A Study of the Relationship between Research Output and National Productivity Development in the Mekong Region

Nichanach Katemukda

Faculty of Engineering, Rajamangala University of Technology Rattanakosin, Nakhon Pathom, Thailand
Email: nichanach.kat@rmutr.ac.th

Received: October 18, 2023
Revised: April 4, 2024
Accepted: June 1, 2024

Abstract

Enhancement of productivity is crucial for national development in the Mekong region (China, Thailand, Cambodia, Laos, Myanmar, and Vietnam). This study aims to investigate potential positive relationships between research output and national productivity. Research output consists of the number of documents, citable documents, citations, self-citations, and citations per document. A correlation analysis was conducted using meta data from the World Bank and SCImago covering the period from 1996 to 2021. The findings reveal that the number of published documents has the strongest positive correlation with national productivity in all countries. The number of documents and citable documents are positively related in 99 percent of the six countries, reflecting a shared effort to generate citable documents. Self-citations show a stronger positive relationship with national productivity than external citations, although both are less influential than the number of documents and citable documents. Linear regression analysis further indicates that the number of published documents is the primary driver of national productivity, with an adjusted R-squared value of 55% at a 95% confidence interval. The study suggests that governments in the Mekong region should encourage researchers to publish a sufficient quantity and quality of research papers. Additionally, they should support research institutes and universities in developing their own Scopus-indexed journals to facilitate knowledge exchange. By increasing knowledge in the region, long-term national productivity can be significantly enhanced.

Keywords: Mekong region, national productivity, research output, knowledge management

Introduction

Driving national productivity is one of the keys to developing a country's wealth. Especially in the Mekong region, enhanced national productivity

means improved standards of living (Lynch and Nyhan, 2001). Increasing the knowledge assets of the country also enhances the country's intellectual capital. Knowledge assets need to be managed, and one of the outputs of knowledge resulting from research is the publication of research, the concept of which is quite similar to knowledge management. Starting from knowledge access, which is where the research began, through discovering new knowledge, and preparation of the formal document, the knowledge is verified by the expertise in the field. Once the new knowledge is published, anyone can easily access it, and the knowledge can be shared and distributed (Mohapatra et al., 2016). In addition to producing new knowledge, research also produces researchers who will ultimately serve as the nation's most valuable resource in terms of human capital. Finally, national productivity can be improved, and the country can also develop for a better standard of living (Kardashevskii and Shestakova, 2000). To encourage researchers to conduct research and publish their findings, the benefit of increased national productivity should be considered. The governments of each country would then recognize the importance of the petition, and policies of support would arise in response. The objective of this research is to look into possible positive links between research output (number of articles, citations, etc.) and national productivity, which is reasonable for government-supported institutes and researchers in the Mekong region countries.

Literature Review and Theoretical Framework

Knowledge Management and Research Publication Mapping

Knowledge is essential for improving efficiency and maintaining a competitive advantage in order to survive turbulent economic times (Hana, 2013). Based on the rapid development of information technology, if people can easily access the source of information, it will be easy to convert the information into knowledge in a short period of time. Thus, knowledge management is important in this circumstance, especially for the knowledge gained from the research (Becerra-Fernandez and Sabherwal, 2014). Knowledge is a dynamic

resource with an expiration date (Williams, 2007). Knowledge develops over time and must be updated. This is the reason behind knowledge management as a cycle. The six steps of knowledge management are as follows (Turban, 2011).

1) Creating knowledge. Knowledge comes primarily from the research process. This knowledge can also be created through two-way communication methods, such as meetings, conferences, etc. Moreover, research as a team also creates new knowledge.
2) Capturing knowledge. The knowledge generated must be archived in either its raw or report form.
3) Refining knowledge. New knowledge must be placed in context and verified in the field.
4) Storing knowledge. Useful knowledge must be stored in a formal format that can be used later.
5) Managing knowledge. Knowledge, like a library, must be kept and easily accessible.
6) Disseminating knowledge. Knowledge must be made available in a useful format and shared with anyone who needs it anywhere and anytime.

Thus, mapping with the research output is based on the knowledge management philosophy (Table 1).

Table 1 Knowledge management and research publication mapping

Knowledge management	Research publication
Create knowledge	Research process
Capture knowledge	Manuscript
Refine knowledge	Peer review
Store knowledge	Publish
Manage knowledge	Journal database
Disseminate knowledge	Search engine such as Google scholar etc.

Universities or any concerned institutes encourage researchers to publish articles that followed the knowledge management philosophy. Research is the process of creating new knowledge, capturing thought-out journal formatting, refining the new knowledge from the reviewer, and storing new knowledge in a journal database as well as disseminating it through a public online system. This study demonstrates that the output of the research process is useful for increasing a country's productivity.

Research Process and Research Output

Research involves finding answers to questions that have not been answered before. It focuses on those inquiries for which no written or human answers currently exist. Thus, research seeks solutions to problems that can be addressed using the available tools and resources (Singh, 2006). This makes research a dynamic part of the knowledge management cycle. The word 'research' is derived from the combination of 're,' meaning to do something again, and 'search,' meaning to find out something. Conducting research involves repeatedly observing phenomena, gathering and analyzing data, and drawing conclusions based on the findings. The goal is to uncover connections between various occurrences in the environment. According to Pandey and Pandey (2015), the research process includes selecting a problem, formulating hypotheses, collecting and analyzing data, and reaching a conclusion. One important output of research is the publication of an article (Ab Rahim et al., 2013), often in internationally recognized journals, such as those indexed in the Scopus database (Lovakov et al., 2022).

The SCImago Journal Rank (SJR) indicator is a measure of academic journals' scientific impact that takes into consideration both the volume of citations a journal receives and the standing or significance of the journals which the citations originate from. The SJR indicator for a journal is a numerical figure that reflects the typical weighted number of citations obtained each year for articles published in that journal over the previous three years, as indexed by Scopus. Greater journal prestige

is intended to be shown by higher SJR indicator values. Scimago Lab is the institute that created SJR (Mañana-Rodríguez, 2015). The database of Scimago consists of documents, citable documents, citations, self-citations, and citations per document (SCImago, 2022). Documents refer to the number of documents published during the selected year. It is usually called the research output of the country. Citable documents refer to a certain year's citable documents. Citations refers to the citations by document made during the year. Self-citations refer to the country's self-citations in the documents published during the year. Finally, citation per document is the average number of citations per document published during the source year. All the data are used as input variables for testing the relationship with national productivity.

National Productivity

Productivity is a critical aspect of the success of agriculture, industry, service firms, and nations (Pastuszak et al., 2013). The ability of people to purchase goods and services, improve their housing and education, as well as support social causes and environmental projects, all increases with increased productivity (Hasan et al., 2018). As a result, raising national productivity can boost living standards, which is why it is a preferred area for improvement. Productivity is often measured as the ratio of output to input used in a production process over a predetermined time period (Singh et al., 2000). The value added of a company is the sales revenue after deducting the cost of goods sold and depreciation (Phusavat et al., 2011). The value added per employee is referred to as value added productivity (Masayoshi et al., 1991). Gross domestic product (GDP) is calculated as the total gross value added by all producers who are residents of the economy, plus any applicable product taxes, minus any unaccounted-for subsidies. Thus, the GDP representing the value added of the national economy, divided by the midyear population, is called national productivity. The unit of the national productivity is in US dollars (Phusavat et al., 2012).

Methodology

Theoretical Framework

The study is one of quantitative research with a focus on the Mekong region. The countries in the Mekong region are China, Thailand, Cambodia, Vietnam, Myanmar, and Laos. It aims to investigate the relationship between the variables of research output and national productivity. The variables of research output are documents, citable documents, citations, self-citation, and citations per document. The theoretical framework is as follows:

1) The number of documents (research articles) is positively related to national productivity.
2) The number of citable documents is positively related to national productivity.
3) The number of citations is positively related to national productivity.
4) The number of self-citations is positively related to national productivity.
5) The number of citations per document is positively related to national productivity.

Second, in parallel with correlation studies between the variables of the research output, for the years 1996 to 2021, all data are available in the World Bank database.

Third, the regression analysis was constructed with all countries (Figure 1).

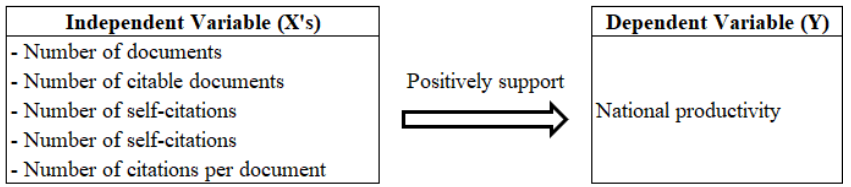

Figure 1 Research framework and hypothesis

Data Analysis

The national productivity (unit is in US dollars) in each country for the correlation analysis is as follows (Table 2).

Table 2 National productivity

Year	China	Thailand	Cambodia	Vietnam	Laos	Myanmar
1996	709.41	3,043.98	319.29	324.15	378.43	129.57
1997	781.74	2,468.18	304.76	348.02	345.92	125.10
1998	828.58	1,845.83	268.99	348.32	248.84	101.14
1999	873.29	2,033.26	295.90	362.92	277.81	122.21
2000	959.37	2,007.74	300.61	390.09	325.19	146.60
2001	1,053.11	1,893.26	321.15	404.81	326.94	131.72
2002	1,148.51	2,096.19	338.99	430.05	320.06	128.10
2003	1,288.64	2,359.12	362.34	480.58	362.82	161.06
2004	1,508.67	2,660.13	408.51	546.91	417.93	193.37
2005	1,753.42	2,894.06	474.11	687.48	475.61	216.31
2006	2,099.23	3,369.54	539.75	784.37	591.00	240.62
2007	2,693.97	3,973.02	631.53	906.28	710.38	314.20
2008	3,468.30	4,379.66	745.61	1,149.42	900.74	460.91
2009	3,832.24	4,213.01	738.05	1,217.27	949.18	586.17
2010	4,550.45	5,076.34	785.50	1,673.33	1,141.24	746.95
2011	5,614.35	5,492.12	882.28	1,942.09	1,378.50	1,061.34
2012	6,300.62	5,860.58	950.88	2,178.04	1,581.63	1,134.30
2013	7,020.34	6,168.26	1,013.42	2,354.87	1,831.94	1,168.17
2014	7,636.12	5,951.88	1,093.50	2,545.42	1,999.96	1,210.10
2015	8,016.43	5,840.05	1,162.90	2,581.62	2,140.04	1,196.74
2016	8,094.36	5,993.31	1,269.59	2,745.57	2,324.40	1,136.61
2017	8,816.99	6,593.82	1,385.26	2,974.12	2,455.21	1,151.11
2018	9,905.34	7,298.95	1,512.13	3,230.93	2,569.09	1,250.17
2019	10,143.84	7,814.38	1,643.12	3,425.09	2,613.94	1,271.11
2020	10,408.67	7,158.77	1,547.51	3,526.27	2,608.98	1,450.66
2021	12,556.33	7,233.39	1,590.96	3,694.02	2,551.33	1,187.24

Source: World Bank national accounts data, and OECD National Accounts data files. (2022)

The research outputs of six countries are as follows (Table 3):

Table 3 Research outputs of China, Thailand, Cambodia, Vietnam, Laos and Myanmar

Country	Year	Documents	Citable Documents	Citations	Self-citations	Citations per document
China	1996	30,859	30,744	303,235	127,576	9.83
China	1997	36,185	36,085	377,640	156,756	10.44
China	1998	42,655	42,564	442,008	197,589	10.36
China	1999	43,376	43,243	534,220	246,669	12.32
China	2000	51,571	51,350	691,335	337,432	13.41
China	2001	65,620	65,311	867,515	431,904	13.22
China	2002	68,555	68,194	1,091,353	548,956	15.92
China	2003	82,003	81,079	1,437,476	716,604	17.53
China	2004	117,172	116,358	1,939,117	988,215	16.55
China	2005	171,437	170,275	2,447,750	1,286,205	14.28
China	2006	201,361	199,528	2,867,645	1,521,816	14.24
China	2007	223,383	221,082	3,364,952	1,798,961	15.06
China	2008	261,462	258,554	3,926,331	2,083,562	15.02
China	2009	308,745	303,903	4,559,340	2,431,464	14.77
China	2010	344,328	335,611	5,062,087	2,737,842	14.70
China	2011	394,330	384,883	5,566,379	3,078,304	14.12
China	2012	416,372	408,973	6,209,261	3,475,662	14.91
China	2013	456,875	447,437	6,776,132	3,893,995	14.83
China	2014	489,224	478,929	7,294,318	4,305,094	14.91
China	2015	465,328	453,473	7,638,213	4,602,159	16.41
China	2016	501,174	488,371	7,448,114	4,590,557	14.86
China	2017	542,098	527,256	7,514,833	4,730,540	13.86
China	2018	609,496	593,011	7,066,586	4,594,430	11.59
China	2019	699,385	682,067	5,820,151	3,824,634	8.32
China	2020	771,730	751,978	4,037,226	2,356,381	5.23
China	2021	860,012	841,099	846,129	555,970	0.98
Thailand	1996	1,243	1,218	30,126	4,393	24.24
Thailand	1997	1,435	1,424	36,849	5,593	25.68

Table 3 Research outputs of China, Thailand, Cambodia, Vietnam, Laos and Myanmar (Cont.)

Country	Year	Documents	Citable Documents	Citations	Self-citations	Citations per document
Thailand	1998	1,647	1,631	41,980	5,999	25.49
Thailand	1999	1,825	1,783	46,769	6,881	25.63
Thailand	2000	2,290	2,242	60,974	8,613	26.63
Thailand	2001	2,374	2,331	56,029	8,273	23.60
Thailand	2002	2,944	2,881	77,962	10,504	26.48
Thailand	2003	3,425	3,298	107,387	13,589	31.35
Thailand	2004	4,004	3,841	132,124	16,182	33.00
Thailand	2005	5,151	4,952	157,855	18,316	30.65
Thailand	2006	6,271	6,023	158,811	21,622	25.32
Thailand	2007	6,743	6,455	181,593	24,755	26.93
Thailand	2008	8,026	7,681	189,592	27,071	23.62
Thailand	2009	8,809	8,285	211,756	29,989	24.04
Thailand	2010	10,252	9,494	201,092	29,391	19.61
Thailand	2011	10,920	10,267	210,586	31,136	19.28
Thailand	2012	12,434	11,590	225,837	33,725	18.16
Thailand	2013	12,595	11,831	201,498	31,890	16.00
Thailand	2014	13,763	12,935	199,077	32,822	14.46
Thailand	2015	13,298	12,483	191,637	31,718	14.41
Thailand	2016	15,082	14,048	191,936	31,078	12.73
Thailand	2017	16,940	15,768	167,704	29,236	9.90
Thailand	2018	19,187	18,127	148,034	26,415	7.72
Thailand	2019	20,311	19,410	114,159	21,953	5.62
Thailand	2020	21,970	20,928	83,291	16,396	3.79
Thailand	2021	25,148	24,169	22,471	5,443	0.89
Cambodia	1996	10	10	173	5	17.30
Cambodia	1997	15	14	101	17	6.73
Cambodia	1998	15	15	534	27	35.60
Cambodia	1999	31	27	657	117	21.19
Cambodia	2000	29	26	720	38	24.83
Cambodia	2001	32	30	1,128	50	35.25
Cambodia	2002	55	47	1,458	157	26.51

Table 3 Research outputs of China, Thailand, Cambodia, Vietnam, Laos and Myanmar (Cont.)

Country	Year	Documents	Citable Documents	Citations	Self-citations	Citations per document
Cambodia	2003	57	53	1,631	167	28.61
Cambodia	2004	91	83	2,464	322	27.08
Cambodia	2005	94	83	3,774	323	40.15
Cambodia	2006	122	106	3,265	371	26.76
Cambodia	2007	149	142	6,199	657	41.60
Cambodia	2008	154	135	5,459	628	35.45
Cambodia	2009	188	166	11,489	746	61.11
Cambodia	2010	198	180	7,944	646	40.12
Cambodia	2011	223	190	6,632	728	29.74
Cambodia	2012	267	226	9,087	923	34.03
Cambodia	2013	277	246	7,842	1,010	28.31
Cambodia	2014	329	276	9,324	1,050	28.34
Cambodia	2015	366	331	9,908	1,120	27.07
Cambodia	2016	422	394	7,801	1,010	18.49
Cambodia	2017	452	402	8,510	808	18.83
Cambodia	2018	510	459	5,135	733	10.07
Cambodia	2019	529	481	4,018	486	7.60
Cambodia	2020	573	532	2,842	306	4.96
Cambodia	2021	627	574	542	88	0.86
Vietnam	1996	298	293	6,381	975	21.41
Vietnam	1997	341	336	5,913	984	17.34
Vietnam	1998	316	315	7,636	1,196	24.16
Vietnam	1999	373	366	9,975	1,097	26.74
Vietnam	2000	404	395	15,465	1,621	38.28
Vietnam	2001	433	428	15,642	1,745	36.12
Vietnam	2002	451	447	13,296	1,647	29.48
Vietnam	2003	665	635	21,345	2,309	32.10
Vietnam	2004	718	696	23,833	2,928	33.19
Vietnam	2005	859	837	26,360	3,005	30.69
Vietnam	2006	988	945	30,666	3,468	31.04
Vietnam	2007	1,167	1,079	31,042	4,602	26.60

Table 3 Research outputs of China, Thailand, Cambodia, Vietnam, Laos and Myanmar (Cont.)

Country	Year	Documents	Citable Documents	Citations	Self-citations	Citations per document
Vietnam	2008	1,514	1,445	39,705	5,823	26.23
Vietnam	2009	1,768	1,669	37,417	5,767	21.16
Vietnam	2010	2,187	2,069	48,758	6,873	22.29
Vietnam	2011	2,426	2,292	48,076	7,428	19.82
Vietnam	2012	3,164	3,007	69,344	9,312	21.92
Vietnam	2013	3,788	3,570	60,777	10,518	16.04
Vietnam	2014	4,041	3,810	69,030	11,474	17.08
Vietnam	2015	4,544	4,363	87,826	12,617	19.33
Vietnam	2016	5,877	5,586	98,806	14,491	16.81
Vietnam	2017	6,731	6,328	103,032	17,249	15.31
Vietnam	2018	8,872	8,309	108,513	21,006	12.23
Vietnam	2019	12,607	11,999	112,692	27,306	8.94
Vietnam	2020	18,155	17,322	114,357	24,323	6.30
Vietnam	2021	18,381	17,636	28,051	5,919	1.53
Laos	1996	11	11	174	49	15.82
Laos	1997	11	11	315	70	28.64
Laos	1998	13	13	507	41	39.00
Laos	1999	11	11	212	29	19.27
Laos	2000	18	18	310	69	17.22
Laos	2001	15	15	456	89	30.40
Laos	2002	23	23	511	80	22.22
Laos	2003	40	38	2,327	209	58.18
Laos	2004	71	69	1,743	150	24.55
Laos	2005	70	65	3,261	292	46.59
Laos	2006	94	90	3,821	471	40.65
Laos	2007	84	71	3,667	366	43.65
Laos	2008	111	104	3,188	403	28.72
Laos	2009	104	97	2,765	314	26.59
Laos	2010	137	120	4,744	392	34.63
Laos	2011	159	147	3,549	519	22.32
Laos	2012	219	194	5,605	632	25.59

Table 3 Research outputs of China, Thailand, Cambodia, Vietnam, Laos and Myanmar (Cont.)

Country	Year	Documents	Citable Documents	Citations	Self-citations	Citations per document
Laos	2013	208	194	4,120	526	19.81
Laos	2014	218	198	5,632	476	25.83
Laos	2015	257	225	6,370	511	24.79
Laos	2016	277	259	5,337	550	19.27
Laos	2017	250	225	3,016	412	12.06
Laos	2018	313	284	3,542	453	11.32
Laos	2019	350	324	2,734	331	7.81
Laos	2020	342	300	1,746	183	5.11
Laos	2021	357	335	334	54	0.94
Myanmar	1996	16	15	375	5	23.44
Myanmar	1997	17	16	443	18	26.06
Myanmar	1998	19	19	545	103	28.68
Myanmar	1999	24	24	599	89	24.96
Myanmar	2000	30	29	1,069	93	35.63
Myanmar	2001	26	26	1,073	81	41.27
Myanmar	2002	28	26	789	144	28.18
Myanmar	2003	36	34	1,671	92	46.42
Myanmar	2004	48	46	1,656	197	34.50
Myanmar	2005	94	92	2,379	155	25.31
Myanmar	2006	74	68	1,579	110	21.34
Myanmar	2007	88	80	1,995	263	22.67
Myanmar	2008	109	106	1,627	133	14.93
Myanmar	2009	139	130	2,049	161	14.74
Myanmar	2010	116	106	2,123	140	18.30
Myanmar	2011	169	158	1,969	187	11.65
Myanmar	2012	119	109	1,715	287	14.41
Myanmar	2013	119	99	1,492	229	12.54
Myanmar	2014	156	133	3,700	370	23.72
Myanmar	2015	228	210	5,218	512	22.89
Myanmar	2016	328	290	18,608	533	56.73

Table 3 Research outputs of China, Thailand, Cambodia, Vietnam, Laos and Myanmar (Cont.)

Country	Year	Documents	Citable Documents	Citations	Self-citations	Citations per document
Myanmar	2017	477	375	13,763	841	28.85
Myanmar	2018	602	552	9,037	728	15.01
Myanmar	2019	786	724	4,709	577	5.99
Myanmar	2020	1062	992	3,316	363	3.12
Myanmar	2021	857	810	802	92	0.94

Source: World Bank national accounts data, and OECD National Accounts data files (2022)

All of the data were prepared, statistical analysis was performed, and correlation analysis was used as the statistical tool.

Results

The correlation results for each country are presented in below (Tables 4-9):

In China, national productivity has been highly positively correlated with documents, citable documents, self-citations, and citations, respectively. Only citations per document has a low relatedness and a negative correlation. The category of documents is highly positively correlated with citable documents. Citations also is highly positively correlated with self-citations (Table 4).

Table 4 Correlation statistical results of China

China	National productivity	Documents	Citable documents	Citations	Self-citations	Citations per document
National productivity	1.0000					
Documents	0.9891	1.0000				
Citable documents	0.9886	1.0000	1.0000			
Citations	0.6907	0.6571	0.6564	1.0000		
Self-citations	0.7248	0.6842	0.6832	0.9948	1.0000	
Citations per document	-0.4505	-0.4825	-0.4824	0.2627	0.2116	1.0000

In Thailand, national productivity has been highly positively correlated with documents and citable documents. The remaining variables are weakly related, particularly citations per document, which has a highly negative correlation. Documents is highly positively correlated with citable documents. Citations also is highly positively correlated with self-citations (Table 5).

Table 5 Correlation statistical results of Thailand

Thailand	National productivity	Documents	Citable documents	Citations	Self-citations	Citations per document
National productivity	1.0000					
Documents	0.9617	1.0000				
Citable documents	0.9580	0.9998	1.0000			
Citations	0.4362	0.2874	0.2736	1.0000		
Self-citations	0.6101	0.4615	0.4473	0.9687	1.0000	
Citations per document	-0.9042	-0.9385	-0.9388	-0.0746	-0.2927	1.0000

In Cambodia, national productivity has been highly positively correlated with documents and citable documents. The remaining variables are weakly related, particularly citations per document, which has a negative correlation. Documents is highly positively correlated with citable documents. Citations also is highly positively correlated with self-citations (Table 6).

In Vietnam, National productivity has been highly positively correlated with documents, citable documents, self-citations, and citations, respectively. Citations per document has a highly negative correlation with national productivity. Documents is highly positively correlated with citable documents. Citations also is highly positively correlated with self-citations (Table 7).

Table 6 Correlation statistical results of Cambodia

Cambodia	National productivity	Documents	Citable documents	Citations	Self-citations	Citations per document
National productivity	1.0000					
Documents	0.9906	1.0000				
Citable documents	0.9870	0.9991	1.0000			
Citations	0.4664	0.3939	0.3739	1.0000		
Self-citations	0.5622	0.4887	0.4692	0.9421	1.0000	
Citations per document	-0.4578	-0.5018	-0.5119	0.4459	0.2412	1.0000

Table 7 Correlation statistical results of Vietnam

Vietnam	National productivity	Documents	Citable documents	Citations	Self-citations	Citations per document
National productivity	1.0000					
Documents	0.8656	1.0000				
Citable documents	0.8628	1.0000	1.0000			
Citations	0.8730	0.6496	0.6445	1.0000		
Self-citations	0.8713	0.7420	0.7372	0.9636	1.0000	
Citations per document	-0.8536	-0.8381	-0.8366	-0.6348	-0.7022	1.0000

In Laos, national productivity has been highly positively correlated with documents and citable documents, respectively. The remaining variables are weakly related, particularly citations per document, which has a negative correlation. Documents is highly positively correlated with citable documents. Citations also is highly positively correlated with self-citations (Table 8).

Table 8 Correlation statistical results of Laos

Laos	National productivity	Documents	Citable documents	Citations	Self-citations	Citations per document
National productivity	1.0000					
Documents	0.9839	1.0000				
Citable documents	0.9815	0.9991	1.0000			
Citations	0.4911	0.4877	0.4760	1.0000		
Self-citations	0.5275	0.5180	0.5113	0.9419	1.0000	
Citations per document	-0.6383	-0.6093	-0.6149	0.1655	0.0624	1.0000

In Myanmar, national productivity has been highly positively correlated with documents, citable documents, and citations, respectively.Citations is weakly related with national productivity. Citations per document has a negative correlation. Documents is highly positively correlated with citable documents. Citations also is highly positively correlated with self-citations (Table 9).

Table 9 Correlation statistical results of Myanmar

Myanmar	National productivity	Documents	Citable documents	Citations	Self-citations	Citations per document
National productivity	1.0000					
Documents	0.7368	1.0000				
Citable documents	0.7232	0.9986	1.0000			
Citations	0.5114	0.3623	0.3279	1.0000		
Self-citations	0.7126	0.5533	0.5185	0.8070	1.0000	
Citations per document	-0.4795	-0.5286	-0.5422	0.3416	-0.0589	1.0000

For the second and third parts of the analysis, all data from all countries were gathered, with the following results:

Overall, national productivity has been highly positively correlated with the number of documents, citable documents, citations, and self-citations, respectively.Citations per document, has a negative correlation and a very weak degree of correlation. On the other hand, the number of published documents has been highly positively correlated with all factors except citations per document (Table 10).

Table 10 Correlation statistical results of all countries in the Mekong region

Mekong region	National productivity	Documents	Citable documents	Citations	Self-citations	Citations per document
National productivity	1.0000					
Documents	0.7440	1.0000				
Citable documents	0.7427	0.9999	1.0000			
Citations	0.6234	0.8615	0.861	1.0000		
Self-citations	0.6261	0.8680	0.8681	0.9971	1.0000	
Citations per document	-0.4777	-0.3077	-0.3079	-0.2470	-0.2403	1.0000

In the third part, the regression model needs only documents as an independent variable and national productivity as the dependent variable.

The simple linear regression result is as follows:

National productivity = 1573.4257 + 0.012(documents)

Table 11 ANOVA Results of the regression model

ANOVA	df	SS	MS	F	P-Value
Regression	1	5,3202,4037.8483	532,024,037.8483	190.9721	0.0000
Residual	154	429,024,442.8340	2,785,873.0054		
Total	155	961,048,480.6823			

According to the p-value less than 0.05, the regression model is valid at the 95 percent confidence interval. R-Square adj. is 55 percent, which means the regression model can explain 55 percent of national productivity. The regression model is valid to predict national productivity, and the remaining 45 percent need further study to find the other factors that were not included in the study. However, the research can draw a conclusion about the relationship between the output of the research and the country's wealth.

Moreover, the study has been benchmarked with more continental regions, especially the developed regions of North America and Europe (Table 12 and 13). Those countries are selected from the developed countries among the members of the group of seven countries (G7). North America includes the United States and Canada, and Europe includes France, Germany, Italy, and the United Kingdom. These are developed countries and are suitable for comparison with the results of the Mekong region in terms of the relationship between each factor and national productivity.

Table 12 Correlation statistical results of the North American region

North America	National productivity	Documents	Citable documents	Citations	Self-citations	Citations per document
National productivity	1.0000					
Documents	0.6438	1.0000				
Citable documents	0.6161	0.9974	1.0000			
Citations	0.2105	0.7614	0.7852	1.0000		
Self-citations	0.1926	0.7602	0.7865	0.9982	1.0000	
Citations per document	-0.7283	-0.2773	-0.2403	0.2931	0.2886	1.0000

The data is consolidated into one table of the relationship between national productivity and other factors for all three regions (Table 14).

Table 13 Correlation statistical results of the European region

Europe	National productivity	Documents	Citable documents	Citations	Self-citations	Citations per document
National productivity	1.0000					
Documents	0.7827	1.0000				
Citable documents	0.7885	0.9919	1.0000			
Citations	0.4135	0.4538	0.4214	1.0000		
Self-citations	0.4355	0.5077	0.4800	0.9871	1.0000	
Citations per document	-0.4282	-0.5342	-0.5526	0.4680	0.3964	1.0000

The interesting findings are as follows:

- In all three regions, national productivity has been highly positively correlated with documents, and citable documents.
- In all three regions, national productivity has been negatively correlated with citations per document.
- Only in the Mekong region has national productivity been highly positively correlated with citations and self-citations. But both in North America and Europe it has been weakly positively correlated with national productivity. This is interesting that can be explored for future research.

Table 14 Correlation statistical results of three regions compared

Variables	National Productivity		
	Mekong Region	North American Region	European Region
Documents	0.7440	0.6438	0.7827
Citable documents	0.7427	0.6161	0.7885
Citations	0.6234	0.2105	0.4135
Self-citations	0.6261	0.1926	0.4355
Citations per document	-0.4777	-0.7283	-0.4282

Thus, the result supports the idea that the number of research documents in the Mekong region can drive national productivity the same as in developed regions such as North America and Europe.

Conclusion

This study highlights the significant role that research output, particularly the quantity of published documents, plays in driving national productivity across the Mekong region. The objective was to investigate the relationship between various aspects of research output and national productivity, and the findings clearly indicate that the number of publications has a stronger positive correlation with national productivity than the number of citations. However, self-citations, despite being less influential, still maintain a notable positive relationship with productivity. These insights suggest that governments in the Mekong region should actively encourage researchers to publish in Scopus-listed journals as part of a broader strategy to enhance knowledge and national productivity. Additionally, governments might consider supporting research institutes and universities in developing their own Scopus-indexed journals, taking inspiration from initiatives like the Thai-Journal Citation Index Centre (TCI), which works to elevate the quality of local journals to international standards. Such policies could enrich the knowledge base within each country and contribute to the long-term enhancement of national productivity.

Acknowledgements

The researcher is grateful to the Industrial Engineering Department, Faculty of Engineering, Rajamangala University of Technology Rattanakosin, for funding this research and for supporting the publication of this study.

References

Ab Rahim, I. S., Yaacob, A., Abd Aziz, N. H., Abd Rashid, S., and Desa, H. (2013). Research publication output by academicians in public and private universities in Malaysia. **International Journal of Higher Education, 2**(1), 84-90.

Becerra-Fernandez, I., and Sabherwal, R. (2014). **Knowledge management: Systems and processes**. New York: Routledge. doi: 10.4324/9781315715117

Hana, U. (2013). Competitive advantage achievement through innovation and knowledge. **Journal of Competitiveness, 5**(1), 82-96.

Hasan, I., Kobeissi, N., Liu, L., and Wang, H. (2018). Corporate social responsibility and firm financial performance: The mediating role of productivity. **Journal of Business Ethics, 149**(3), 671-688.

Kardashevskii, V. and Shestakova, G. (2000). A rise in the standard of living can be achieved only through productivity. **Problems of Economic Transition, 43**(8), 92-96.

Lovakov, A., Panova, A., and Yudkevich, M. (2022). Global visibility of nationally published research output: The case of the post-Soviet region. **Scientometrics,** 1-17.

Lynch, T. D. and Nyhan, R. C. (2001). A holistic approach to productivity. In **Handbook of public quality management**. (pp. 171-178). New York: Routledge.

Mañana-Rodríguez, J. (2015). A critical review of SCImago journal & country rank. **Research Evaluation, 24**(4), 343-354.

Masayoshi, S., Kiyoshi, W., and Kazuo, N. (1991). **Value added productivity**. Tokyo: Asian Productivity Organization.

Mohapatra, S., Agrawal, A., and Satpathy, A. (2016). Knowledge management cycles. In **Designing knowledge management-enabled business strategies**. (pp. 13-29). Switzerland: Springer Cham.

Pandey, P. and Pandey, M. M. (2015). **Research methodology tools and techniques**. Romania: Bridge Center.

Pastuszak, Z., Helo, P., Lee, T. R., Anussornnitisarn, P., Comepa, N., and Fankham-Ai, K. (2013). Productivity growth: Importance of learning, intellectual capital, and knowledge workers. **International Journal of Innovation and Learning, 14**(1), 102-119.

Phusavat, K., Comepa, N., Sitko-Lutek, A., and Ooi, K. B. (2011). Interrelationships between intellectual capital and performance: Empirical examination. **Industrial Management & Data Systems, 111**(6), 810-829.

Phusavat, K., Comepa, N., Sitko-Lutek, A., and Ooi, K. B. (2012). Intellectual capital: National implications for industrial competitiveness. **Industrial Management & Data Systems, 112**(6), 866-890.

Singh, H., Motwani, J., and Kumar, A. (2000). A review and analysis of the state-of-the-art research on productivity measurement. **Industrial Management and Data Systems, 100**, 234-241. https://doi.org/10.1108/02635570010335271

Singh, Y. K. (2006). **Fundamentals of research methodology and statistics**. New Delhi: New Age International (P).

Turban, E. (2011). **Decision support and business intelligence systems**. Pearson Education India.

Williams, P. J. (2007). Valid knowledge: The economy and the academy. **Higher Education, 54**(4), 511-523. http://www.jstor.org/stable/29735128

Websites

SCImago. (2022). **SJR-SCImago Journal & Country Rank [Portal]**. Retrieved September 15, 2022, from http://www.scimagojr.com

The World Bank. (2022). **World Bank national accounts data, and OECD National Accounts data files**. Retrieved July 20, 2022 from https://data.worldbank.org/indicator/NY.GNP.MKTP.CD