



FACTORS TO MEASURE THE INNOVATION IN NATIONS

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ABSTRACT

Innovation is an important factor of sustained economic growth, since the production and transformation of knowledge fosters economic wealth, social welfare and human development. In this way, innovation indices measure, monitor and promote the progress of innovation results. Currently, there are several indices that are taken as a reference by governments to determine the effectiveness of public policies. The most important indices are: Global Innovation Index, Technology Index of the World Economic Forum, Industrial Development Scoreboard of the United Nations Industrial Development Organization, the Technological Success Index of the United Nations Development Program, finally, the Technology Capabilities Index (ArCo). This research proposes the use of four factors to measure innovation in nations based on the conceptual framework of the National Innovation System (NIS).

Keywords: National Innovation System, innovation, index, knowledge.

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1. INTRODUCTION

Governments and industrial leaders are interested in finding the reason for the success of some nations and organizations, some fail and others do not [1], because of this, innovation becomes a topic of political - economic and business discussion, understanding this, as the prosperity of the nations [2]. The concept of the National Innovation System (NIS) refers to the agents that make up innovation systems and the relationship of interaction with the purpose of accessing, absorbing, disseminating, creating and exploiting knowledge. For this reason, the measurement of the NIS is important for decision-making in public policies, because it determines the strengths and weaknesses of government programs in the promotion of innovation [3]–[5].

This paper proposes the use of four factors to measure innovation in nations based on indexes. The conceptual basis of the factors is supported in the measurement of the knowledge flows of nations presented in the works of Mahroum & Al-Saleh [6] and the OECD [3].

2. BACK GROUND OF THE STUDY

In recent years, academic interest has increased over the explanations of differences between countries in growth rates, composition of trade, competitiveness, human development and employment [7]. Therefore, various composite indicators were created in order to measure these issues, the most outstanding indices found in the literature up to now are described.

The Global Innovation Index (GII) consists of seven pillars, which build two sub-indexes, the first sub-index is the Resource Index for Innovation and is composed of five of the seven pillars, which are: institutions, capital human and research, infrastructure, market development, and business development. The second sub-index, the Index of Innovation Results, is made up of the last two pillars: knowledge and technology production, and creative production [8].

The Technology Index of the World Economic Forum (WEF) contains a large amount of data and statistical analysis. This index is divided into two indicators, one for competitiveness and the other for economic development, the first dedicated to the medium term (Growth Competitiveness Index - GCI) and the second for the short term (Current Competitiveness - Index - CCI). The first indicator (GCI) was developed to analyze the growth potential of the economic system in the medium term through the evaluation of macroeconomic competitiveness factors. The growth indicator was integrated into three components: the level of technology, the quality of public policies, and the conditions of the macroeconomic environment [9].

The Industrial Development Scoreboard of the United Nations Industrial Development Organization (UNIDO) is an index that collects a large number of indicators for 87 countries. It considers four categories: the technological effort related to patents and spending on R & D; competitive industrial performance based on manufacturing value added and exports of high technology products; the importation of technology mainly measured by direct foreign investment and capital goods; and the capacities and infrastructure measured with the number of license plates and telephone lines, respectively [7], [9].

Finally, the Technological Capacities Index (ArCo) developed by [10] is a composite indicator that takes into account variables related to three different dimensions of technological changes for 162 countries and for two years. The first category is represented by the innovative activity of the economic system of the countries measured in terms of number of patents and scientific publications. The second dimension includes the diffusion of new and old technologies (Internet, telephone lines and cell phones), while the third dimension deals with the quality of human capital.

3. MEASURING INNOVATION

It is important to measure innovation at the national level, since it is one of the main drivers of sustained economic growth. Innovation consists of a series of stages, such as basic research, applied research, development and commercialization. These stages give rise to economic benefits of different types such as the improvement of productivity and economic growth [11].

The conceptual framework most used for the understanding of innovation processes in the economic sphere is the concept of the National Innovation System (NIS). It has its origin in

Freeman in 1987, Dosi in 1988 and Lundvall in 1988, later again Lundvall in 1992, Nelson in 1993 and Equist in 1997 [12]. The definition of Freeman (1987) (cited by Feinson [12], the NIS are activities and interactions to import, modify and disseminate new technologies, all this through a network made up of public and private institutions.

Based on the concept of the National Innovation System, the measurement of innovation in nations focuses on knowledge flows, which are based on four categories: Access, absorption and diffusion, creation and exploitation of knowledge [3], [6]. Thus, innovation policies are structured according to these four categories in any National Innovation System [6].

3.1. ACCESS TO KNOWLEDGE FACTOR

Knowledge is the main engine of social and economic development, so it is important to guarantee access to global knowledge flows and access new ideas. Access to knowledge is the ability of an economy to link and connect to international networks of knowledge and innovation. The flow of information is increasingly increased through networks formed by organizations with offices around the world. So this factor refers to the ability to access the global information network. The connection with the international knowledge network allows universities and companies to identify and assess relevant sources of knowledge and developments in other places and use them to acquire, produce and distribute new knowledge [6].

3.2. ABSORPTION AND DISSEMINATION OF KNOWLEDGE FACTOR

The absorption of knowledge refers to the identification and adaptation of external sources of new knowledge to the local economy. In the dissemination of knowledge requires that new knowledge is disseminated and shared throughout the economy. The ability to disseminate knowledge is the ability of a nation to adapt and assimilate innovations, new practices and technologies throughout the economy [6].

The dissemination of knowledge is the movement of ideas, information and knowledge among people, companies and institutions. Attracting and cultivating highly qualified population helps the transmission of knowledge and ideas. In this way, human capital plays an important role in the dissemination and absorption of knowledge. People with greater skills or knowledge facilitate the acquisition and exchange of knowledge [6].

The ability to evaluate and use external knowledge depends to a large extent on prior knowledge. Therefore, human capital plays a key role in all stages of the innovation process. For Mahroum & Al-Saleh [6] the ability to produce, disseminate and use knowledge is based on the ability to produce high-level personnel for companies that are engaged in a continuous process of innovation.

For this reason, human resources is the set of characteristics, which help companies to obtain competitive advantages in foreign markets [13], [14]. The adult literacy rate and enrollment in tertiary education measure the degree of transmission of knowledge and ideas in the countries. In addition, it is a necessary condition for the development of human capabilities. In contrast, enrollment in tertiary education provides an estimate of skilled labor. In developed countries, the public sector is largely responsible for the training of qualified human resources, this as a training agent (universities and public institutes). In these countries, the public sector accounts for the largest share of spending on science and technology activities, such as technology centers, R & D centers and universities [15].

In this order of ideas, evaluating and using external knowledge also depends on the absorption capacity of knowledge. The ability of a company to absorb knowledge depends on human capital in the workforce. This is the ability of the nation to attract possible sources of

new knowledge and retain them locally. The best indicator to measure the absorption of knowledge is by means of Foreign Direct Investment (FDI) [6], [10].

FDI increases available capital and for developing countries it is one of the most important sources of technology transfer [16]. FDI is crucial to stimulate innovation, to provide new technologies and knowledge for the country. When companies and countries want to achieve a level of absorptive capacity that allows them to attract and retain foreign companies, FDI can be an important source of technology transfer and commercial expansion [17]. It is also an important way of transmitting skills, knowledge and technology in developing countries, and therefore, it is important for the competitiveness of nations, taking into account the positive impact on economic development [18], [19].

3.3. KNOWLEDGE CREATION FACTOR

The creation of knowledge is the capacity of the country to be a source of new ideas, discoveries and innovations. It is understood as new ideas, concepts, skills and competences, or technical and organizational advances.

R & D expenditure measures the level of inputs for science and technology [20]. It is an essential element that determines the process of innovation in the country, and a basic element to improve the international competitiveness of the countries [21]. Likewise, they are a central component of technological innovation activities and the most important of innovation expenditures [13].

On the other hand, researchers dedicated to R & D represent the human resources available for science and technology activities [20]. Research and applications of researchers and engineers have direct effects on innovation processes, technologies, production systems and new products, among others [19].

Patents are a measure of the product of created knowledge. The number of patent applications granted indicates the success of innovation activities and indicates a greater accumulation of knowledge in the economy. They measure the innovation generated for commercial purposes. They represent a form of coded knowledge generated for profit by companies and organizations [17].

3.4. KNOWLEDGE EXPLOITATION FACTOR

The exploitation of knowledge is the ability to use knowledge commercially and extract value from it. It is the most visible form of innovation and most direct of the extraction of value linked to the process of knowledge creation. Organizations acquire knowledge, create new ideas and turn them into commercial products. Although generally the production of knowledge is carried out in some organizations such as universities, it is the responsibility of the business sector to exploit this knowledge [6].

The effective exploitation of knowledge is fundamental to the creation of value in the country. Countries that are capable of effectively exploiting knowledge are more competitive. However, the exploitation of knowledge depends on the functioning system of innovation and absorption capacity, which allows access to knowledge, absorbed and disseminated throughout a country. Such systems facilitate the highest possible propensity for the subsequent exploitation and commercialization of knowledge [6].

The commercial outlet of knowledge is reflected in exports. It is expected that competition and learning generated by exports improve innovation efforts in companies, especially when local companies have a certain level of technological skills [22].

Similarly, R & D intensity has an impact on the export of high technology by increasing the production capacity of companies in high technology products, increasing and improving

the national intellectual capital, the number of applications and the number of innovative companies. Therefore, this is considered a determining factor in the evolution of high-tech exports [23].

4. CONCLUSIONS

Current models of innovation measurement are based on subjective assessments of the theoreticians who construct them, in addition, the use of data collected by surveys generate inaccuracies, since there is no standard method to perform them, especially when it comes to measuring indicators of innovation. It is important that the composite indexes to measure innovation are objective, since from these, decisions are derived at the national level with the objective of achieving higher economic development.

The factors for measuring innovation in nations are four: access to knowledge, absorption and dissemination of knowledge, creation of knowledge and exploitation of knowledge. Access to knowledge is the ability to connect and link international knowledge and innovation networks. Absorption and dissemination of knowledge is the ability to identify and adapt external sources of knowledge including people and organizations, adapting and assimilating innovations, new practices and technologies. The creation of knowledge is perceived as the ability to generate and contribute new knowledge to the world. Finally, the exploitation of knowledge is the ability to use and exploit new knowledge for social and commercial purposes.

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