

The Innovative Capacity of Governments: An Approach to the Global Context

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Abstract

This article describes an important recent study on the innovative capacity of governments. The study attempts to show the global context. This purpose was achieved through a heliographic and bibliometric analysis. In addition, several computational tools such as “Publish or Perish”, VOSviewer, and EndNote were used in the process. This document is composed of the following study results: 1) Bibliometric analysis of the subject under investigation, innovative capacity in governments. 2) Innovative capacity of nations. 3) Determinants of innovative capacity in governments. 4) Measurement of the innovative capacity of governments. 5) Index of innovative capacity of governments. The contribution concludes that innovation has become perhaps the most important source of competitive advantage in advanced economies, and the creation of innovative capacity has a strong relationship with the overall competitiveness and level of prosperity of a country. A framework for analyzing national innovative capacity has been shown, building on our previous research, and we use it to construct an innovative capacity index that allows us to rank countries based on overall innovative capacity as well as its important components. Although the available data and statistical procedures face real limitations, the rankings match the knowledge about individual countries and reveal the strengths and challenges faced by each country surveyed.

Keywords

Management, Innovation, Economy, Finance, Social Culture, Local Governments, National Governments, Public Administration

1. Introduction

Contemporary social policy has driven Non-Profit Organizations (NPOs) from the fringes to the mainstream of providing public services to local communities.

This document is based on the first major research study on the innovative capacity of NPOs. The research itself has been reported elsewhere. This article aims to explore its implications for local government and for its management of the innovative capacity of NPOs. It begins by briefly describing the methodology used and continues by describing the main findings of the study. It concludes by offering guidelines for local government for the future on its relationship with and management of the innovative capacity of NPOs (Bravo Hidalgo & León González, 2018). Today's organizations, within a dynamic of high competitiveness and economic openness, tirelessly seek to excel and achieve success (Jaime & Sabate, 2004). From there come the strategies and efforts that allow the development and management of organizational tools to achieve this end (Alonso, 2007). Innovation emerges as a priority issue for companies and as a tool of superior impact to achieve organizational success; its high potential for long-term economic growth is highlighted (Tamayo-Torres et al., 2010).

Organizations aim for innovation to be something systematic that can be managed, measured, and controlled, which is why it is necessary to develop and strengthen skills and capacities that allow this end (Aguilar, 2008). Innovation capacities (IC) then appear as the calls to fulfill this task. In the study of IC, one of the most predominant currents is the one that addresses them with a technological approach, mainly in the manufacturing and high-technology context (Longo, 2009). In fact, there are few research studies that are evidenced for service organizations, with scales and constructions developed exclusively thinking about their particularities, which denotes a flaw when trying to extrapolate the resources, assets, and management that structure the IC, from a sector as particular as industrial, to another such as services (Batkovskiy et al., 2015; Jyoti et al., 2011).

The aim of this scientific contribution is to show the environment of the innovative capacity of governments from the perspective of an approach to the global context and from an approach to the Ecuadorian context. To achieve this objective, the present research is based on a bibliographic and bibliometric analysis. In addition, several computational tools such as "Publish or Perish", VOSviewer, and EndNote are used in the process. This document is composed of the following study results: 1) Bibliometric analysis of the subject under investigation, innovative capacity in governments. 2) Innovative capacity of nations. 3) Determinants of innovative capacity in governments. 4) Measurement of the innovative capacity of governments. 5) Index of innovative capacity of governments.

2. Methodology

In this scientific contribution, "Publish or Perish" has been used, which is a software program that retrieves and analyzes academic citations. It uses a variety of data sources (including Google Scholar and Microsoft Academic Search) to retrieve the raw citations, then analyzes them and presents the following metrics:

- Total number of articles and total number of citations
- Average citations per article, citations per author, articles per author, and ci-

tations per year

- Hirsch h-index and related parameters
- Egghe's g-index
- The contemporary h-index
- Three individual h-index variations
- The average annual increase in the individual h-index
- The age-weighted citation rate
- An analysis of the number of authors per article.

The results are available on screen and can also be copied to the Windows clipboard (for pasting into other applications) or saved in a variety of output formats (for future reference or further analysis). Publish or Perish includes a detailed help file with search tips and additional information on citation metrics (Bravo et al., 2018; Bravo Hidalgo, 2015; Bravo Hidalgo et al., 2017). In this computational tool, the phrase “innovative capacity in organizations” was established as the search term, and the search was limited to the “Google Scholar” database. This analysis resulted in 540 scientific contributions, including 21 scientific articles related to Ecuador.

In addition to this tool, the computer program for bibliometric analysis and mapping of scientific activity, VOSviewer, was used. This is a software tool for building and visualizing bibliometric networks. These networks can include, for example, individual journals, researchers, or publications, and can be built on the basis of citations, bibliographic coupling, co-citation, or co-authorship relationships. VOSviewer also offers text mining functionality that can be used to build and visualize co-occurrence networks of important terms extracted from a body of scientific literature. The VOSviewer functionality can be summarized as follows: 1) Creation of maps based on network data. You can create a map based on a network that is already available, but it is also possible to build one of the networks. VOSviewer can be used to build networks of scientific publications, scientific journals, researchers, research organizations, countries, keywords, or terms. The elements of these networks can be connected by links of co-authorship, co-occurrence, citation, bibliographic coupling, or co-citation. For the purpose of building these networks, data from Web of Science, Scopus, Dimensions, PubMed, RIS, or Crossref JSON or data from the aforementioned Publish or Perish software may be used. 2) View and explore maps. VOSviewer provides three visualizations of a map: the network visualization, the overlay visualization, and the density visualization. The zoom and pan feature allows you to explore a map in full detail, which is essential when working with large maps containing thousands of items. Although it is primarily intended to analyze bibliometric networks, in fact, it can be used to create, visualize, and explore maps based on any type of network data.

VOSviewer has been developed in the Java programming language. Because Java is platform independent, the tool works on most hardware platforms and operating systems. It can be downloaded from <http://www.vosviewer.com> and used freely for any purpose. **Figure 2** and **Figure 3**, which will be detailed and applied later in this document, are the result of processing the data of the scientific con-

tributions detected in the Publish or Perish software, in this fascinating scientometric tool called VOSviewer.

To manage the references and their representation in the APA standard, the End-Note computational tool is used. This reference management software contains the following functions: 1) Maintain all references and reference-related materials in a personal searchable library. 2) Synchronization of references between up to three of your personal computers, an online library, and your iPad or iPhone through End-Note Sync. (You must be the owner and user of all three computers). 3) Set up a team to share libraries and collaborate effortlessly with up to 100 co-authors and colleagues. 4) Citation of your references in word processing documents to create citations and formatted bibliographies or independent reference lists.

3. Results and Discussion

3.1. Bibliometric Analysis of the Topic Investigated Innovative Capacity in Governments

It is a trend in the international scientific community that there has been an increase in scientific publications related to this topic. **Figure 1** shows how this area of research has gained strength in the last decade. This research concludes that this is due to two fundamental factors. First, the increasingly dynamic social interaction between organizations, government management, and citizens. And last but not least, the financing of both private and governmental institutions for this type of research. These two phenomena are manifested on a global scale.

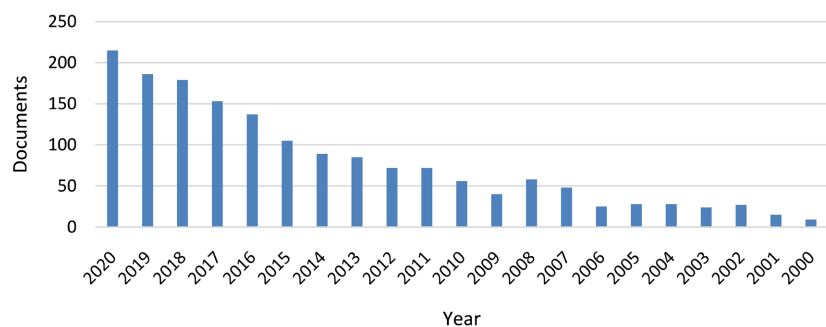


Figure 1. Shows the number of scientific contributions published in the last 20 years, directly related to the subject, and the innovative capacity of organizations.

Using the VOSviewer software, **Figure 2** was obtained. This figure shows a map of terms in this thematic field, that is, the innovative capacity of organizations. The colors indicate the different thematic lines as a function of time. The dimension of each sphere indicates the volume of thermal co-occurrence by volume of published investigations detected. The curves indicate how these themes interact and establish a temporality status of these interactions, because these curves also have colors that are represented on the time axis in the lower right part of **Figure 2**. This figure offers a result that corresponds with what is shown in a quantitative way in **Figure 1**, since this theme gained force within the scientific community from the year 2010. It can be seen that the largest sphere is the one that corre-

sponds to the term “innovative capacity” and this sphere represents the color assigned to the year 2010 on the time axis of colors.

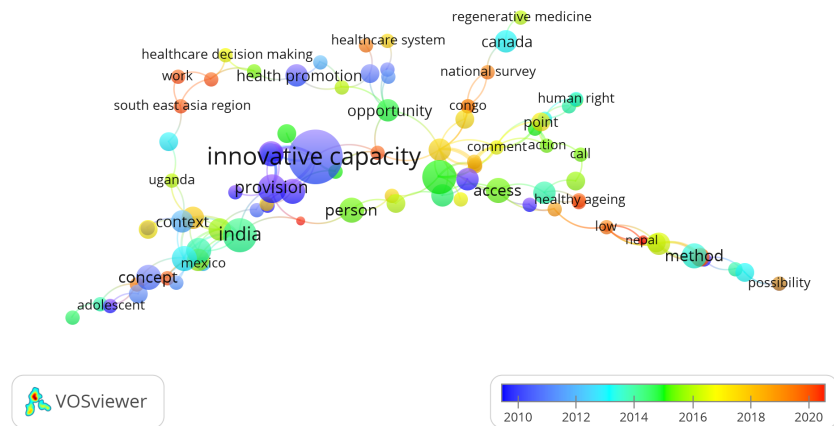


Figure 2. Shows a map of terms created from text mining on the keywords of the published contributions. In this graph, a co-occurrence of the term greater than 5 is considered.

The author interaction network allows us to show which and how the main researchers on this topic are related. **Figure 3** shows the most prolific and active researchers in this research area. The vast majority of them are concentrated in nations such as the United States, India, Cuba, Turkey, Germany, and the United Kingdom.

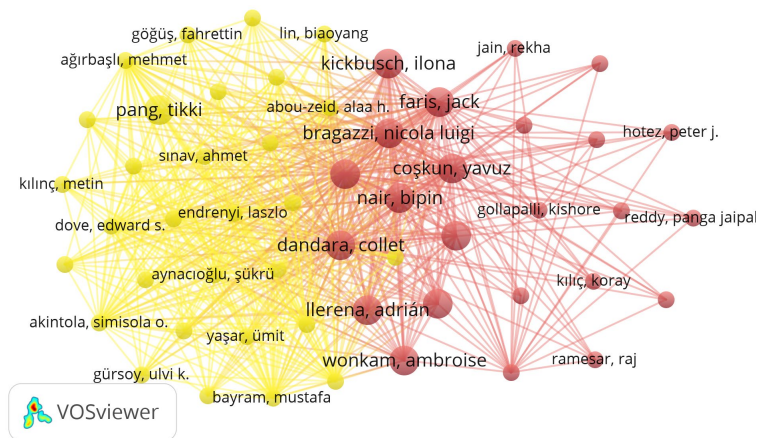


Figure 3. Author correlation map. This scientometric analysis only considers authors with 10 citations or more. This limitation allows a more focused approach to researchers with the highest incidence in the scientific community, in the thematic area of this research.

3.2. Innovative Capacity of Nations

The defining challenge for competitiveness has changed, especially in advanced countries. The challenges of a decade ago were restructuring, reducing costs, and raising quality. Today, continuous operational improvement is a given, and companies in many countries can acquire and implement the best current technology. In advanced nations with relatively high labor costs and equitable access to global

markets, producing standard products using standard methods will not maintain a competitive advantage. Instead, the advantage must come from the ability to create and then commercialize new products and processes, shifting the technological frontier as quickly as rivals can catch up.

Although R&D investments are made in all countries, a small number of geographic locations tend to dominate the global innovation process in specific technology areas and sectors. For example, although biomedical research takes place worldwide, more than three-quarters of all biotech pharmaceutical patents originate from a handful of regional conglomerates in the United States (Lewis & Ricard, 2014).

Global innovative activity is also concentrated in a relatively small, albeit growing, number of countries. From the early 1970s to the late 1980s, the United States and Switzerland maintained a per capita rate of “international” patents much higher than all other economies - see Figure 4. The growth rate of international patents has varied dramatically among OECD countries. Scandinavian nations, Japan, and emerging East Asian economies have posted strong increases, while Western European nations such as France and the United Kingdom have achieved a relatively constant rate of innovation (Lewis et al., 2013).

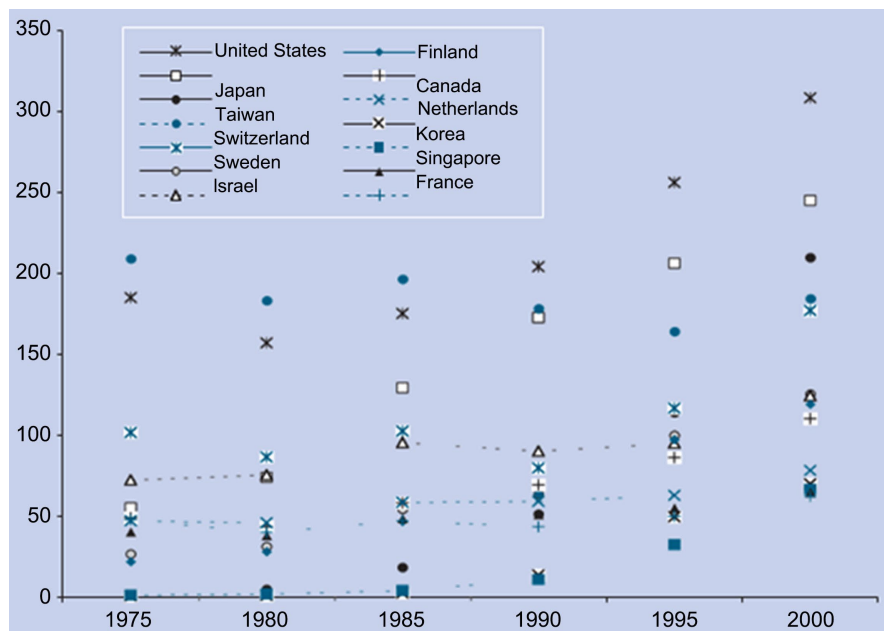


Figure 4. International patents per capita, leading countries, 1975-2000.

Why does the intensity of innovation vary from country to country? How does innovation depend on location? On the one hand, companies and the private sector are the ultimate drivers of innovation. On the other hand, the innovative activities of companies within a country are strongly influenced by national politics and the presence and vitality of public institutions. In other words, the intensity of innovation depends on an interaction between private sector strategies and public sector policies and institutions. Competitiveness advances when the public

and private sectors together promote an environment conducive to innovation.

Understanding the role of innovation in competitiveness and economic development has become increasingly important. As advanced nations face the prospect of slowing population growth and the completion of the structural reforms that have fueled OECD economies for the past two decades, an accelerated rate of innovation is needed to fuel growth. Faster productivity growth will be required to maintain healthy economic growth rates. A higher rate of innovation in one nation does not have to come at the expense of others. Increasing the rate of innovation in many nations can improve their productivity and prosperity and collectively accelerate the rate of global economic growth.

Ultimately, innovation also has the potential to address our most pressing human and social challenges. Many policy discussions assume that there is a marked trade-off between goals such as health, environment, security, and short-term economic growth. However, a healthy rate of innovation increases the likelihood that new technologies will emerge that substantially attenuate or even eliminate such trade-offs. Over the past few years, we have conducted a number of research projects aimed at assessing the role of location in innovation and the ways in which the geographic distribution of innovation has changed over time (Matsunaga, 2018).

3.3. Determinants of Innovative Capacity in Governments

The vitality of innovation in a place is determined by the national innovative capacity. National innovative capacity is the potential of a country, as a political and economic entity, to produce a stream of commercially relevant innovations. This capability is not simply the level of innovation performed, but also reflects the fundamental conditions, investments, and policy choices that create the environment for innovation in a particular place or nation.

National innovative capacity depends in part on the technological sophistication and size of the scientific and technical workforce in a given economy, and also reflects the variety of investments and policy options by the government and the private sector that affect incentives for and investment in the productivity of a country's research and development activities. National innovative capacity is also distinct from the purely scientific or technical achievements of an economy, which do not necessarily imply the economic application of new technology. The national innovative capacity framework aims to identify the factors that enable a region to innovate at the global frontier. Although the framework was created for application at the national level, it can also be used to assess innovative capacity at the regional or local level (Marginson & James, 2008).

National innovative capacity depends on three general elements that capture how location shapes the ability of companies in a particular location to innovate at the global frontier. Of course, leveraging the national environment for innovation is far from automatic, and companies based in the same location will differ markedly in their innovation success. However, the marked differences in inno-

vative production in different locations suggest that location exerts a strong influence (de la Cruz et al., 2020).

A nation's common innovation infrastructure is the set of cross-cutting investments and policies that support innovation throughout the economy. This set includes the general human and financial resources that a country dedicates to scientific and technological advances, public policies related to innovative activity, and the level of technological sophistication of the economy. The foundation of a nation's common innovation infrastructure is its pool of scientists and engineers available to contribute to innovation throughout the economy. A strong common innovation infrastructure is also built on excellence in basic research, which promotes fundamental understanding and is at the root of many new commercial technologies, where government funding remains essential in virtually every country. Cross-cutting areas of innovation policy include the protection of intellectual property, the scope of tax incentives for innovation, the degree to which the application of antitrust laws fosters competition based on innovation, and the opening of the economy to trade and investment. In general, a strong common innovation infrastructure requires a set of national investments and policy options that span decades (Sood & Higgins, 2012).

3.4. Measurement of the Innovative Capacity of Governments

To assess the sources of differences in innovative capacity between countries, we expanded our previous research using new data and measures drawn from the GCR Survey. Using country-level data on innovative production, we identify elements of the national innovation environment with a statistically significant relationship to innovation. These elements are then used to calculate rankings that reflect how countries are performing on each of the main dimensions of innovation, as well as to build a general national classification of innovative capacity.

National innovative capacity is inherently difficult to measure for several reasons. First, measures of innovative production are imperfect (only certain types of innovation can be measured) and are subject to some random fluctuations (Phillips, 1969). Second, traditional data sources make it difficult to develop measures associated with the more nuanced drivers of innovative capacity, such as innovation policy and the cluster-specific innovation environment (Simpkin et al., 2019).

Because our focus here is on innovation at the technological frontier and comparing innovation across nations, the most useful measure of innovation is "international" patenting, as measured by the number of patents that the United States Patent and Trademark Office (USPTO) granted to foreign and American inventors in 1999 and 2000. Over the past quarter century, there has been a dramatic increase in the rate of international patents, from less than 25,000 per year in the late 1970s to over 100,000 in the late 1990s.

We use USPTO patents as a measure of national innovative performance for several reasons. When a foreign inventor files a US patent, it is a sign of the po-

tential economic value of the innovation due to the costs involved (McMahon & Reguly, 2009). In addition, the use of US patents helps ensure a standard of technological excellence that is at or near the global technological frontier. Of course, no single measure of innovation is ideal. In our related research, we have explored several alternative measures of innovation success, such as the pattern of exports in international high-tech markets. However, in general, international patents constitute the best available measure of innovation that is consistent across time and place (Rafferty et al., 2021).

We use regression analysis to assess the relationship of international patents to nuanced measures of the innovation environment. Regression analysis allows us to assign relative weights to individual items in our innovative ability rankings. This procedure provides a level of confidence that our country innovative capacity level assessments are clearly linked to long-term measures of international innovative performance.

To examine the link between the innovation carried out and the measures associated with the national innovative capacity, the analysis is carried out in three steps (Lipitz & Weiss, 1984). First, we control for population and historical technological sophistication, and we include a measure of human resources commitment to innovative activity. To do this, we regress the national level of international patents in a sample of 75 countries between 1999 and 2000 on the total population, the proportion of scientists and engineers employed within the nation, and a metric of the “stock” of international patents generated by a country between 1985 and 1994. This reference analysis includes the historical patents of each country to take into account the past differences in the ability of countries to innovate at the international border, as well as differences in their propensity to patent their inventions in the United States relative to the standard of living of a nation. (Karim et al., 2021)

The number of patent holdings varies substantially between countries and over time, as does the number of technology personnel, which is affected by a set of national human resource policies (Lalich, 2002). For example, although their living standards are similar, the percentage of the workforce that are scientists and engineers is three times higher in Japan than in Italy or Spain. Surprisingly, more than 80 percent of the total variance in international patents worldwide, controlled for population, can be explained by these two determinants of national innovation intensity. In other words, countries vary significantly in their historical capacity to produce global innovation. They also vary significantly in their current commitment of resources for innovative activity (Morison et al., 2010).

3.5. Government Innovative Capacity Index

The four sub-indices are combined into an overall innovative ability index. The overall index is calculated as the unweighted sum of the sub-indices. The first column of Table 1 reports the results. The United States ranks first, followed by Finland. Germany, the United Kingdom, Switzerland, the Netherlands, Australia,

Sweden, and France complete the first tier. The overall ranking agrees well with our previous research and that of others on international innovation patterns. Over the past quarter century, the pool of top-tier innovative economies has expanded to include many of the northern European countries. More recently, Australia, Japan, Israel, and have reached high levels. Singapore has also moved to a high level, although its performance is partly the result of a large number of US multinationals that have established themselves there. This convergence in the achievement of innovation among a set of OECD economies is strongly linked to a substantial improvement in the environment for innovation.

An interesting difference from the previous work that emerges in this study is the ranking of Japan. Our previous research revealed that Japan was developing the elements associated with the first level of innovative capacity. We see that here in Japan's strength in scientific and technical personnel (Kertesz, 2006). However, this study reveals Japan's weaknesses in innovation policy and in establishing strong linkages, resulting in a lower ranking on the overall index of innovative capacity. Japan will have to make progress in these areas if it is to become a broader-based innovation-driven economy. Overall, the OECD is responsible for the vast majority of global innovation, reflecting a more favorable environment for innovation in these advanced economies (Bak, 2020).

However, some of the Asian economies, notably and Singapore, as well as Israel outside Asia, have achieved the conditions to support innovation at a pace compatible with many Western European economies. Many other areas of the world lag far behind in terms of innovative capacity. China and India are still at a fairly early stage of development in terms of global innovation, although they are making good progress relative to their current level of per capita income. Some Asian economies, such as Indonesia, Malaysia, and Thailand, lag far behind their Asian peers in innovative capacity, a major challenge (de la Cruz et al., 2020).

Despite impressive improvements in macroeconomic stability over the past two decades in Latin America and positive political change in Eastern Europe, these areas of the world still do not offer environments that support innovation at the global frontier. Similarly, African nations lag behind: none rank above 29. However, South Africa has a higher-than-expected index of innovative capacity, given its overall level of economic development (Kertesz, 2006).

4. Conclusion

Innovation has become perhaps the most important source of competitive advantage in advanced economies, and innovative capacity building has a strong relationship with the overall competitiveness and level of prosperity of a country. A framework for analyzing national innovative capacity has been developed, building on our previous research, and we use it to construct an innovative capacity index that allows us to rank countries based on overall innovative capacity as well as its important components. Although the available data and statistical procedures face real limitations, the rankings match the knowledge about individual

countries and reveal the strengths and challenges faced by each country surveyed. Those economies, such as Finland and Taiwan region, that have proactively built innovative capacity, have prospered. On the contrary, a limited focus on innovative capacity will limit progress for countries like Greece and Norway, as well as for many countries in Latin America and Eastern Europe. The development of national capacity for innovation will represent the fundamental development challenge facing many countries in the coming years.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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