The barometer of scientific endeavour: A comparative analysis

Sam Ramaila, Leelakrishna Reddy and Padmanabhan Nair

Physics Department, University of Johannesburg, Johannesburg, South Africa

E-mail: samr@uj.ac.za

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Abstract. The quality of scientific output of a country is to a large degree intrinsically linked to global competitiveness. Concerted efforts have been made by scientists in various countries across the globe in a bid to elevate both the quality and quantity of scientific output in the face of pervasive resource constraints. Within the nexus of these concerted efforts, this article provides a comparative analysis of scientific output in terms of research publications and the number of Nobel laureates in selected countries. Commensurate with developments in this regard, a concomitant reflection on some of the key underlying factors associated with the achievement level of scientific progress and development in various selected countries has been contemplated in accordance with the core thrust outlined. These factors have largely been considered as critical parameters that underpin the level of scientific progress and development in these selected countries.

1. Introduction

The level of economic development and growth is critically dependent upon a number of factors such as research and innovative capacity. Scientists all over the world pursue their research interests within the constraints of available resources. The provision of resources in some cases appears to be inadequate to the extent that it becomes virtually impossible to make substantial progress on a broader scale with the research projects undertaken. Given this challenge, it has become imperative for many countries to adopt nuanced approaches in order to accelerate the pace of scientific development and technological innovation. It is in recognition of the significance of the desire to realise these aspirations that this article provides a comparative analysis of scientific output in terms of research publications and the number of Nobel laureates in selected countries.

2. Contextual factors

Contextual factors such as human and intellectual capital play an increasingly important role in research and development in any country. It is striking to note that there is no link between research and development and growth in poor countries [1]. As an additional consideration, poorest countries invest more in research and development in relation to Gross Domestic Product than middle-income countries [1]. However, research and development has a positive and statistically significant effect on growth in terms of sales and productivity [2]. The interplay between contextual factors in the research and development sphere is characterised by complex ramifications which appear to hamper global efforts geared towards the realisation of research and development goals. Another complex paradox stems from the fact

that it is considerably difficult to prove that companies that focus solely on research achieve a higher return on their research and development than manufacturing companies [2].

In addition, it has also been observed that privately conducted research and development funded by the government had a negative effect on productivity in sixteen Organisation for Economic Co-operation and Development (OECD) countries during the period 1980-1998 [3]. Some of the observations in relation to the effects of basic research and university-funded research and development have also been documented, namely: If publicly-funded research is conducted at universities or laboratories; the stock of knowledge available to companies and society at large increases; basic research leads to the development of new methods and instruments that will be useful in future research and development work in both the universities and the companies; knowledge produced in universities can be patented; conducting research at universities means that the personnel get further training and that their ability to absorb new knowledge increases; universities train and provide a pool of researchers and students that the private sector can benefit from [4]. The pros and the cons affecting research and development need to be coherently harnessed for the sake of making the required significant progress.

3. Design of the inquiry

The data used in this inquiry is sourced from the Global Competitiveness Report 2012-2013 compiled by the World Economic Forum [5]. By its very nature, the report provides specific comprehensive details about the performance of countries across the globe in various critical areas of human endeavour. Analysis of data in this inquiry is informed by interpretivism as the underlying theoretical perspective.

4. Analysis of data

Table 1 below indicates Nobel Prize frequency and the quality of scientific research institutions in selected countries. The Nobel Prize frequency appears to be a function of the quality of scientific research institutions in selected countries. The data seems to suggest that countries such as Russia, Italy and India still face the imperative to significantly improve the quality of scientific research institutions in order to strengthen their competitive edge. The improvement of the quality of scientific research institutions would arguably lead to increased levels of research outputs necessary for the consumption needs of society.

Table 1: Nobel Prize frequency and the quality of scientific research institutions in selected countries

Country	Nobel Prize frequency	Quality of scientific research institution
Unites states of America	98	5.8
United Kingdom	29	5.8
Germany	22	5.2
France	10	4.2
Russia	11	3.5
Switzerland	8	5.8
Japan	6	5.1
Netherlands	6	5.3
Sweden	4	5.5
Denmark	3	5.2
Italy	2	3.5
Ireland	1	5.0
Canada	1	5.2
Austria	1	5.0
China	1	4.5
India	1	3.8
Australia	1	5.2

The quality of mathematics and science education and quality of the education system in selected countries are depicted in Table 2 below. While the quality of mathematics and science education seems to be commensurate with the quality of the education system in selected countries, Russia and Italy posted comparatively lower scores. South Africa's score for the quality of mathematics and science education and quality of the education system is lower as compared to other countries which produced Nobel Prizes.

Table 2: Quality of mathematics and science education and quality of the education system in selected countries

Country	Quality of mathematics and science education	Quality of the education system
Unites states of America	4.3	4.7
United Kingdom	4.5	4.8
Germany	4.4	4.9
France	5.1	4.5
Russia	4.3	3.4
Switzerland	5.8	5.9
Japan	4.9	4.4
Netherlands	5.4	5.2
Sweden	4.9	5.3
Denmark	4.8	5.0
Italy	3.9	3.3
Ireland	4.6	5.2
Canada	5.4	5.4
Austria	4.6	4.7
China	4.7	4.0
India	4.7	4.4
Australia	5.1	5.1
South Africa	2.0	2.2

As reflected in Table 3 below, selected countries such as Russia, Italy, Ireland and India posted lower scores in terms of the capacity for innovation and university-industry collaboration in research and development.

Table 3: Capacity for innovation university-industry collaboration in research and development in selected countries

Country	Capacity for innovation	University-industry collaboration in research and development
Unites states of America	5.2	5.7
United Kingdom	4.8	5.8
Germany	5.7	5.2
France	5.1	4.2
Russia	3.5	3.5
Switzerland	5.8	5.8
Japan	5.8	5.1
Netherlands	5.0	5.3
Sweden	5.7	5.5
Denmark	5.1	5.2
Italy	4.0	3.5
Ireland	3.8	5.0
Canada	4.1	5.2
Austria	4.8	5.0
China	4.2	4.5
India	3.6	3.8
Australia	4.0	5.2

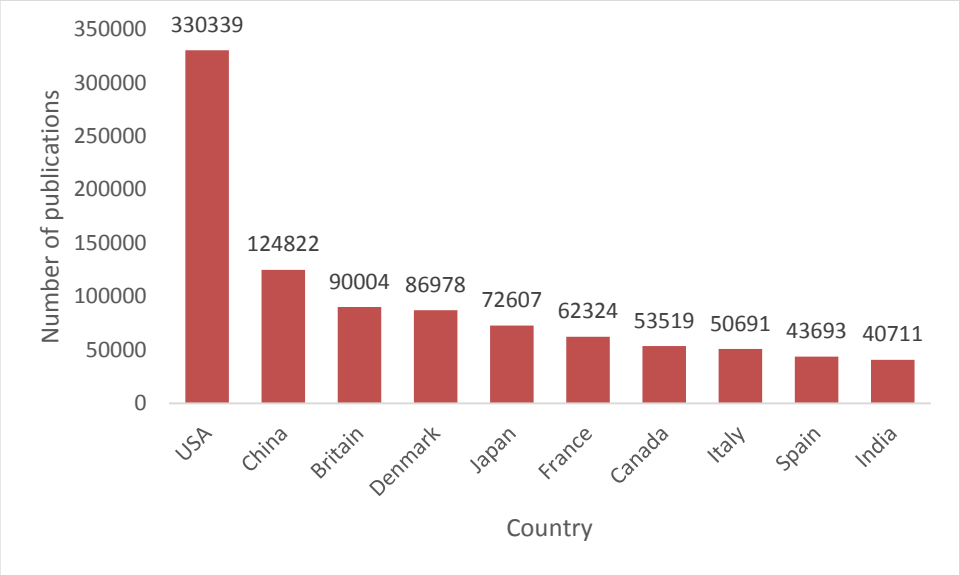
Institutions in the United States of America (USA) produced considerable number of Nobel Prizes (Table 4). This can partly be attributed to availability of key scientific infrastructure necessary for the enhancement of capacity for innovation.

Table 4: Frequency of Nobel Prize at various institutions in selected countries

Institution	Frequency of Nobel Prize	Country
Stanford University	10	United States of America
Harvard University	9	United States of America
University of Cambridge	7	United Kingdom
University of California	7	United States of America
Massachusetts Institute of Technology	7	United States of America
California Institute	7	United States of America
Princeton University	6	United States of America
Columbia university	6	United States of America
P.N. Lebedev Physical Institute	5	Russia
Cornell university	4	United States of America
CERN	4	Switzerland
College de France	3	France

The USA made significant strides in terms of the generation of scientific outputs as compared to other selected countries (Figure 1). Other countries need to step up efforts geared towards the generation of sufficient key scientific outputs in order to meet the consumption needs of the global community. Equitable sharing of global scientific expertise is vital for social and economic development in developing countries in terms of the generation of adequate scientific outputs. This mission can be accomplished through global cohesion between developing and developed economies.

Figure 1: Number of publications produced in selected countries



5. Discussion

Research and development are core ingredients required for meaningful economic growth in various countries. Yet policy response by various administrations in relation to the provision of adequate infrastructural support required to undertake research activities in many countries appears not to be attuned to scientists' expectations. In terms of the selected countries in this article, significant strides still need to be made so that key scientific outputs can be made available on a sufficient scale for the benefit of the broader global community. The monopolisation of the research and development sphere by few countries is certainly not in the best interest of global scientific and technological progress. Cross-pollination with regard to the provision of critical scientific expertise and equitable sharing of resources is absolutely essential in many respects.

6. Conclusion

A coherent global system of innovation is arguably necessary to promote global cohesion among developed and developing countries. This imperative would call for extreme levels of cooperation, unity and active participation from various countries in order to act as a formidable force required to accelerate the pace of research and development on a continental scale.

7. References

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