Relationship among Economic Growth, Internet Usage and Publication Productivity: Comparison among ASEAN and World's Best Countries

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Abstract

Publication productivity, as measured by the number of papers, has been regarded as one of the main indicators of reputation of countries and institutions. Nevertheless, the relationship among research publications, economic growth and World Wide Web in ASEAN countries is still unclear. The main intention of this study was to identify publication productivity among ASEAN and the world's top ten countries in the last 16 years (1996-2011). This study also aimed at finding the relationship among publication, gross domestic product (GDP) and internet usage. Furthermore, the publication trend in the 10 first Malaysian universities was evaluated for the same periods. Scopus database was used to find the overall documents, overall citations, citations per document and international collaboration from 1996 to 2011 for each country. The World Bank database (World Data Bank) was used to collect the data for GDP and the number of internet users. Moreover, to evaluate 10 top Malaysian universities, the number of published articles, conferences, reviews, and letters for the same periods was collected. The results of this study showed significant differences among ASEAN and top 10 countries regarding publication productivity. Moreover, a positive and significant relationship was observed between indices, GDP and internet usage for these countries. Surprisingly, international collaboration had a significant and negative relationship with economic growth. Malaysia had fewer citations per document (7.64) and international collaboration (36.9%) among ASEAN countries. In conclusion, international collaboration between academic institutes and researchers is influenced by economic growth and access to internet in the countries. Furthermore, publication trends in ASEAN countries are promising. However, policy makers and science managers should try to find different ways to increase the quality of the research publication and to raise citation per document.

Keywords: ASEAN countries, publication productivity, citation, internet user, collaboration, economic growth

1. Introduction

The Association of Southeast Asian Nations, a geo-political and economic organization including ten countries located in Southeast Asia, was formed on 8 August 1967 by Indonesia, Malaysia, the Philippines, Singapore and Thailand. Since then, the membership has expanded to include Brunei, Burma (Myanmar), Cambodia, Laos, and Vietnam. One of the main aims of this association is accelerating economic growth (Sarel, 1997). The main tool for measuring a country's economy is Gross domestic product (GDP) that is the market value of all officially recognized final goods and services produced within a country in a given period of time.

Based on the literature, there is a relationship between economic growth and education and research publication. However, this relationship has not been well supported by realistic evidence (Jin & Jin, 2013; Nelson & Phelps, 1966; Lucas, 1988; Becker, 2009; Romer, 1990). The Researches by Mankiw et al. (1992) and Barro (1991) showed positive and significant effects of education on economic growth (Mankive et al., 1992; Barro, 1991). While the study by Bils and Klenow (2000) showed a possibility of reverse relationship between economic growth and education (Bils & Klenow, 2000). Moreover, in a recent research study, Jin and Jin (2013) indicated that publication productivity in different fields has dissimilar effects on economic growth. For instance, engineering and science have positive influences on economic growth in comparison with publication output in the field of social sciences (J. Jin & L. Jin, 2013). These days, publication productivity is a main task for researchers and students than in the past decades and the results of research should benefit the community (Zain et al., 2009). Based on new developmental principles, the number of knowledgeable employees could be increased by education (J. Jin & L. Jin, 2013). In addition, educated human resource would help the economy of the countries to grow faster. Moreover, it is widely observed that the world's top productive research universities are in the highly developed countries such as the United States, the United Kingdom and Canada et al.

Publication count is an indicator of research productivity and used to rank countries and universities (Liu & Cheng, 2005; Meho & Spurgin, 2005; Narin & Hamilton, 1996; Toutkoushian et al., 2003; Yazit & Zainab, 2007). It can also be used to determine authors' productivity or the publication productivity of research groups (Liu & Cheng, 2005; Hart, 2000; Uzun, 2002; Gu & Zainab, 2001; Fox, 1983). The number of citations of previously published works is an indicator of its subsequent recognition and impact in a field of study. Reviewing articles that are frequently cited can provide information about the dominant areas of a discipline and also highlight the growth of particular fields. Furthermore, top-cited articles are often written by recognized experts who can offer insights into future directions of the discipline (Joynt & Leonard, 1980; Kelly et al., 2010; Lefaivre & O'Brien, 2011; Ponce & Lozano, 2010).

Science Citation Index appeared in 1961 (following that, the Social Sciences Index was formulated in 1966). Using this index, it has been possible to answer questions such as "who publishes more articles" and "whose articles are being cited more often?" (Bar-Ilan, 2008; Heeks & Bailur, 2007; Meho & Yang, 2007). Hirsch developed the H-index (proposed by Jorge E. Hirsch, a physicist at UCSD, in 2005) as an alternative to traditional bibliometric measures. The H-index is a single bibliometric indicator that combines measures of productivity and impact into one. Hirsch argued that this combination reflects the impact of a publication on the corresponding scientific community (Braun et al., 2006; Schubert & Glänzel, 2007). H-index retrieved by citation indexes (Scopus, Google scholar, and Web of Science) is used to measure the scientific performance and the research impact studies based on the number of publications and citations of a scientist. It is also easily available and may be used for performance measures of scientists and for recruitment decisions (Aghaei et al., 2013; Ale Ebrahim et al., 2013; Brown & Gardner, 1985; Fooladi et al., 2013).

In this study, we used the human development index (HDI) to find the top ten countries around the world. HDI is a composite statistic used to rank countries according to their development levels from "very high" to "low". Countries are placed based on life expectancy, education, living standard, child welfare, health care, economic welfare, and population's happiness.

The main purpose of this study was to compare publication productivity among ASEAN and the world's top ten countries from 1996 to 2011. In addition, we intended to find the relationship among publication productivity, gross domestic product (current US$), and internet usage. Finally, we aimed to investigate the publication trend of the 10 first Malaysian universities in the same periods. In this study, Scopus database (WWW.SCIMAGOJR.COM) was used since it is a primary full-text scientific database and offers about 20% more coverage than Web of Science (Anad & Sen, 1994).

We hypothesized publications of academic papers as the research outputs have positive relationship with economic growth and the number of people with access to the worldwide network. Also, there is a significant difference between ASEAN publication productivity and the world's top ten countries.

2. Method

To identify publication productivity among ASEAN and the world's top ten countries, Scopus database (SCImago) was used to compare overall documents and citations, cited documents, un-cited documents, self-citations, citations per document and international collaboration from 1996 to 2011. Moreover, the World Bank database (World Data Bank) was used to collect data for GDP and the number of internet users in these countries.

To find the top ten countries around the world, we used the human development index (HDI) (Anad & Sen,

1994). Moreover, to find the 10 first universities in Malaysia, we used the number of publications in Scopus database. Furthermore, to evaluate these universities, the number of published articles, conferences, reviews, and letters for the same periods was collected (1996-2011).

2.1 Data Analysis

Prior to data analysis, normality test was done for the obtained data. The normality test revealed that all variables were not distributed normally. So, to answer the research questions, non parametric test was used. To evaluate the relationship among related items of publication, GDP and Internet usage, Spearman correlation coefficient test was applied. Moreover, to compare ASEAN countries with the top ten countries, Mann–Whitney U test was used. For evaluating the differences in number of documents, citations, self-citations, and citations per document among ASEAN countries, Kruskal-Wallis test was applied. The Kruskal-Wallis test is a nonparametric test that compares three or more unmatched groups and it is an extension of the Mann-Whitney U test to allow the comparison of more than two independent groups.

3. Results

Based on human development index (HDI), the top ten countries around the world are listed as follow: Norway, Australia, USA, The Netherlands, Germany, New Zealand, Ireland, Sweden, Switzerland, and Japan.

Table 1. Comparison between ASEAN countries and the 10 first countries around the world (publication productivity and country ranking)

Country		Overall Documents (1996_2011) in Scopus	Country ranking*	
			publication	H-Index
ASEAN	Brunei	1064	133	140
	Cambodia	1296	128	112
	Indonesia	16139	63	57
	Laos	853	141	135
	Malaysia	75530	42	54
	Myanmar	906	139	146
	Philippines	11326	70	56
	Singapore	126881	32	30
	Thailand	69637	43	39
	Vietnam	13172	67	60
TOP TEN	Norway	141143	31	21
	Australia	592533	11	11
	USA	6149455	1	1
	Netherland	487784	14	8
	Germany	1581429	5	3
	New Zealand	114495	34	26
	Ireland	91125	39	27
	Sweden	337135	18	10
	Switzerland	350253	17	9
	Japan	1604017	4	6

* based on 238 countries in the world.

Table 2. Kruskal Wallis test

ASEAN countries	Documents (Mean)	SD	Chi square*	p.value
Brunei	66.5	32.26		
Cambodia	81	64.46		
Indonesia	1008.688	663.05		
Laos	53.3125	45.95		
Malaysia	4720.625	5443.05	138	<0.01
Myanmar	56.625	41.21		
Philippines	707.875	283.60		
Singapore	7930.063	3940.70		
Thailand	4352.313	2963.70		
Vietnam	823.25	609.77		
ASEAN countries	Overall Citation (Mean)	SD	Chi square*	p.value
Brunei	484.0625	194.40		
Cambodia	801.1875	614.26		
Indonesia	7406.875	2823.18		
Laos	478.1875	400.11		
Malaysia	17601.19	5917.94	140.628	<0.01
Myanmar	428.0625	245.58		
Philippines	7586.875	2320.56		
Singapore	83167.75	32859.46		
Thailand	33060.56	14704.18		
Vietnam	6725.25	2789.02		
ASEAN countries	Self-citation (Mean)	SD	Chi square*	p.value
Brunei	43.4375	19.69		
Cambodia	88.0625	72.82		
Indonesia	857.4375	223.05		
Laos	64.875	50.88		
Malaysia	4345.5625	2483.06	142.822	<0.01
Myanmar	33.625	18.62		
Philippines	866.0625	240.79		
Singapore	11939.563	4584.45		
Thailand	5831.5	2407.33		
Vietnam	789.25	394.57		
ASEAN countries	Citation per document (Mean)	SD	Chi square*	p.value
Brunei	9.5081	5.37		
Cambodia	12.2075	6.05		
Indonesia	10.8456	5.18		
Laos	11.8269	5.86		
Malaysia	7.64	3.98	13.099	<0.01
Myanmar	11.5994	6.61		
Philippines	12.9463	6.20		
Singapore	12.5063	5.02		
Thailand	10.6606	4.97		
Vietnam	11.755	5.75		

To investigate the differences among ASEAN countries, Kruskal Wallis test was applied. The results for all these indices showed that there were significant differences among these countries.

As Tables 1 and 2 show, Singapore had the highest publications (126881 documents) and Laos had the lowest publications (853 documents) among ASEAN countries, while Malaysia ranking (with 75530 documents) was the second and the forty second among ASEAN and all the world countries, respectively (based on 238 countries in the world). Laos with 853 documents, and the publication ranking of 141 from 1996 to 2011 was the last country in this region. The USA was the first country in the world with the highest number of publications (6149455), H-index (1035) and overall citation (114546415) (see Table 1).

Interestingly, Malaysia had the fewest citations per document (overall 7.64 cite per document) and the least collaboration with the world (37%) among ASEAN countries, whereas Laos had the most international collaboration (91%) in this region from 1996 to 2011 (see Figure 1 and Table 2). Furthermore, Malaysia and the United States had the highest self-citations with 24 % and 48% of all the citations that were relieved during that period among ASEAN and the top ten countries in the world (see Table 2 and Figure 1). Moreover, Malaysia had the least collaboration with the world in the last 16 years among ASEAN countries (1996-2011). As Table 2 shows, there are significant differences among the number of documents ($H(2) = 138$, $p < 0.01$), citations ($H(2) = 140.62$, $p<0.01$), self-citations ($H(2) = 142.82$, $p<0.01$), and citations per document ($H(2) = 13.09$, $p<0.01$) among ASEAN countries.

Publication trends in ASEAN countries are promising in comparison with the top ten countries in the world (see Figure 2 and Table 3). There was a significant difference ($p<0.01$) between ASEAN and developed countries in number of documents, citable documents, citations (overall), self-citations, cited documents and research collaboration with the world. The rate of growth (Figure 2) in scientific publication was 24% in Cambodia (the highest in ASEAN), while Japan had 1.4% of growth in publication among these countries.

To evaluate the relationship among related items of publication productivity and GDP and Internet usage, Spearman correlation coefficient was applied. Table 4 shows the correlation between indices and GDP and internet usage for ASEAN and the top ten countries separately. The results showed that there was a positive and significant relationship between GDP and the number of publications, citable documents, citation, self-citation and cited documents in ASEAN and the top ten countries in the world. However, one variable of international collaboration had a significant and negative relationship with GDP.

Regarding the relationship between internet usage and all the variables, we found a significant and positive relationship in ASEAN countries except for the variable of international collaboration. However, there was a positive and significant ($p<0.01$) relationship between international collaboration and internet usage in the top ten countries.

Prior to data analysis, normality test was conducted. The results revealed that all variables were not distributed normally so that we used Kruskal Wallis test, a non-parametric test, to examine publication productivity among the top ten Malaysian universities. Table 5 shows the mean and standard deviation for all types of publications among the top ten universities in Malaysia. The results of Kruskal Wallis test confirmed a significant difference among these universities. The institution with the first ranking in Malaysia was University of Malaya with 13105 publications from 1996 to 2011. The main field of research in this university was physics and astronomy with 15 % of all publications. et al.,Moreover, the result of Spearman correlation coefficient test showed a positive and significant relationship among the number of articles, conference papers, reviews and letters published during these years. Except the number of conference papers and letters, all other coefficients showed a strong relationship.

Table 3. Comparison between ASEAN and the top 10 countries for publication

REGION	ASEAN		TOP TEN COUNTRIES		Z	P value
	Mean	SD	Mean	SD		
Documents	1980.0	3453.7	71558.6	112595.0	-14.5	<0.01
Citable Documents	1859.9	3263.2	67369.3	104758.0	-14.518	<0.01
Citation (overall)	15774.0	27026.4	1190700.0	2256220.0	-14.9	<0.01
Self-citation	2485.9	4098.7	446135.2	1079040.0	-14.86	<0.01
Cited Documents	1277.8	2021.3	53836.4	84267.2	-14.748	<0.01
International Collaboration	63.2	19.4	39.8	11.2	-10.206	<0.01

To compare ASEAN countries and the top ten countries, Mann–Whitney U test was applied. The results showed significant differences for all indices

Table 4. Spearman correlation coefficient

REGION	Index	GDP	Internet users
ASEAN	Documents	.853**	.681**
	Citable Documents	.854**	.669**
	Citation (overall)	.699**	.511**
	Self-citation	.737**	.534**
	Cited Documents	.823**	.646**
	% International Collaboration	-.502**	-.595**
TOP TEN	Documents	.972**	.201*
	Citable Documents	.973**	.199*
	Citation (overall)	.757**	-.224**
	Self-citation	.780**	-.165*
	Cited Documents	.940**	0.121
	% International Collaboration	-.407**	.557**

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5. Kruskl Wallis test was applied to examine publication productivity among the top ten Malaysian universities

university	Article		Conference		Review		Letter	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
University of Malaya	638	618	125	152	32	34	9	6
Universiti Sains Malaysia	570	609	131	160	19	24	4	4
Universiti Putra Malaysia	570	645	114	143	20	24	1	2
Universiti Kebangsaan Malaysia	416	509	188	287	14	20	2	3
Universiti Teknologi Malaysia	180	262	210	282	6	12	0	0
Universiti Teknologi MARA	103	153	150	281	4	7	0	1
International Islamic University Malaysia	98	131	57	92	4	4	1	2
Multimedia University	111	100	89	87	4	5	0	0
Universiti Teknologi Petronas	51	98	85	155	2	4	0	0
Universiti Malaysia Perlis	32	58	43	70	1	2	0	0
Chi square	84		22		73		90	
P value	<0.01		<0.01		<0.01		<0.01	

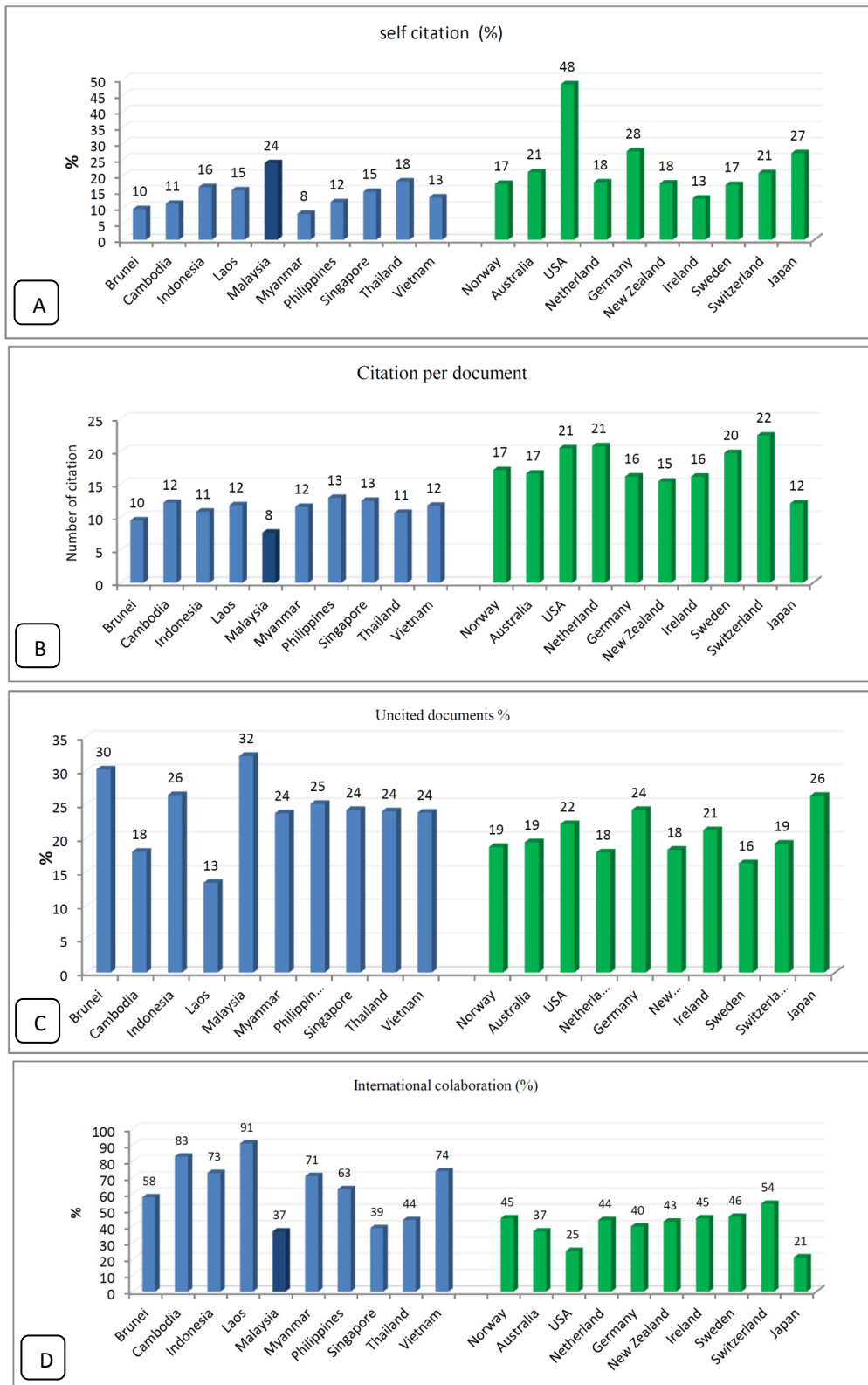|	Article	Conference	Review
Conference	.817**		
Review	.894**	.717**	
Letter	.746**	.488**	.741**

Spearman's rho Correlation Coefficients

Figure 1. Comparison among ASEAN and World's Best Countries regarding self citation (A); Citation per document (B); Un-cited documents (C); and International collaboration (D)
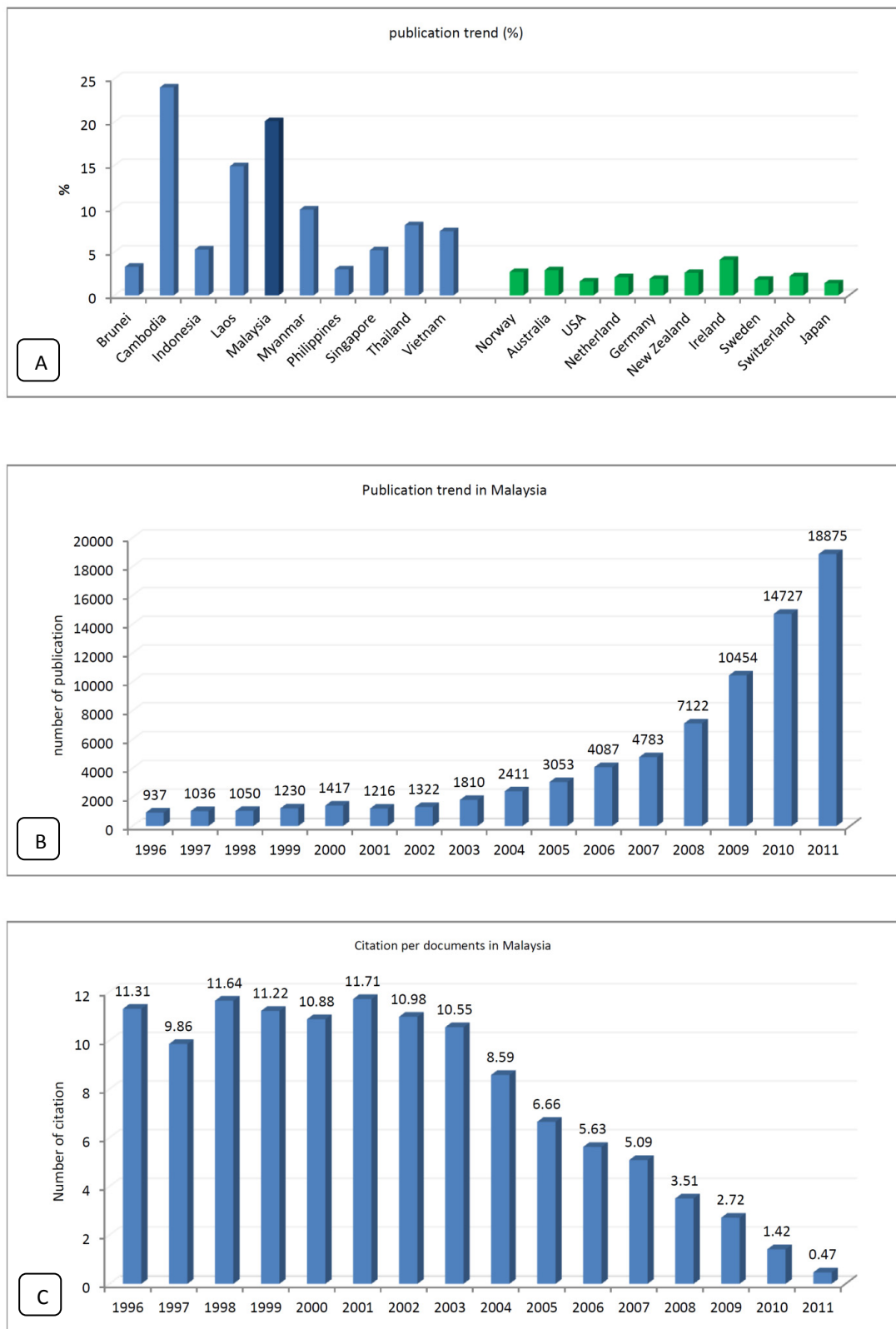
Figure 2. Publication trend in ASEAN countries and World's Best Countries (A); Publication trend in Malaysia (B); Citation per document in Malaysia (C)

4. Discussion and Conclusion

In the current study, we made a comparison in Scopus database (SCImago) between ASEAN and the top 10 countries in the world regarding the relationship among economic growth, internet usage and publication productivity from 1996 to 2011. In addition, we made a comparison among the first 10 Malaysian universities.

We used SJR, or SCImago Journal and Country Rank, as a measure of the scientific prestige of scholarly sources derived from the Google Page Rank™ algorithm. It attempts to even out the differences in citation practice in different subject fields and facilitate direct comparisons of sources. Furthermore, the SCImago Journal and Country Rank portal displays journal and country scientific indicators developed from the information contained in the Scopus® database. These indicators can be used to assess and analyze scientific domains.

Publication productivity could be a good indicator of research output and used to rank countries, research institutes, or researchers in different fields (Liu & Cheng, 2005; Meho & Spurgin, 2005; Narin & Hamilton, 1996; Toutkoushian et al., 2003; Yazit & Zainab, 2007). The impact of a publication is assessed in terms of the number of citations that it has received in relation to other outputs in the journal (Yi et al., 2008). However, the number of times cited for an article is highly correlated with the length of time since its publication (Yi et al., 2008). There was a significant difference ($p < 0.01$) between citation per document (Yi et al., 2008; Calver & Bradley 2009) in ASEAN region (11.1 citation per document) and developed countries (17.7) (see Table 3). Malaysia got 31.5 % and 57.1 % less citation per document in comparison with the average of citation per document in ASEAN and top ten developed countries respectively. However, Malaysia had the highest self-citation in this region with almost 24 % of all citations which were received during this period. The United States had the highest number of publications as well as the highest self-citation (48%) in the world. Malaysia had the least collaboration with the world in comparison with other ASEAN countries and it could be one of the reasons for receiving less citation per document (Ale Ebrahim et al., 2013). Based on the literature, the mean value of citation per publication of collaborative papers was higher than that of single country publications.

Publication trends in ASEAN countries with 10.1% growth are promising in comparison with the developed countries studied in our research (2.3%). Figure 2 represents the publication trend and the number of publications in Malaysia between 1996 and 2011. The number of publications increased dramatically after 2007 with 4783 to 18875 documents in 2011 (almost 4 times). However, the number of citations decreased rapidly from 5.09 to 0.47 citations per document during these years (11times). One of the main reasons for the increase in the number of publications in Malaysia could be focusing heavily on increasing the quality of research in its research universities such as University of Malaya. Malaysia spends 1% of its gross domestic product on development and research projects as determined in the 10th Malaysian Plan. Moreover, increasing the number of PhD students and changing their program from conventional dissertations to paper-based dissertations (Its requirement is publication in high peer-reviewed journals) could be another reason. The number of PhD students in Malaysia has increased 10 times in recent years (from about 4,000 students in 2002 to almost 40,000 in 2012). Table 5 shows the 10 first universities in Malaysia. The first top five universities have been chosen as research universities and received additional government funding. Two third (68.8 %) of all Malaysian publications have been produced by these research universities from 1996 to 2011.

Chemistry, Physics, and Astronomy are the first fields regarding the number of publications and citations. Institutes that are working in these fields could publish more papers and get more citations. Malaysian universities mostly work on Engineering and Medicine in comparison with the top universities located in the top countries such as the United States.

Our findings in this study showed a positive and significant relationship between GDP and the number of publications. This finding was similar to the previous researches that found positive and significant relationship between education and economic growth (Mankiw et al., 1992; Barro, 1991; Bils & Klenow, 2000). Moreover, a recent research study by Jin and Jin (2013) indicated that publication productivity in different fields has dissimilar effects on economic growth. Surprisingly, for one variable i.e., international collaboration, we found that there is a significant and negative relationship between international collaboration and the GDP in ASEAN countries, while the number of people with access to the World Wide Web in developed countries had significant and positive relationship with research collaboration projects. The countries with more economic growth like the United States had less research collaboration with other counties.

Publication trends in ASEAN countries and especially in Malaysia (20.14 times increased) are encouraging in comparison with the top ten developed countries. Nevertheless, these publications could not get reasonable citations. Researchers, science managers, as well as policy makers should try to find different ways to increase citation per document (Ale Ebrahim et al., 2013) such as improving the quality and visibility of their researches

and invest more on research studies whose outputs lead to more rapid economic growth.

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