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RESEARCH ON THE RELATIONSHIPS AMONG INVESTMENTS IN SCIENCE, TECHNOLOGY & INNOVATION AND SOCIOECONOMIC DEVELOPMENT

Pesquisa sobre relacionamentos entre os investimentos em ciência, tecnologia & inovação e desenvolvimento socioeconômico

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ABSTRACT

The purpose of this article is to correlate socioeconomic development indicators from a sample of fourteen countries, including Brazil, and the performance indicators in Science, Technology and Innovation CT&I. Statistical techniques of correlation between Science, Technology and Innovation indicators published by International Reference Institutions were used and the results showed high correlations between gross investments in ST&I and the Gross Domestic Product - GDP, as well as the position in scientific production (R^2= 0.85 in both analyzes). The correlation between investments in CT&I and the competitiveness ranking was low; however, the innovation ranking showed a median correlation (R^2 = 0.61) when related to the percentages of GDP invested in CT&I. The correlations between the innovation and competitiveness rankings with the HDI were also median (R^2 = 0.61 and R^2 = 0.56, respectively). The ST&I indicators were not correlated with GDP growth rates and unemployment rates. The study is limited to a sample of fourteen countries, chosen due to similarities with Brazil, but it can help in directing public policies for generating knowledge through investments in science, technology and innovation. The study is particularly important due to the indication that investments in knowledge generation (science, technology and innovation) do not necessarily decrease unemployment, but improve the HDI - Human Development Index.

Keywords: Knowledge; Innovation; Technology; Science; People management.

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PESQUISA SOBRE RELACIONAMENTOS ENTRE OS INVESTIMENTOS EM CIÊNCIA, TECNOLOGIA & INOVAÇÃO E DESENVOLVIMENTO SOCIOECONÔMICO

Research on the relationships among investments in science, technology & innovation and socioeconomic development

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RESUMO

O objetivo deste artigo é correlacionar indicadores de desenvolvimento socioeconômico de uma amostra de quatorze países, incluindo o Brasil, e os indicadores de desempenho em Ciência, Tecnologia e Inovação CT&I. Foram utilizadas técnicas estatísticas de correlação entre indicadores de Ciência, Tecnologia e Inovação divulgados por Instituições de Referência Internacional e os resultados mostraram altas correlações entre os investimentos brutos em CT&I e o Produto Interno Bruto - PIB, bem como a posição na produção científica (R^2 = 0,85 em ambas as análises). A correlação entre os investimentos em CT&I e o ranking de competitividade foi baixa; entretanto, o ranking de inovação apresentou correlação mediana (R^2 = 0,61) quando relacionado aos percentuais do PIB investidos em CT&I. As correlações entre os rankings de inovação e competitividade com o IDH também foram medianas (R^2 = 0,61 e R^2 = 0,56, respectivamente). Os indicadores de CT&I não se correlacionaram com as taxas de crescimento do PIB e taxas de desemprego. O estudo se limita a uma amostra de quatorze países, escolhidos por semelhanças com o Brasil, mas pode auxiliar no direcionamento de políticas públicas de geração de conhecimento por meio de investimentos em ciência, tecnologia e inovação. O estudo é particularmente importante devido à indicação de que investimentos em geração de conhecimento (ciência, tecnologia e inovação) não necessariamente diminuem o desemprego, mas melhoram o IDH - Índice de Desenvolvimento Humano.

Palavras-chave: Conhecimento; Inovação; Tecnologia; Ciência; Gestão de Pessoas.

INTRODUCTION

Analysis of opportunities and threats, as well as clarity about global megatrends, allow countries to prepare for the constant changes that affect society and the economy of the current world (Marcial, 2015).

The Brazilian economy has been formally in recession since the second quarter of 2014. The Brazilian per capita product fell about 9% between 2014 and 2016, the growth rate of the Brazilian economy fell from 4% to 2% per year and the sector Brazilian public went from a primary surplus of 2.2% in 2012 to a primary deficit of 2.7% in 2016 (Barbosa Filho, 2017).

Following the downturn in the economy, federal government budget cuts were made in different areas, including science, technology & innovation (CT&I). In 2014, Brazil allocated 1.27% of GDP to research activities, totaling R $ 7.3 billion (Davidovich, 2017).

Nevertheless, in March 2017, the costing and investment budget of the Ministry of Science, Technology, Innovations and Communications (MCTIC), which excludes personnel expenses, was limited to R $ 3.2 billion in 2017 - 44% lower than what had been established in the budget law, and less than half of the committed budget of 2014. The budget for 2018 was about one third of that allocated eight years ago (Davidovich, 2017). On March 29, 2019, contingency of 42,27% of the CT&I budget for 2018 was announced by the federal executive branch, having now only R$ 2.947 billion for discretionary expenses in 2019 (SBPC, 2019)[1].

1 THEORETICAL BACKGROUND

Megatrends are driven by the innovation economy, for which scientific and technological advance expected for the next decades will put humanity in a new era, where several areas stand out, such as: automation, robotics, nanotechnology, biotechnology, among others (Marcial, 2015).

Faced with these conditions, the Brazilian scientific community, mainly coordinated by the Brazilian Academy of Science (ABC) and the Brazilian Society for the Progress of Science (SBPC), mobilize efforts to demonstrate to government officials that resources for "science is not spent, it is investment! " (ABC et al., 2017).

The future is uncertain, whose unpredictability and globalization have an impact on unlikely, unpredictable and highly disruptive changes in a short period. Nevertheless, global megatrends remain - social, economic, political, environmental or technological - that are configured as changes that are slow, however, once they take root, they have a lasting influence on many activities, processes and perceptions (Boumphrey and Brehmer, 2017). This relative stability makes it possible to predict a likely medium-term future in the long run, with some degree of confidence, and today guides the governance of public and private organizations.

2 METHODOLOGY

In order for comparative analyzes between socioeconomic and ST&I indicators to be carried out, some countries were chosen for data collection. The choice was based on different parameters, namely: (i) countries that have active cooperation with Brazil, that is, that have cooperation agreements in the area of ST&I in force and several activities in progress; and (ii) countries that are renowned for scientific production, innovation and competitiveness in the world.

Among all the countries that fit the above characteristics, a categorization was carried out in order to balance the number of countries according to the following characteristics: GDP, HDI and how much is invested in ST&I (percentage of GDP)[2]. Four groups were created, whose countries in each group have the following indicators in common:

[1] http://portal.sbpcnet.org.br/noticias/entidades-cientificas-e-academicas-criticam-severo-corte-do-orcamento-atingira-em-cheio-a-cti-nacional/
[2] https://www.weforum.org/agenda/2018/12/how-much-countries-spend-on-r-d

• Group 1) leading countries in the world economy (highest GDP), with high HDI (developed countries) and with significant investments in ST&I: United States, Japan, Germany and South Korea.

• Group 2) leading countries in the world economy or with expressive GDP (over U $ 1 trillion / year), with a median HDI (developing countries) and which have representativeness in ST&I: China, India, Brazil and Mexico.

• Group 3) countries with lower GDP (below U $ 1 trillion / year), with a high HDI (developed countries) and with a high percentage of GDP invested in ST&I: Netherlands, Switzerland, Israel.

• Group 4) countries with lower GDP (below U $ 1 trillion / year) and low investment in ST&I: Turkey, Argentina and Chile.

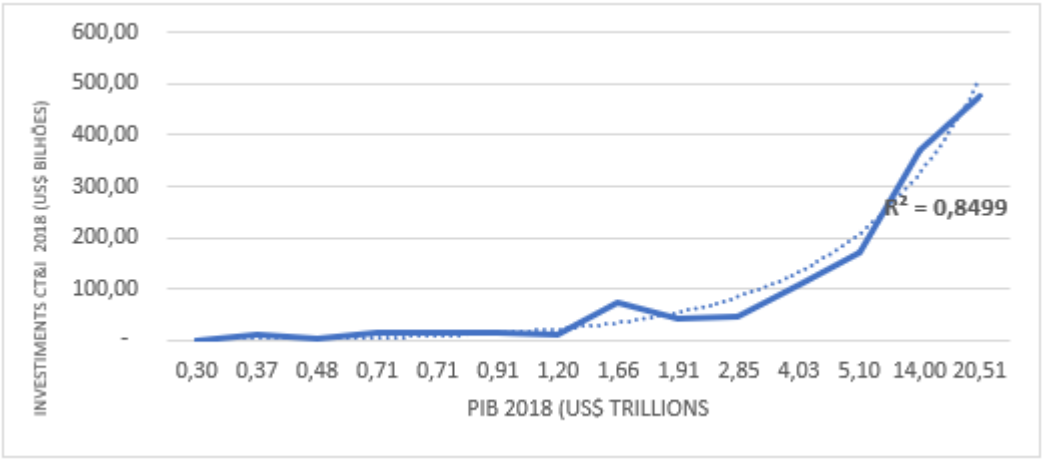
3 RESULTS

Data on socioeconomic development and CT&I performance for the selected countries can be seen in Table 2. The countries that invest most in ST&I (in US $) are, in decreasing order, the United States and China. Brazil, in turn, is in seventh position among the selected countries. Chile, on the other hand, is the country that least invests in ST&I among the countries analyzed here, both in terms of gross investment values and the percentage of GDP, with the lowest GDP as well.

Although Israel is the second lowest GDP, its gross investment in CT&I equals that of Switzerland and Mexico. This is because Israel, like South Korea, is the country that most bets its development strategies in ST&I in relation to the percentage of GDP (4.3%).

The correlation between GDP and investments in ST&I in 2018 (in US$) shows a high exponential correlation ($R^2 = 0.85$), as shown in Figure 1. However, when comparing the GDP of the selected countries with the percentages of GDP invested in CT&I there was no correlation ($R^2 = 0.13$).

Figure 1 - Correlation between 2018 GDP and CT&I investments in 2018, in gross values (US $)



Source of data: Desjardins (2018) and IMF (2019).

It appears that there is a high exponential correlation between how much is actually invested in CT&I (US $) and the position in the SJR ($R^2 = 0.85$). Nevertheless, the linear correlation of GII and the exponential correlation of CGI with gross investments in CT&I were low ($R^2 = 0.43$ and $R^2 = 0.32$ respectively). This can be explained because the SJR considers, in the main, the numbers of publications and citations - concrete results of investments in CT&I and, therefore, reflect the volume of research projects and scholarships awarded.

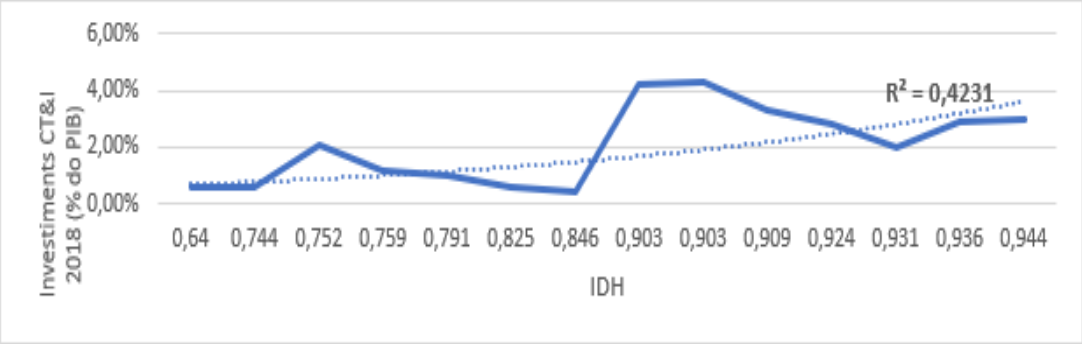
The CGI and GII are more complex rankings, considering more factors for determining the index that determines the position in the ranking. The GII, for example, in addition to considering the number of patents, takes into account the business, political and regulatory environments, as well as human resources, infrastructure, market sophistication and business. The GCI, on the other hand, considers trust in the analyzed market, such as transparency, property rights, security, and social capital, among others.

The correlation in the rankings was demonstrated according to the percentage of GDP invested in CT&I. In this context, the SJR does not show a high correlation when compared to gross investments (R^2 of only 0.26). The GCI correlations for gross investments or percentage of GDP were similar (R^2 close to 0.45 for both). The GII, on the other hand, presented a slightly more pronounced linear correlation when considering the percentage of GDP invested in CT&I, although the correlation is still moderate (R^2 = 0.61).

Regarding the correlations between the GDP growth rates and investments in ST&I - both gross investment (US $) and the percentage of GDP -, as well as the positions in the Global Innovation Index and the Global Competitiveness Index, were not found any correlations for 2018 (negative R - data not shown).

Considering the HDIs of 2018, the correlation analyzes with investments in ST&I in the same year showed that, when the gross values (US $) were considered, there was no identification of correlation in the countries analyzed (R^2 = 0.008). However, when considering the percentage of GDP investment in CT&I, the correlation was moderate (R^2 = 0.42) as may be seen in Figure 2. It is noteworthy that the HDI is a complex and multifactorial index, which includes as one of its parameters the percentage of GDP invested in ST&I, not gross investment.

Figure 2. - Correlation between human development indices (HDI) and GDP percentages investments in ST&I in 2018



Source: UNDP (2018)

When the HDI correlations were evaluated in 2018 and the positions in the GCI, GII and SJR, there were median exponential correlations in the first two (R^2 close to 0.6) and no correlation with the last (negative R).

When analyzing unemployment rates and investments in ST&I - in gross values (US$) and percentages of GDP - low correlations were identified (R^2 = 0.2 for both).

The correlations between the 2018 unemployment rates and the GCI, GII and SJR positions were also insignificant (R^2 below 0.2).

When assessing the correlation of the country's degree of innovation, inferred by its position in the Global Innovation Index, there was a greater correlation when considering the percentage of GDP invested than when considering the gross value of investment in CT&I.

Brazil occupies the 64th position in the Global Innovation Index 2018 (Dutta et al., 2018) and the 72nd position in the Global Competitiveness Index 2018 (Schwab, 2018), which shows little adherence to the "Blue Ocean" theory strategy, not creating business environments and favorable regulation to stimulate innovation and, therefore, greater competitiveness.

Nevertheless, the country is the 14th in terms of scientific publications in Scimago Journal & Country Rank 2017 (SJR, 2017), which may indicate that there are few resources being invested in the country in research, but rather the business strategy of investing in innovation, here inferred by the percentage of GDP that the country invests in ST&I, may be the limiting factor.

The HDI correlations and the positions in the Global Competitiveness Index 2018, the Global Innovation Index 2018 and the Scimago Journal & Country Rank 2017 show moderate correlations in the first two.

The three correlated indices are multifactorial and have similarities in parameters. This fact may possibly explain the presence of a correlation between the countries evaluated.

With the world increasingly inserted in industry 4.0, digital transformation and adaptation to global megatrends are now essential. In this context, perhaps investing in ST&I does not necessarily provide more jobs, contrary to what many claim and as demonstrated by the lack of correlation between ST&I indicators and unemployment rates.

This may be explained because machines today are increasingly replacing human labor and, therefore, the population will necessarily have to invest more in training.

Investments in CT&I, as well as involving resources regarding research grants, may assist in the training of human resources; however, although it has not been analyzed in this work, investment in education must be more correlated with the unemployment rate than investment in ST&I itself.

It could be observed that, although all the correlation shown are relatively low, they could help to infer trends, since the relationships may not be necessarily linear. It is also noteworthy that the selected countries had an expressive relationship with Brazil within the scope of CT&I and do not necessarily represent a considerable sample number for statistical analysis.

CONCLUSION

It is inferred that countries that adopt as a strategy to allocate a higher percentage of their GDP in ST&I are those that use more of innovation to promote their development. It is not necessarily the gross amount invested in CT&I that defines a country's degree of innovation, but rather the prioritization that the country gives to the area.

It is possible that countries that invest a higher percentage of their GDP in ST&I also invest more in providing dynamic business environments, with regulation that reduces bureaucracy and gives security to processes, which stimulate creativity and innovation.

With a view to the study, more accurate comparative analyzes are suggested between the countries and / or the selected groups and Brazil, especially in indicators that showed high or moderate correlations, in order to identify good strategies that could be used for possible public policies.

Additionally, the number of samples or indicators could be increased. In this study, some multifactorial indicators were used so they may have distorted the direct correlation performed here. Therefore, another possibility could be to choose some specific parameters for each index and make the direct correlation.

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