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Science, Scientists and Economic Growth

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Abstract

Education, research and innovation are very important for the sustainable development of any country. The purpose of this study was to find out correlation between gross domestic product (GDP) of 40 different countries (developed and developing) with total number of scientists and also with total number of research documents published in respective countries. Among the countries included in this study, Japan and Germany have the highest GDP while Nepal had the lowest. There is also variation in total number of scientists, percentage of female scientists and the number of publications from country to country. A strong positive correlation between GDP growth and the number of scientitsts was found with r = 0.932 and P = 0.01. In addition, a posative correlation was also observed between the number of scientists and the number of publications (r = 0.817, p = 0.01). On the basis of this study, it is very crucial to give priority to education, science and technology as it will lead to more innovation and knowledge-based economy which will strengthen the economy of the country and the standard of life.

Keywords: GDP, Economy, Scientists, Publications, Knowledge-based economy.

Introduction

For the sustainable development of any country, education, research and innovation are very important. The research conducted, in both natural and social sciences, not only improves the living standard and quality of life of people but also improves the economic status of the country. As, research is very important for economic growth of any country, hence, the countries are now focusing on knowledge based economy, with less dependence on natural resources. Many successful examples of different countries, like, Singapore, South Korea and Finland, etc., clearly highlight the importance of intellectual resources. Therefore, it is important to do more investment in research, science and technology for social and economic development of any country (Macilwain, 2010).

Scientific output of any country is measured by different parameters and the number of scientific documents or research papers is one of the most important parameter which indicates the scientific productivity of a country and its institutes. Besides the number of articles, their quality is measured by global citations (cited by other researchers) and other parameters including number of patents, number of professionals produced, translation of technology into valuable products, etc. (Durieux and Gevenois, 2010).

The scientific output of a country is measured by the number of researchers, both male and female. There is a huge difference in the number of male and female researchers in some countries of the world, e.g. in a country, like, Nepal, there are less than 10% female researchers while in others this number exceeds 50% (UNESCO Institute for Statistics). There is a great need to reduce the gender gap for better research output.

It is very important for researchers to publish their scientific findings, otherwise all the work perishes and technology cannot exist without publishing scientific data. Scientific publications are not only the main component of academic excellence but also a reliable indicator of the development of a country. In order to promote academic writings and publications, there is a great need to develop true scientific environment with significant funding and conducive environment for experimental work (Meo et al., 2013).

According to research reports, the economic success of a country is also based on research information seeking behaviour of its people; it is a two way process, investing more on education, science and technology, will boost economy on one hand. On the other hand a vibrant country can spend more on education, science and technology. The spending on science and technology always pays back so it is very important for most developing countries to increase their budget for education, science and technology for sustainable development as there is a direct relationship between investment in research and overall development of a country (Meo et al., 2013).

The present study was done to find out a

correlation between gross domestic product (GDP) of 40 different countries with the total number of scientists and also with a scientific output of the country in the form of total number of research documents.

Materials and Methods

A total of 40 countries were selected across the globe, including, both developed and developing countries. The data for GDP was collected from the World Bank, for the year 2013. The information about the total number of scientists and number of female scientists was obtained from UNESCO Institute for Statistics (2014) and the total number of scientific documents was obtained from SCImago/Scopus for the year 2013 under countries comparison tab of SCImago website (www.scimagojr.com).

Statistical analysis

The data was subjected to statistical analysis, using SPSS 20 programme and Correlation coefficients "r" between GDP growth of 40 countries and the number of scientists and the number of publications were recorded (**P = 0.01 or *P = 0.05).

Results and discussion

The names of the countries across the globe, their GDP in million USD, total number of scientists, percentage of female scientists and total number of publications in the year 2013 are listed in Table 1. Among the countries listed, Japan has the maximum number of scientists followed by Germany and both the countries also have the highest GDP (4,901,530 and 3,634,823 million USD, respectively). Nepal was ranked the lowest in these 40 countries on the basis of its GDP. Moreover it has the lowest number of female researchers (7.4%) while Libya which is ranked at 33rd position on the basis of GDP has the minimum number of scientists (460) (Table 1).

Correlation between the GDP and the number of scientists

In this study, when comparison was made between GDP growth of 40 countries with the number of its scientists, it was found that there was a strong positive correlation between these two factors (r = 0.932, P = 0.01). The countries which have high GDP growth and a high number of scientists, contribute more to the scientific community and a positive correlation is observed between the number of scientists and the number of publications (r = 0.817, p = 0.01). The percentage of female researchers is quite variable, both among developed and developing counteis. Japan, for example has just 13.8% female researchers while New Zealand has 52%. Among developing countries Philippines and Azerbaijan have over 52% female resarchers while Nepal has just 7.8% (Table 1).

Most of the countries now focus on knowledge-based economy and less dependence on natural resources (Wong and Goh, 2012). According to the present study, there is a strong positive correlation between the number of scientists and GDP growth which truly indicates that if a country has more researchers, there will be more innovation and that will lead to its economic development as indicated by Japan. It has the highest number of researchers in the list of 40 countries (Table 1) and also has the highest GDP growth. In addition, a positive correlation was also found between the number of researchers and the number of scientific output of the country with a direct proportionally. However, there are some exceptions too, e.g., Indonesia and Libya, which are big economies but the number of scientists is less and the reason of their big economy is their natural resources (oil and gas). GDP is the economic growth measure of any country and it is the main indicator of the strength of any country's economy as it represents the total value of all the goods and services produced by a country over a specific period of time (Meo et al., 2013).

In addition, countries, like, Japan, Germany, France, United Kingdom, Russia, Italy, Spain, South Korea, Turkey, Switzerland, Sweden, Iran and Egypt, show a strong correlation between economic strength and number of scientists as well as number of scientific documents from these countries. Although, we have found an overall positive correlation between GDP and the number of scientists as well as the number of scientific documents, produced by the country. However, according to Meo et al. (2013), the research outcome of a country does not depend only on GDP but it also depends on how much percentage of total GDP is spent on research and development. According to their results, the investment in research and development is a major factor for scientific progress and innovation and this was also observed in the current study. Among the Asian countries in the list, Japan, South Korea, Iran and Turkey spend huge money on research and development, and as a result thereof, their scientific outcome is also more as compared to other Asian countries (Meo et al., 2013).

According to a study, conducted in China on the relationship between the expenditure on science, technology and economic growth, the results clearly indicate that greater input in research and development results in better economic growth. Spending more in science and technology not only enhances the capabilities of individuals as well as organisations but also creates new knowledge and innovation which result in an overall better performance and an increased output (Zhang, 2012).

This study is also in accordance with the study conducted by Halpenny et al. (2010), as they also found a positive correlation between the number of

publications and the percentage of GDP spent on research and development. Some countries are big economies but they have less number of scientists and their research output is not huge, like, India, Indonesia, Nigeria, Pakistan, Bangladesh and Nepal etc. One of the reasons is the migration of scientists, as many researchers from these countries move to North America, Europe or Australia and spend rest of their lives there (Van Noorden, 2012).

Table 1. Countries, GDP, number of scientists, percentage of female scientists and total number of publications of selected countries.

No.	Country	*GDP (Million USD)	**Total scientists	**Percentage of female scientists	***No. of publications (2013)
1	Japan	4,901,530	894,138	13.8	121,668
2	Germany	3,634,823	484,566	24.9	148,278
3	France	2,734,949	319,051	25.6	108,092
4	United Kingdom	2,521,381	394,755	38.3	162,574
5	Russia	2,096,777	368,915	41.7	43,930
6	Italy	2,071,307	149,807	34.5	92,906
7	India	1,876,797	154,827	14.8	103,029
8	Spain	1,358,263	224,000	38.4	79,383
9	Korea	1,304,554	345,912	16.7	71,072
10	Mexico	1,260,915	44,577	31.6	17,662
11	Indonesia	868,346	35,564	30.6	4,175
12	Turkey	820,207	124,796	35.8	37,446
13	Switzerland	650,377	45,874	30.2	38,450
14	Sweden	558,949	72,692	35.7	33,033
15	Nigeria	521,803	17,624	23.3	4,926
16	Norway	512,580	44,774	35.7	16,863
17	Thailand	387,252	38,506	51.1	11,313
18	Iran	368,904	107,810	26.6	39,240
19	South Africa	350,630	40,797	40.8	15,181
20	Malaysia	312,435	73,752	48.7	23,190
21	Chile	277,199	9,453	32.4	8,601
22	Philippines	272,017	11,490	52.3	1,631
23	Egypt	271,973	90,990	42.3	13,554
24	Pakistan	236,625	51,954	27.2	10,915
25	Iraq	222,879	40,521	34.2	1,614
26	Portugal	220,022	96,234	45.5	20,106
27	New Zealand	185,787	16,650	52	12,664
28	Ukraine	177,431	70,378	45.5	9,004
29	Vietnam	171,392	41,117	42.8	3,443
30	Bangladesh	129,857	6,097	14	2,911
31	Morocco	104,374	36,732	30.2	3,577
32	Oman	80,570	1,446	24.9	1,168
33	Libya	75,456	460	24.8	411
34	Azerbaijan	73,560	11,891	52.1	708
35	Cuba	68,234	4,618	48.7	2,180
36	Sri Lanka	67,182	5,162	36.9	1,101
37	Bulgaria	53,010	14,138	48.6	3,654
38	Tunisia	47,129	33,199	47.4	5,672
39	Jordan	33,678	11,310	22.5	2,298
40	Nepal	19,294	5,123	7.8	803

*GDP: World Bank Report-2013 (http://databank.worldbank.org/data/download/GDP.pdf)

**Scientists and female scientists: UNESCO Institute for Statistics (March, 2014) (http://data.uis.unesco.org/Index.aspx?queryid=64)

***No. of Publications: SCImago-2013 (http://www.scimagojr.com/countryrank.php)

Conclusion

According to the present study, there is a strong positive correlation between economic growth of the country and the number of scientists as well as between number of scientists and scientific output (publications) of the country. So in order to be a developed country with vibrant economy, it is extremely important to spend more on education, science and technology. This will result in more innovation and knowledge based economy which will strengthen the country economically leading to a better living standard of life.

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