $\hat{\mu}_{it}$, $\hat{\mu}_{it}^*$ and $\hat{\eta}_{it}$ are respectively estimated from the above secondary regressions, since $\hat{\varepsilon}_{it}$ is drived from Equation (6).

3.5 Fully Modified OLS (FMOLS)

If the cointegration relationship exists between variables, the long-run coefficients are estimated using the fully modified ordinary least squares (FMOLS) of non-stationary panel proposed by Kao and Chiang (2001). This estimator corrects for the bias estimates of OLS, as well as it takes care of the serial correlation and potential endogeneity problems and it's allows for a high degree of heterogeneity among cross sections. Let consider the following model:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it} \tag{7}$$

$$x_{it} = x_{it-1} + \mu_{it} \tag{8}$$

where α_i is the country specific effect, ε_{it} is the stationary error term, y_{it} and x_{it} is non-stationary cointegrated variables for all countries with β cointegrating vector. The FMOLS modifies for autocorrelation and endogeneity of OLS parameters as:

$$\hat{\beta}_{FM} = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} ((x)_{it} - (\bar{x})_i)' \right]^{-1} \times \left[\sum_{i=1}^{N} \left(\sum_{t=1}^{T} ((x)_{it} - (\bar{x})_i) (y)_{it}^+ + T\hat{\Delta}_{\mu\varepsilon}^+ \right) \right] \tag{9}$$

where $(y)_{it}^+$ is the converted variable of $(y)_{it}$ to capture the edogeneity problem, and $\hat{\Delta}_{\mu\varepsilon}^+$ is the term adjusts for serial correction between the error terms. The FMOLS is non-parametric approach produces asymptotically unbiased parameters with normal error distribution.

3.6 Dynamic OLS (DOLS)

Dynamic ordinary least squares (DOLS) also suggested by Kao and Chiang (2001), the method takes care of the two problems that appear in pooled OLS, serial correlation and the potential endogeneity of right hand side variables. To attain unbiased estimates for the long-run parameters, the DOLS estimator uses parametric correction to the errors by including the previous (lags) and future (leads) values of the differenced non-stationary regressors. The Dynamic OLS estimator can be obtained from the following Equation:

$$y_{it} = \alpha_i + \beta x'_{it} + \sum_{j=-q1}^{j=q2} \partial_{ij} \Delta x_{i,t+j} + v_{it} \tag{10}$$

where ∂_{ij} is the coefficient of the lag or lead of the first differenced independent variable. The DOLS coefficients can be driven as:

$$\hat{\beta}_{DOLS} = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \pi_{it} \pi'_{it} \right)^{-1} \left(\sum_{t=1}^{T} \pi_{it} y_{it}^+ \right) \tag{11}$$

Where $\pi_{it} = \left[(x)_{it} - (\bar{x})_i, \Delta(x)_{it-q}, \dots, \Delta(x)_{it+q} \right]$ Which is 2 (q+1) x1 vector.

4. Results and Discussion

4.1 Panel Unit Root Test

All the variables are tested for the presence of a unit root in level as well as the first difference including intercept as well as intercept and trend. The lag length is selected based on Schwarz information criterion SIC. Table 1 presents the outcomes of LLC and IPS unit root tests. The results reveal that the variables LGDP, LHIV, LSER, LCF and LPG tend to have unit root in level for case with constant and time trend. However, the variables are stationary after taking first difference in case of constant and constant and trend for all variables except LSER, which stationary in first difference when time trend is included, but we still can conclude that LSER is stationary in first difference. The variables LTB and LLF are shown by LLC test to be integrated of order one, but when the deterministic trend is included the variables tend to be I(1). In addition, the IPS test shows that the LD does not have unit root at level when the time trend is included. Although, the two tests show some contradictory results about variables' order of integrating, but we still unable to consider them as I(0) due to the statistical consequences of treating I(1) variable to be I(0) (Irz, Niemi & Liu, 2013). Therefore, the general conclusion of the panel unit root test is that the variables are I(1), thus; LGDP, LD, LTB, LHIV, LSER, LLF, LCF and LPG are non-stationary variables.

4.2 Panel Cointegration Tests

The next step after identifying variables' order of integration is to test for the existence of the long-run cointegration relationship between the non-stationary variables. The study employs three tests; Kao (1999), Johansen-Fisher Maddala and Wu (1999), and Pedroni (2004) to confirm that the variables move together in the long-run. Table 2–illustrates the results of Johansen-Fisher trace and max-eigen tests values, and Kao's ADF values for panel cointegration test, respectively. Additionally, Table 3 presents Pedroni results for PP-statistics

and ADF-statistics for within and between groups, respectively. The findings of the three cointegration tests provide evidence of long-run equilibrium relationship among variables for our three models which allow us to estimate the long-run coefficients using one of the long-run estimation techniques.

Table 1. LLC and IPS panel unit root tests results

Test	LLC		IPS	
Variable	Intercept	Intercept & trend	Intercept	Intercept & trend
Level				
LGDP	-0.19	-1.51	2.11	-0.77
LD	-1.40	-0.72	-1.38	-2.08**
LTB	-3.19**	1.76	0.71	4.34
LHIV	-0.27	6.27	-0.91	-0.01
LSER	-1.72	-0.36	0.26	-0.56
LLF	-4.03**	-0.53	-0.58	0.37
LCF	-0.18	-0.65	0.87	-0.06
LPG	1.44	3.12	1.73	-1.34
1st difference				
ΔLGDP	-6.62**	-5.96**	-5.11**	-3.95**
ΔLD	-4.23**	-2.21**	-6.75**	-5.61**
ΔLTB	-1.91	-1.72**	-0.51	-3.54**
ΔLHIV	-4.02**	-1.29	-7.51**	-5.42**
ΔLSER	-6.05**	-5.36**	-5.25**	-4.26**
ΔLLF	-4.82**	-5.01**	-4.11**	-4.28**
ΔLCF	-5.26**	-4.88**	-4.92**	-3.57**
ΔLPG	-5.99**	-4.07**	-6.37**	-4.31**

Note: ** indicates significant at 5%. Maximum lag length selection based on SIC.

Table 2. Panel cointegration test (Johansen-Fisher & Kao)

a.)	Model 1		Model 2		Model 3	
No. of CE(s)	trace	max-eigen	trace	max-eigen	trace	max-eigen
None	120.8**	74.07**	156.0**	79.96**	135.3**	82.03**
At most 1	63.87**	34.92**	92.77**	63.32**	66.48**	35.07**
At most 2	36.08**	23.59**	41.37**	24.66**	36.66**	19.08**
At most 3	19.33**	11.27	23.67**	14.97	22.67**	13.88
At most 4	14.82	10.70	16.29	11.09	15.78**	14.12
At most 5	20.29	20.29	22.91	22.91	12.08	12.08

b.) Kao cointegration test			
	Model 1	Model 2	Model 3
ADF	-4.07**	-4.89**	-4.39**

Note: ** indicates significant at 5%. Probabilities of Jonhansen-Fisher test are computed using asymptotic Chi-square distribution. The lag length of the VAR system based on sequential modified LR test statistic.

Table 3. Pedroni panel cointegration test

	Within-dimension (panel)		Between-dimension (group)	
	PP-Stat	ADF-Stat	PP-Stat	ADF-Stat
First Model	-1.89**	-2.26**	-2.81**	-2.19**
Second Model	-5.19**	-3.71**	-8.76**	-3.90**
Third Model	-3.33**	-3.32**	-5.53**	-3.80**

Note: ** indicates significant at 5%. The results with deterministic trend and intercept. The lag length selected based on SIC.

4.3 The Estimation of FMOLS and DOLS

Equation 1 is estimated using FMOLS and DOLS for the case of dengue, TB and HIV, respectively to obtain unbiased and consistent parameters that outperform OLS (Kao & Chiang, 2001) (Kao, Chiang & Chen, 1999). The dependent variable is LGDP per capita in the three equations; the proxy for health are dengue reported cases LD, the incidence of tuberculosis LTB, and LHIV from 15-49 as a percentage of total population. The other explanatory variables are secondary school enrollment LSER, total labor force LLF, gross capital formation LCF and population growth LPG. Tables 4 and 5 show FMOLS and DOLS results of the estimated long-run equations. Quite similar outcomes were obtained from both methods, particularly our variables of interest, health indicators. First model's coefficients indicate negative relationship between dengue cases and GDP per capita and it is significant at 1% level for FMOLS findings, which cannot be confirmed by DOLS results since it shows insignificant relation. The FMOLS findings show substantial negative impact of disease, like dengue on economic performance in these particular countries. The trends of dengue infection and cost of treatment in these countries are increasing largely over time. The FMOLS long-run coefficient can be expressed as long-run elasticity, 1 % increase in dengue cases cause -0.44% reduction in GDP per capita. On the other hand, the economic gain from reduction of such diseases can be expressed by 10% decline in dengue infection would lead to 4.4% increase in GDP per capita.

Table 4. Long-run FMOLS: LGDP is dependent variable

Variable	First model	Second model	Third model
LSER	0.317*** (8.885)	0.603*** (19.64)	0.316*** (8.121)
LLF	1.040*** (93.84)	0.187*** (9.799)	0.978*** (60.15)
LCF	0.128* (1.901)	0.210*** (9.627)	0.224*** (2.848)
LPG	-0.047** (-2.376)	-0.041 (-0.719)	-0.068 (-1.460)
LD	-0.439*** (-3.558)		
LTB		-0.466*** (-106.3)	
LHIV			-0.089** (-2.027)
R-squared	0.930	0.997	0.997

Note: ***, ** and * indicate significant at 1%, 5% and 10% respectively. The t-statistics values are in parentheses, all variables are in log form.

Table 5. Long-run DOLS: LGDP is dependent variable

Variable	First model	Second model	Third model
LSER	0.325*** (5.349)	0.513*** (9.319)	0.346*** (5.277)
LLF	1.035*** (9.745)	0.262* (1.937)	0.999*** (12.18)
LCF	0.163*** (2.952)	0.148*** (3.472)	0.161*** (2.777)
LPG	-0.052** (-2.166)	-0.011 (-0.692)	-0.046* (-1.890)
LD	-0.007 (-0.453)		
LTB		-0.433*** (-6.369)	
LHIV			-0.022 (-0.818)
R-squared	0.997	0.998	0.997

Note: ***, ** and * indicate significant at 1%, 5% and 10% respectively. The t-statistics values are in parentheses, all variables are in log form.

Similarly, the findings of the second model reveal that the prevalence of tuberculosis in the selected Southeast Asian countries is significant and negatively related to economic growth for both results of FMOLS and DOLS. The results obtained by FMOLS and DOLS explain -0.47% and -0.43% decrease in GDP is attributable due to 1% increase in tuberculosis. However, the third model results show negative and significant relationship between HIV prevalence and GDP per capita in case FMOLS, but insignificant when DOLS is used. Although, the proportion of the population with HIV/AIDS is almost constant over time for all countries except Malaysia, the impact of HIV/AIDS still poses a real threat for individuals and governments. Another possible explanation is that the disease of HIV/AIDS has a long incubation period, which can explain that the impact can have long period, besides, the cost of medical treatment that patients should pay (Gardner, 2010).

The findings of the FMOLS and DOLS of other variables for the three estimated models tend to have a positive and significant impact on GDP per capita. The estimated results show that the role played by education, labor and capital in explaining economic performance in these countries is very decisive. The estimated models show

that the population growth negatively related to GDP per capita, which to some extent make sense especially when GDP growth is less than the population growth. The estimated elasticity tends to provide more value for labor, education, and capital in influencing GDP, respectively. From these findings, it could be argued that healthier and more educated labor force with adequate capital are important factors that can lead to improve GDP per capita and therefore, stimulate economic growth.

5. Conclusion

In this research, the long-run impact of communicable diseases on the economic performance was studied in selected Southeast Asian countries. The prevalence of diseases like dengue, tuberculosis and HIV/AIDS pose a real threat and contribute largely to total disability-adjusted life years, especially in the region of Southeast Asia (Gupta & Guin, 2010). The study attempted to measure the effects of disease prevalence, such as dengue, tuberculosis and HIV/AIDS on the economic performance from 1990-2011. The sample of the study contains five countries with complete data: Indonesia, Malaysia, Philippines, Singapore and Thailand. The econometric analysis starts with panel unit root test for variables stationarity and the study adopts Levin et al. (2002) and Im et al., (2003) tests. The findings show that all the variables have a unit root in level, but they are stationary after taking first difference indicating that the variables are I(1). The test for cointegration relationship using Johansen-Fisher, Kao and Pedorni tests confirms the existence of the cointegration relationship among the variables and they move together in the long-run. The long-run parameters are estimated using non-parametric approach FMOLS and parametric approach DOLS, which outperform OLS, to obtain unbiased estimates (Kao & Chiang, 2001). The results of FMOLS and DOLS revealed that economic performance to large extent is affected negatively by prevalence of diseases. First, the impact of dengue was found to be negative and significant in explaining GDP per capita reduction. Second, the incidence of tuberculosis is also affecting economic performance negatively. Third, the results from the third model of FMOLS came out with negative and significant impact for HIV prevalence on economic performance. In addition, the other explanatory variables, such as secondary school enrollment, labor force, and gross capital formation, were found to have a positive and significant impact on GDP per capita in the three estimated models, respectively, but population growth is found to be negatively related to the economic performance. From the results, it can be argued that healthier and well-educated labor with sufficient amount of capital can lead to stimulate GDP per capita and economic growth. The evidence from this study suggests that great benefits such as improving economic performance can be obtained by the reduction of communicable diseases. Therefore, governments of these countries are highly advised to play an equal role in terms of giving health and medical care the attention required, and increase health spending to reduce the prevalence of diseases.

References

Afawubo, K., & Mathey, S. (2014). Employment and education effects on HIV/AIDS prevalence rate and economic growth: empirical investigation in ECOWAS. *Applied Economics Letters*, *21*(11), 755-759. http://dx.doi.org/10.1080/13504851.2014.887188

Arndt, C. (2006). HIV/AIDS, human capital, and economic growth prospects for Mozambique. *Journal of Policy Modeling*, *28*(5), 477-489. http://dx.doi.org/10.1016/j.jpolmod.2005.12.004

Bleakley, H., & Lange, F. (2009). Chronic disease burden and the interaction of education , fertility , and growth. *The Review of Economics and Statistics*, *91*(February), 52-65.

Coker, R. J., Hunter, B. M., Rudge, J. W., Liverani, M., & Hanvoravongchai, P. (2011). Emerging infectious diseases in southeast Asia: regional challenges to control. *Lancet*, *377*(9765), 599-609. http://dx.doi.org/10.1016/S0140-6736(10)62004-1

Couderc, N., & Ventelou, B. (2005). AIDS, Economic Growth and the Epidemic Trap in Africa. *Oxford Development Studies*, *33*(3-4), 417-426. http://dx.doi.org/10.1080/13600810500199236

Cuesta, J. (2010). How much of a threat to economic growth is a mature AIDS epidemic? *Applied Economics*, *42*(24), 3077-3089. http://dx.doi.org/10.1080/00036840801964849

Engle, R. F., & Granger, C. W. J. (1987). Co-Integration and Error Correction : Representation , Estimation , and Testing. *Econometrica*, *55*(2), 251-276.

Gardner, L. K. (2010). The Impact of HIV / AIDS on Health Capital and Economic Growth : A Panel Study of Countries from 1 – 200, *27*(1).

Garg, P., Nagpal, J., Khairnar, P., & Seneviratne, S. L. (2008). Economic burden of dengue infections in India. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *102*(6), 570-577. http://dx.doi.org/10.1016/j.trstmh.2008.02.015

Goenka, A., & Liu, L. (2010). Infectious diseases and endogenous fluctuations. *Economic Theory*, *50*(1), 125-149. http://dx.doi.org/10.1007/s00199-010-0553-y

Gupta, I., & Guin, P. (2010). Communicable diseases in the South-East Asia Region of the World Health Organization: towards a more effective response. *Bulletin of the World Health Organization*, *88*(3), 199-205. http://dx.doi.org/10.2471/BLT.09.065540

Han, L., Vasan, S. S., Birgelen, L., Murtola, T. M., Gong, H., Field, R. W., & Mavalankar, D. V. (2010). *Immediate cost of dengue to Malaysia and Thailand : An estimate, 34*, 65-76.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of econometrics, 115*(1), 53-74.

Irz, X., Niemi, J., & Liu, X. (2013). Determinants of food price inflation in Finland—The role of energy. *Energy Policy*, *63*, 656-663. http://dx.doi.org/10.1016/j.enpol.2013.09.023

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of economic dynamics and control*, *12*(2), 231-254.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of econometrics*, *90*(1), 1-44.

Kao, C., & Chiang, M. H. (2001). On the estimation and inference of a cointegrated regression in panel data. *Advances in econometrics*, *15*, 179-222.

Kao, C., Chiang, M. H., & Chen, B. (1999). International R&D spillovers: an application of estimation and inference in panel cointegration. *Oxford Bulletin of economics and Statistics*, *61*(S1), 691-709.

Levin, A., Lin, C. F., & James Chu, C. S. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics, 108*(1), 1-24.

Lucian, U., Oreste, S., Traian, M. T., & Tudor, B. C. (2007). Relationship and causality between economic growth rate and certain diseases in the European Union. *Economic Science Series*, 478-485.

Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics*, *61*(S1), 631-652.

Ouattara, M. (2004). HIV infection and economic growth. *The Journal of Policy Reform*, *7*(3), 141-149. http://dx.doi.org/10.1080/1384128042000261774

Pedroni, P. (2004). Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric theory*, *20*(3), 597-625.

Rajeswari, R., Balasubramanian, R., Muniyandi, M., Geetharamani, S., Thresa, X., & Venkatesan, P. (1999). Socio-economic impact of tuberculosis on patients and family in India. *The international journal of tuberculosis and lung disease : the official journal of the International Union against Tuberculosis and Lung Disease*, *3*(10), 869-877. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10524583

Shepard, D. S., Undurraga, E. A., & Halasa, Y. A. (2013). Economic and disease burden of dengue in Southeast Asia. *PLoS neglected tropical diseases*, *7*(2), e2055.

Veenstra, N., & Whiteside, A. (2005). Economic impact of HIV. *Best practice & research. Clinical obstetrics & gynaecology*, *19*(2), 197-210. http://dx.doi.org/10.1016/j.bpobgyn.2004.10.005

Young, A. (2005). The gift of the dying: the tragedy of AIDS and the welfare of future African generations. *Quarterly Journal of Economics, 120*, 423-466.

Copyrights