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Knowledge-based Economy (KBE) Frameworks and Empirical Investigation of KBE Input-output Indicators for ASEAN

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Abstract

The purpose of this paper is to build a policy focused knowledge-based economy (KBE) framework based on the OECD KBE definition in order to identify the KBE factors in the Association of South East Asian Nations (ASEAN) region. The paper utilises the Beta coefficient technique which allows us to rank the most important KBE input factors to KBE output factors. After identifying KBE input-output factors, following the Australian Bureau of Statistics KBE framework assumptions, standardized beta coefficients are used to assess how many standard deviations a dependent variable will change, per standard deviation increase in the predictor variable. Standardization of the coefficient is usually done to answer the question of which of the independent variables have greater effects on the dependent variable in a multiple regression analysis, when the variables are measured in different units. Data are mostly collected from secondary sources such as the World Bank's World Development Indicators and the International Institute for Management Development's World Competitive Yearbook. The results show Singapore is the best performer in knowledge acquisition, production and distribution and the Philippines is the best performer in knowledge utilization. Indonesia, on the other hand, shows weak performance in almost all the KBE dimensions. The lessons from the success of Singapore and the Philippines for weak performance countries in KBE are to improve the efficiency of FDI inflows, to optimise the use of research and development expenditure, to increase the secondary school enrolment ratio and finally to increase the interaction between academia and industry, which facilitates the creation and commercial use of knowledge. This paper provides empirical evidence to rank the important KBE input factors that gives governments some insight on where to focus investment in order to become a successful KBE.

Keywords: knowledge economy, KBE frameworks, policy- focused framework, ASEAN, input and output factors, beta coefficient, knowledge dimensions

JEL classification: 020, 057

1. Introduction

In the past decade, a substantial body of research has been conducted on productivity-led economic growth and its determinants (Sundac & Krmpotic, 2011). A major reason for this is the widespread belief that economic growth that is due to rapid factor accumulation is subject to diminishing returns and, hence, not sustainable. Recently, there has been growing interest in the contribution of knowledge to total factor productivity growth and, consequently, to sustainable long-term economic development. In East Asia, especially in the ASEAN (Association of Southeast Asian Nations) region, the awareness and emphasis on KBE began less than a decade ago. The OECD (Organization for Economic Development and Co-operation), APEC (Asia-Pacific Economic Co-operation), WBI (World Bank Institute) and ABS (Australian Bureau of Statistics) have proposed different KBE frameworks focusing on the best use of knowledge for economic development, under which they suggests different KBE pillars and large sets of KBE indicators.

The motivation for this research comes from looking at the gap in the existing literature whereby the OECD, APEC, WBI and ABS studies propose a large number of KBE variables and suggest investing in those indicators

in order to become a KBE (Fen & Chaudhry, 2006). However, it would be financially unsustainable and unfocused for countries to invest in all of the variables proposed by the OECD, APEC, WBI and ABS. Therefore it would be useful for a government to know which factors of the knowledge economy are the best contributing factors to a country's economic progress. To do that we considers five ASEAN economies, namely Indonesia, Malaysia, Singapore, the Philippines and Thailand as study countries and propose a policy-focused KBE framework based on the definitions of the OECD, APEC and WBI. This study uses some critical assumptions to choose important variables out of large sets of KBE indicators and apply the beta coefficient technique to investigate the best contributing indicators behind the successful countries in ASEAN in transition towards KBEs. While the literature on knowledge management and national innovation systems encompasses many disciplines, this paper focuses on a specific economic approach to the topic.

We divide our paper into five major sections. Section 2 briefly reviews relevant literature regarding different KBE frameworks and develops a policy-focused KBE framework for analysis. Section 3 describes the methodology of the study and Section 4 explains the results and findings. Section 5 gives concluding remarks and policy suggestions.

2. Literature Review

Southeast Asia has been the world's leading emerging market for several years. To promote economic, cultural and political cooperation in the region, the ASEAN group comprising Indonesia, Malaysia, the Philippines, Singapore and Thailand was established in 1967. Brunei, Myanmar, Laos and Vietnam joined later. From the inception of the ASEAN, it was claimed that the high-growth phenomenon of the East Asian economies was not sustainable because their expansion was derived from massive inputs of labour and physical capital and not from gains in technological efficiency (Taylor, 2007). The reason for the inefficiency of the high-growth process is because labour and capital are subject to diminishing returns (Romer, 1986, 1990, Grossman and Elhanan, 1991).

According to the OECD KBE framework, the root of a knowledge economy has been formulated by Romer (1986) and Grossman and Elhanan (1991) who developed *new growth theories* to explain the forces which drive long-term economic growth. In the neo-classical production function, returns diminish as more capital is added to the economy, an effect which may be offset, however, by the flow of new technology. In new growth theory, knowledge can raise the returns on investment, which can in turn contribute to the accumulation of knowledge. It does this by stimulating more efficient methods of production as well as new and improved products and services. There is thus the possibility of sustained increases in investment which can lead to continuous rises in a country's growth rate. It has been found that the successful transition to the knowledge-based economy typically lies in efficient investments in education, public research and development expenditures, developing innovation capability, modernizing the information infrastructure, and having an economic environment that is conducive to market transactions (WBI, 1999). These elements have been termed by the World Bank, OECD, and APEC as the pillars of the knowledge economy and together they constitute the knowledge economy framework.

2.1 KBE Frameworks and a Proposed Policy-focused KBE Framework

The concept of the KBE was first introduced by the OECD, defining it as an economy which is *directly based on the production, distribution and use of knowledge and information* (OECD, 1996). Later APEC referred to KBE as *an economy in which the production, distribution and use of knowledge is the main driver of growth, wealth creation and employment across all industries* (APEC, 2000 and 2004). These models describe the environment necessary for the KBE and the indicators used to measure the various characteristics of the environment. While doing so, the OECD in its report on the Growth Project (OECD, 2001) emphasized the importance of a stable and open macroeconomic environment with effective functioning markets; diffusion of ICT; fostering innovation; development of human capital; and stimulating firm creation. Under these core KBE dimensions they proposed a large set of indicators.

The APEC report strives to provide the analytical basis useful for promoting the effective use of knowledge, and the creation and dissemination of knowledge among APEC economies (APEC, 2000). The Australian Bureau of Statistics (ABS) framework (2002) was developed to measure knowledge in the Australian economy and society. The framework draws on the work of the APEC Report (2000) and the OECD Model (1996) except that it explicitly includes the concept of the knowledge based society because of the presumed importance of societal factors and the potential positive and negative impacts on society with the increasing emphasis on knowledge. The World Bank Institute (1999) has developed the Knowledge Assessment Methodology (KAM) as a KBE framework for its member states in order to indicate their level of knowledge-based economic development and as a policy input to the achievement of sustainable economic growth. The WBI defines KBE as an economy

where knowledge is acquired, created, disseminated and used effectively to enhance economic development. The WBI Knowledge Assessment Methodology (KAM) (Note 1) is based on 83 structural and qualitative variables that serve as proxies for the four knowledge economy pillars: Overall Economic Performance (9), Economic Incentive and Institutional Regime Index (19), Innovation System Index (24), Education and Human Resources Index (19) and ICT Index (12).

These models and frameworks have one common trait in that they all give a basic analysis of the environment a KBE should possess and claim that a successful KBE should have the four core dimensions, namely, knowledge acquisition, knowledge production, knowledge distribution and knowledge utilization. However, it is interesting that none of the current methodologies explicitly divide the KBE indicators under these four core dimensions. That is the approach taken in this paper *viz.* to segregate the available KBE indicators under these four dimensions as knowledge input-output indicators for a better understanding of the performance of a KBE (see, for example, Lee, 2001; Tan, Hooy, Manzoni & Islam 2008 and Karahan, 2011). To build our policy- focused KBE framework which is presented in Table 1 we select the variables under some assumptions. We consider the assumptions following the ABS framework (2002) to pick a set of input-output KBE variables out of a large number of indicators. The assumptions are that the indicators should:

1. be relevant to the characteristics they are intended to describe (including policy relevant)
2. be supported by reliable and timely data
3. be sensitive to the underlying phenomena which they purport to measure
4. be intelligible and easily interpreted
5. preferably be available for several time periods including recent periods and
6. preferably be available for other study countries as well, for the purposes of international comparison.

Under these assumptions the relevant variables in the dimensions might be replaced with others over time due to the constant changes in KBEs. Indicators used in the past may no longer be appropriate as an economy progresses. Therefore the KBE variables are flexible, rather than rigid in nature (Fen & Chaudhry, 2006). It is possible to add more variables if they fulfil the above criteria to show the performance of a KBE. It is important to note that all the variables may not be the best contributing variables for all countries. According to Chen (2008), traditional economy indicators like GDP and GNP are often criticised due to ignorance of socio-cultural factors like the enrolment ratio for secondary education, total education expenditure, ICT users etc. There are many flaws in assessing a country's KBE performance by the traditional economy indicators including the lack of KBE input-output variables. Hence, we can say that KBE is a broad concept that needs to be addressed from all dimensions of knowledge i.e. creation, acquisition, distribution and utilization.

Table 1. Policy- Focused KBE framework

Dimensions	**Knowledge acquisition**	**Knowledge production**	**Knowledge distribution**	**Knowledge utilization**
Input	1.Openness=(Exports + imports)/GDP 2. FDI inward flows as % GDP 3. Legal and regulatory quality 4. Transparency	1.Scientific R & D expenditure as % GDP 2.Intelectual Property Rights (IPR)	1. Education expenditure as % GDP 2. Net enrolment ratio at secondary school	1. Knowledge Transfer rate (university to industry) 2.FDI inflows % of GDP
Output	Real GDP growth	Scientific publications per 1000 population	PC penetration per 1,000 population	High-tech export % of Total export

Table 1 is an example of variable segregation out of many KBE indicators depending on data availability. Many of the factors listed above define the knowledge economy and its effect on entrepreneurial activities and economic development (Kassicieh, 2010). For instance, Derek, Chen and Dahlman (2004) emphasized that education and skilled workers are key to efficient knowledge dissemination which tends to increase productivity when shared by information and communication technology (ICT) infrastructure. ICT infrastructure refers to the accessibility of computers, internet users, mobile phone users etc. Accordingly, we consider education expenditure and the school enrolment ratio as an input variable and computer users per thousand populations as the output variable for the knowledge distribution dimension.

The World Bank Institute (1999) has stated that an effective innovation system depends on research and development (R&D) expenditure, foreign direct investment (FDI) inflows, and knowledge sharing between universities and industry. These variables are often considered as knowledge utilization inputs in order to produce domestic knowledge intensive products in a national innovation system (Poorfaraj, Samimi and Keshavarz, 2011). Hence, we consider FDI inflows and the knowledge transfer rate as input variables and high-tech exports as a percentage of total export as the output variable in the knowledge utilization dimension.

In many developing countries, knowledge and technology is nurtured from foreign sources and enters the country through FDI, imports of equipment and other goods which are promoted by trade openness and licensing agreements (Poorfaraj, Samimi and Keshavarz, 2011). These variables can make an enormous contribution to economic growth provided the existence of a sound, transparent legal and regulatory system in the individual countries. Therefore we consider FDI, trade openness, transparency and legal and regulatory quality as inputs while real GDP growth is the output variable in the knowledge acquisition dimension.

Dahlman and Andersson (2000) have stated that East Asian economies are weak in innovation activities compared to other, advanced economies, which account for nearly 90 per cent of global R&D expenditures and about the same proportion of patents granted and scientific and technical papers produced. They also argue that stronger protection of intellectual property rights enhances the efficiency of innovation systems in a KBE. Hence in our policy focused framework, we include these variables under the knowledge production dimension. In subsequent sections we will illustrate the best performing countries among the ASEAN-5 nations in each KBE dimension using raw data and investigate the most important KBE input variables behind their success under these dimensions using the standardized beta coefficient technique.

3. Methodology

This study uses the simple beta coefficient method to investigate the important contributing factors to a KBE. Instead of finding significant variables from simple linear regression models, this method uses the variables' standard deviations to estimate the beta coefficient. According to Chen (2008), the KBE indicators that are proposed by the OECD, WBI, APEC and ABS are different from one another in indices description, measured categories and measured variables. Therefore we use the standardized beta coefficients - a well-known and stabilized methodology to overcome the problem of variation in measurement units. Standardized beta coefficients refer to how many standard deviations a dependent variable will change, per standard deviation increase in the predictor variable. Standardization of the coefficient is usually done to answer the question of which of the independent variables have greater effects on the dependent variable in a multiple regression analysis, when the variables are measured in different units (Gujarati, 2004, Rubinfeld & Pindych, 1997). Hence, standardized coefficients describe the relative importance of the independent variable in a multiple regression model to find out the contributing indicators in each knowledge dimension. We consider the period 1995-2010 while using the beta coefficient technique to rank the significant input variables. To calculate the beta coefficient, we first set some linear regression models for each dimension. In our study, all data are collected from secondary sources, including the WDI, WCY and ASEAN statistical yearbooks. The equations are:

Knowledge acquisition dimension:

$GZGDP = \beta 1 + \beta 2\ OPENNESS + \beta 3\ FDI + \beta 4\ LRQUA + \beta 5\ TRANS$

Knowledge production dimension:

$STAR = \beta 1 + \beta 2\ RDEXP + \beta 3\ IPR$

Knowledge distribution dimension:

$COMPUSE = \beta 1 + \beta 2\ EDUEXP + \beta 3\ SECONDEN$

Knowledge utilization dimension:

$HITECHEXPO = \beta 1 + \beta 2\ KNOWTRANS + \beta 3\ FDI$

Here, the data sources of input variables:

OPENNESS= Trade openness rate (Penn table, 2010)

FDI= FDI inflows % GDP (World Development Indicators, WDI-2010)

LRQUA= Legal and regulatory quality (World Competitiveness Yearbook, WCY-2011, IMD WCY executive survey based on an index from 0 to 10)

TRANS = Transparency of government policy is satisfactory (WCY-2011, IMD WCY executive survey based on an index from 0 to 10)

IPR = Intellectual property rights are adequately enforced (WCY-2011, IMD WCY executive survey based on an index from 0 to 10)

RDEXP = Research and development expenditure % GDP (WDI-2010, WCY-2011)

EDUEXP = Education expenditure % of GDP (WCY-2011)

SECONDEN = Secondary enrolment % of total (WDI-2010, WCY-2011)

KNOWTRANS = Knowledge Transfer rate from university to industry (WCY-2011 executive survey based on an index from 0 to 10)

Data sources of output variables:

GZGDP= Growth of real GDP (WCY-2011)

STAR = Number of Scientific and technical Journal articles per year (WDI-2010)

HITECHEXPO = High-tech export % of Total export (WCY-2011)

COMPUSE= Computer user per 1000 population (WCY-2011)

We run the regression with the above linear models in e-views software and determine each coefficient value. Using descriptive statistics option in e-views, we get the standard deviations of each dependent and independent variables for each equation. We then apply the beta coefficient technique for each equation by

Beta coefficient, $\hat{\beta}_n = \hat{\beta}_n \frac{SDX_n}{SDY}$

Here, n = 2, 3, 4, 5, ...k

SD= Standard deviation

Y= dependent variable

X= independent variable

We apply all these linear equations for each ASEAN-5 country and find out the beta coefficient values for each independent variable which we consider as KBE input variables on output variables that are dependent variables. We ignore the sign and focus on the value of each independent variable to rank the contributing input factors on output for each study country.

4. Results and Discussion

In this section we represent the performance of the ASEAN-5 countries in terms of KBE output variables and subsequently show the most important input variable behind their success over time using the beta coefficient calculation results. The performance of ASEAN-5 countries in terms of KBE output variables are revealed by using raw data for the years 1995 and 2010 as shown in Tables 2 through 5.

Table 2. Real GDP Growth

Economy	**1995**	**2010**
Indonesia	8.20	5.80
Malaysia	9.80	7.20
Singapore	8.00	14.10
Philippines	4.70	7.30
Thailand	9.30	7.80

Source: WDI 2010

We consider real GDP growth as the output variable of the knowledge acquisition dimension. As shown in Table 2, Malaysia, closely followed by Thailand, was the best performer i.e. achieved the highest GDP growth in 1995, while Singapore outperformed all the countries having almost doubled their real GDP growth in 2010. This implies that Singapore tremendously improved in this dimension over the years. Now the question is what is the most important factor behind this success of Singapore in this dimension? We hope to get some insight by observing standardized beta coefficient results in the later part of this section.

Table 3. Scientific and technical journal articles

Economy	**1995**	**2010**
Indonesia	129.5	200.75
Malaysia	365.8	880.0
Singapore	1141.4	3901.6
Philippines	144.7	197.0
Thailand	339.6	1827.40

Source: WDI 2010

Table 3 presents the performance results of the knowledge production dimension. Here we use scientific and technical journal articles per thousand people as the output variable and R&D expenditure as a percentage of GDP and intellectual property rights (IPR) as input variables. All the countries have improved their performance by increasing the numbers of articles published over the years which can be considered as the generation of new ideas in a KBE. Singapore and Thailand have shown substantial increases in this area between 1995 and 2010. It could be expected that R&D expenditure will be shown to be more important than IPR in beta coefficient results for all the countries.

Table 4. Number of computers per 1000 people

Economy	**1995**	**2010**
Indonesia	4.80	42.51
Malaysia	53.94	337.59
Singapore	207	827.48
Philippines	8	81.21
Thailand	18	122.61

Source: Computer Industry Almanac (Updated: JUN 2011), extracted WCY-2011

Table 4 shows the knowledge distribution performance of the ASEAN-5 in terms of computer users per thousand people. In this dimension, Singapore and Malaysia are the consistent performers in both years. The beta coefficient results will tell us the most important input variable behind their success.

Table 5. High-technology exports (% of manufactured exports)

Economy	**1995**	**2010**
Indonesia	7.22	13.20
Malaysia	46.10	48.11
Singapore	53.92	50.01
Philippines	36.80	65.65
Thailand	24.45	27.17

Source: WDI- 2010

Table 5 shows performance in the knowledge utilization dimension. In this dimension, Indonesia is the lowest performing country while the Philippines show a remarkable improvement in 2010 compared to 1995. Our study considers two input variables in this dimension namely FDI inflows as a percentage of GDP and the knowledge transfer rate from university to industry. We will show the most important variable behind the success of the Philippines.

Table 6. Beta coefficient values of KBE input variables

KBE Dimension	*Input factors*	Malaysia	Indonesia	Singapore	Philippines	Thailand
Knowledge	LRQUA	0.15	0.65	0.14	0.42	0.087
acquisition	TRANS	0.04	0.51	0.14	0.40	0.42
	FDI	0.66	0.83	0.34	0.07	0.68
	OPENNESS	0.20	0.59	0.14	0.59	0.43
Knowledge	RDEXP	0.80	0.53	0.66	0.32	0.85
Production	IPR	0.23	0.13	0.30	0.13	0.73
Knowledge	EDUEXP	0.33	0.14	0.017	0.70	0.11
Distribution	SECONDEN	0.60	0.96	0.64	0.01	0.61
Knowledge	KNOWTRANS	0.29	0.22	0.54	0.51	0.68
Utilization	FDI	0.22	0.38	0.24	0.15	0.21

Table 7. Ranking of KBE input variables from Beta coefficient results

KBE Dimensions	*Input factors*	Malaysia	Indonesia	Singapore	Philippines	Thailand
Knowledge	LRQUA	3	2	2	2	4
acquisition	TRANS	4	4	2	3	3
	FDI	1	1	1	4	1
	OPENNESS	2	3	2	1	2
Knowledge	RDEXP	1	1	1	1	1
Production	IPR	2	2	2	2	2
Knowledge	EDUEXP	2	2	2	1	2
Distribution	SECONDEN	1	1	1	2	1
Knowledge	KNOWTRANS	1	2	1	1	1
Utilization	FDI	2	1	2	2	2

Table 6 shows the standardized beta coefficient values from the multiple linear regression analysis while Table 7 ranks KBE input variables according to the beta coefficient values for each country. To understand the beta coefficient values we represent the knowledge acquisition dimension result of Indonesia as an example. All other results will be provided on request to the corresponding author.

Table 8. The regression results of the knowledge acquisition dimension for Indonesia (including the regular and the standardized coefficients)
(Dependent variable: real GDP growth (GZGDP))

Variable	Coefficient	Standardized beta coefficient	T statistic (for std. coefficient)	Prob.
FDI	2.4	0.83	3.28	0.0073
OPENNESS	0.40	0.59	2.43	0.033
LRQUA	3.75	0.65	2.08	0.06
TRANS	2.85	0.51	1.68	0.12

The coefficients in the second column tell us the effect of a unit change in each of the independent variables on the dependent variable. But it is hard to compare the importance of the independent variables in determining real GDP growth (GZGDP), since the units of measurement vary. The standardized beta coefficients, in the third column, are more appropriate for this purpose. The most important determinant of the GZGDP is FDI inflows as a percentage of GDP (the standardized coefficient is the highest of all the independent variables). The two variables are positive and statistically significant as well. All other remaining variables and their respective dimensions follow the same pattern. Hence, Table 7 ranks the independent variables (KBE inputs) according to the standardised beta coefficient values in each knowledge dimension for the ASEAN-5. The results indicate remarkable consistency among countries and some interesting exceptions. For knowledge acquisition, FDI ranks as the most important input indicator for all countries except the Philippines, for which it is the least important of the four inputs considered. For the Philippines, openness is estimated to be the most important input. For knowledge production, R & D expenditure is the most important input for all 5 countries; and for knowledge utilization, the transfer of knowledge from universities to industry is most important for all countries except

Indonesia. Finally, for knowledge distribution, secondary school enrolment was most important for all countries except the Philippines.

Considering results by country, for Malaysia, in terms of knowledge acquisition, FDI ranks highest as an input dimension followed by openness, legal & regulatory quality (LRQUA) and transparency (TRANS) in their effects on real GDP growth. This is supported by the fact that in Malaysia, FDI, openness and manufactured exports (especially high technology products) played an important part in generating high economic growth in the last three decades (Yusof and Bhattasali, 2008*)*. In terms of knowledge distribution, the high secondary school enrolment ratio is of greater importance compared to total education expenditure in their impact on PC penetration. In the case of knowledge utilization, Malaysia has a high rate of knowledge transfer between universities to industry which in turn increases high-tech export growth and this was found to be more important than FDI for this particular dimension. For knowledge production, as measured by scientific publications per 1,000 populations, research and development expenditure was ranked as the most important input variable.

In Indonesia, FDI contributes most in knowledge acquisition like the other fast growing ASEAN-5 nations. It is interesting to see that legal and regulatory quality gets second position which is ahead of openness in the same dimension. This implies a favourable environment for international investment in Indonesia. Secondary school enrolment ratio is high in Indonesia, which generates human resources in the knowledge distribution dimension but there is a low rate of knowledge transfer from university to industry in the knowledge utilization dimension. This might indicate that Indonesian knowledge workers are less innovative relative to those in the other countries. Certainly, the country is depending more on FDI for generating new ideas and innovation than on internal knowledge transfer.

In Singapore, FDI is the highest contributing factor for knowledge acquisition. Others factors in this dimension get equal ranking. Singapore has high secondary school enrolment which contributes to building a skilled workforce. It also has an innovative workforce which is captured by a higher knowledge transfer rate in the knowledge utilization dimension compared to FDI inflows.

Unlike other ASEAN-5 countries, for the Philippines openness is the highest contributing factors in knowledge acquisition. This is followed by legal and regulatory quality, transparency and FDI. The Philippines has high education expenditure which is shown in the knowledge distribution dimension and its knowledge transfer rate is high as well in the knowledge utilization dimension. This implies the Philippines is making good use of its education expenditure in order to produce new knowledge and ideas in the universities that eventually transfer this knowledge to high-tech industrial growth. Research firm the Meta Group ranked the Philippines No. 1 in the world in terms of knowledge workers (http://www.slcv.edu.ph/news/news7-03.htm). Its Cyber Atlas of 2000 put the Philippines ahead of 47 other countries, including the United States, Australia, France, Canada, and India.

In Thailand the interesting point in the knowledge acquisition dimension is the lowest ranking of legal and regulatory quality. According to the World Bank Institute governance indicators 2005, Thailand got 63.9 points out of 100 in regulatory quality (a higher value indicates strong regulatory quality); while Freedom House ranking for 2007 shows Thailand got 7 in political rights in a range of 1-7 (lower value indicates a good system of political rights; a higher value indicates bad system political rights) compared to other East Asian nations and 5 out of 10 (higher value indicates positive democratic development) points in the stability of democratic institutions variable in the Bertelsmann transformation Index-2006 (http://www.demcoalition.org/pdf/H_Thailand.pdf). Political instability seems to be the root cause of weaker legal and regulatory quality in Thailand in the past decade. In our analysis, legal and regulatory quality gets the lowest ranking for Thailand compared to FDI, and openness and transparency. For knowledge distribution and knowledge utilization, education expenditure and knowledge transfer are ranked one respectively.

In summary, the results shows FDI and openness in knowledge acquisition, R&D expenditure in knowledge production, secondary school enrolment in knowledge distribution and knowledge transfer rate in knowledge utilization dimensions are generally the most important KBE factors of ASEAN-5. Moreover, we can say that the recent success of Singapore in knowledge acquisition, production and distribution and the Philippines' success in knowledge utilization dimension depend on:

- Efficient use of FDI inflows
- Optimum use of R&D expenditure
- An increase in the secondary school enrolment ratio
- An increase the interaction between academia and industry, which facilitates the creation and commercial use of knowledge.

The weaker performers like Indonesia can use these findings and invest accordingly in order to become a successful KBE in ASEAN as well as in the world.

5. Conclusion

The results of our analysis have interesting policy implications for promoting sustainable knowledge and economic growth in the ASEAN region. We wish to stress that the findings of the study are critically based on the choice of KBE variables, and hence, the policy implications discussed here should be considered within this perspective. This study has built a policy focused KBE framework which clearly shows the input-output indicators of KBE under certain assumptions. Then, by using the Beta coefficient method, it has identified the ranking of KBE input to output variables for the ASEAN-5. It is hoped that this work gives some insight into research strategies that might aid policy formation into KBE investments for long run sustainability. The results shows FDI and trade openness in knowledge acquisition, R&D expenditure in knowledge production, secondary school enrolment in knowledge distribution and the knowledge transfer rate in knowledge utilization dimensions are generally the most important factors for the ASEAN-5 nations. We consider the 1995-2010 time periods to show the performance and determine the most important KBE variables for individual and successful countries. Data are mostly collected from secondary sources like WDI, WCY etc. The recent data shows Singapore in the first three KBE dimension and the Philippines in the knowledge utilization dimension are the best performers. Indonesia on the other hand shows weak performance in almost all the dimensions. The lessons from the success of Singapore and the Philippines for Indonesia as well as other weak performance countries are to improve the efficiency of FDI inflows, to optimise the use of R&D expenditure, to increase the secondary school enrolment ratio and finally to increase the interaction between academia and industry, which facilitates the creation and commercial use of knowledge. Interestingly, these findings indicate that policy recommendations for the ASEAN-5 may not be that unique compared to those for other developing countries. There is obviously room for further sophistication in this type of research and for investigation into the efficiency with which inputs are transformed into KBE outputs. It is hoped that this study had made a positive contribution to the subject.

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Note

Note 1. (www.worldbank.org/kam)