

**The Impact of the Development of Smart Cities on the Patent System: a comparison
between Brazil and the United States of America (USA)**

**O Impacto do Desenvolvimento das *Smart Cities* no Sistema de Patentes: um
comparativo entre Brasil e Estados Unidos da América (EUA)**

**El Impacto del Desarrollo de las Ciudades Inteligentes en el Sistema de Patentes: una
comparación entre Brasil y los Estados Unidos de América (EE.UU)**

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Abstract

Objective: This article aims to investigate the impact of the innovative concept of Smart Cities on the patent system, comparing the economies of a developing country such as Brazil and that of a developed country such as the United States of America (USA).

Methodology: The research constitutes an exploratory stage of data collection, adopting a quantitative-qualitative approach. Data was collected from 2015 to the present day. The research design is bibliographic, investigating the Web of Science and Scopus databases, as well as patent bases.

Relevance: Relevance consists of the need for in-depth studies on the impacts generated on a country by the economic development through the perception of the importance of adopting innovative technologies to change technological paradigms.

Main results: In both countries, the results show the concentration of patent applications in the IPC (International Patent Classification) H04, focusing on technologies linked to the Internet of Things (IoT). However, in Brazil the concentration of patent applications intended for application in Smart Cities had a small increase from 2021 onwards, while in the USA there was an exponential increase from 2019 onwards.

Theoretical Contributions: The influence of the technological trajectory of the countries analyzed can be seen, making it clear that in a country with a production economic matrix there is no significant impact on the patent system, while in a country with an economic matrix of knowledge, there is a large increase in patent filings.

Keywords: Smart Cities; Patent System; New Institutional Economics.

Resumo

Objetivo: Este artigo tem como objetivo investigar o impacto do conceito inovativo das *Smart Cities* no sistema de patentes, fazendo um comparativo entre economias de um país em desenvolvimento como o Brasil e a de um país desenvolvido como os Estados Unidos da América (EUA).

Metodologia: A pesquisa se constitui em uma etapa exploratória de levantamento de dados, adotando uma abordagem quanti-qualitativa, com dados coletados a partir do ano de 2015 até os dias atuais. O delineamento da pesquisa é bibliográfico, investigando as bases de dados Web of Science e Scopus, bem como as bases de patentes.

Relevância: A relevância consiste na necessidade de aprofundamento de estudos sobre os impactos gerados no desenvolvimento econômico de um país através da percepção da importância da adoção de tecnologias inovadoras para a alteração dos paradigmas tecnológicos.

Principais resultados: Em ambos os países os resultados mostram a concentração de pedidos de patentes no IPC (International Patent Classification) H04, com foco em tecnologias vinculadas à Internet das Coisas (IoT). No entanto, no Brasil a concentração de pedidos de patentes destinadas à aplicação em *Smart Cities* teve um pequeno aumento a partir do ano de 2021, enquanto nos EUA verifica-se um aumento exponencial a partir do ano de 2019.

Contribuições Teóricas: Percebe-se a influência da trajetória tecnológica dos países analisados, sendo claro que em um país com a matriz econômica de produção não há um impacto significativo no sistema de patentes, enquanto no país com matriz econômica de conhecimento, há um grande aumento nos depósitos de patentes.

Palavras-chaves: Cidades Inteligentes; Sistema de Patentes; Nova Economia Institucional.

Resumen

Objetivo: Este artículo tiene como objetivo investigar el impacto del concepto innovador de Ciudades Inteligentes en el sistema de patentes, haciendo una comparación entre las economías de un país en desarrollo como Brasil y la de un país desarrollado como los Estados Unidos de América (EE.UU.).

Metodología: La investigación constituye una etapa exploratoria de recolección de datos, adoptando un enfoque cuantitativo-cualitativo, con datos recolectados desde el año 2015 hasta la actualidad. El diseño de la investigación es bibliográfico, investigando las bases de datos Web of Science y Scopus, así como bases de patentes.

Relevancia: La relevancia consiste en la necesidad de profundizar en los estudios sobre los impactos que se generan en el desarrollo económico de un país a través de la percepción de la importancia de adoptar tecnologías innovadoras para cambiar los paradigmas tecnológicos.

Principales resultados: En ambos países, los resultados muestran la concentración de solicitudes de patentes en el IPC (Clasificación Internacional de Patentes) H04, centrándose en tecnologías vinculadas al Internet de las Cosas (IoT). Sin embargo, en Brasil la concentración de solicitudes de patentes destinadas a su aplicación en Ciudades Inteligentes tuvo un pequeño aumento a partir de 2021, mientras que en EE.UU. hubo un aumento exponencial a partir de 2019.

Aportes Teóricos: Se puede observar la influencia de la trayectoria tecnológica de los países analizados, dejando claro que en un país con una matriz económica de producción no hay impacto significativo en el sistema de patentes, mientras que en un país con una matriz económica de conocimiento, Hay un gran aumento en las solicitudes de patentes.

Palabras clave: Ciudades Inteligentes; Sistema de Patentes; Nueva Economía Institucional.

Introduction

In recent decades, sustainability has been widely used to promote control of challenges related to urban balance (Lopes & Leite, 2021). In this context, the term "smart cities" or "cidades inteligentes" emerges, applied in association with new technologies that are used in attempts to modernize urban centers. With population growth, recent surveys by the United Nations (UN) estimate that more than 60% of the world's population will live in urban areas by 2030, making it impossible to build a sustainable future without good city planning (Sharif, 2023).

In studies for the development of cities, public administration normally uses public policies that apply the adoption of innovation, since this technique is more agile and easier to measure than the generation of innovation (Cavalcante, 2017). The main objectives of these

public policies are to generate efficiency in internal actions, improve services and solutions for citizens and businesses, and promote innovation in other sectors (De Vries, Bekkers & Tummers, 2016).

In this field of innovation and technology, prospective studies of the patent system can and should be a tool to be used in decision-making in various areas of society, being a way to understand the degree of innovation and patentability of applications in smart cities (Kalleya, Purnomo, Madyatmadja and Karmagatri, 2023). Through the survey of patents, important technological information and market trends are collected, making it possible to outline and evaluate innovation options showing a positive future forecast (Fernandes, Marchietti, Konopatzki & Júnior, 2024).

In this context, this study surveys the use of the keyword “smart city” and its plural forms, making a comparison to verify whether there is a visible technological advance through the analysis of the results obtained in the patent databases of the United States of America (USA) and Brazil. This study performs a comparative analysis between data extracted from scientific articles and patent databases. The *PATENTSCOPE* database was used to collect data on patents filed in Brazil and the United States. The investigation determines whether patents can act as strategic planning indicators.

The research collected data from 2015 onwards, focusing on the actors involved in patent applications related to specific technologies for application in Smart Cities. The objective is to investigate whether patents can serve as an indicator of technological development in the field of innovation through delimiters such as the adoption of an innovative concept, such as Smart City, and not only through research such as IPC or technological areas, comparing the results between a developing country and a developed country.

Thus, in addition to the introduction, the article is divided into four symbols. The first presents the main concepts that involve the approach regarding the concept of Smart City and the Patent System, as well as theoretical aspects related to the New Institutional Economy (Norte, 1991) and the Theory of Economic Complexity (Hausmann, Hidalgo, Bustos, Coscia & Yildirim, 2011); the second section presents the methodology used in the study; the third section presents the analysis of the results; and the fourth section presents the final considerations.

Theoretical framework

The Smart Cities

The term 'smart cities' or intelligent cities was adopted in the post-industrial era as an intersection between social sciences and engineering and, although this expression has been used for years in the political and scientific fields, there is no simple definition of its concept (Kochetkov, Vuković, Sadekov & Levkiv, 2019). In common sense, a smart city employs technological initiatives, and achieving smart city status requires the integration of a variety of information, as well as the application of a variety of simulations and analyses to interpret this information (Harrison et al., 2010).

The origin of this concept can be traced back to the late 1990s with movements such as *Smart Growth* and even earlier, in which concepts such as "cybernetically planned cities" were already mentioned (Höjer & Wangen, 2014). Currently, one of the most widely used definitions is the report of the International Telecommunications Unit (ITU-T, 2014: p. 14):

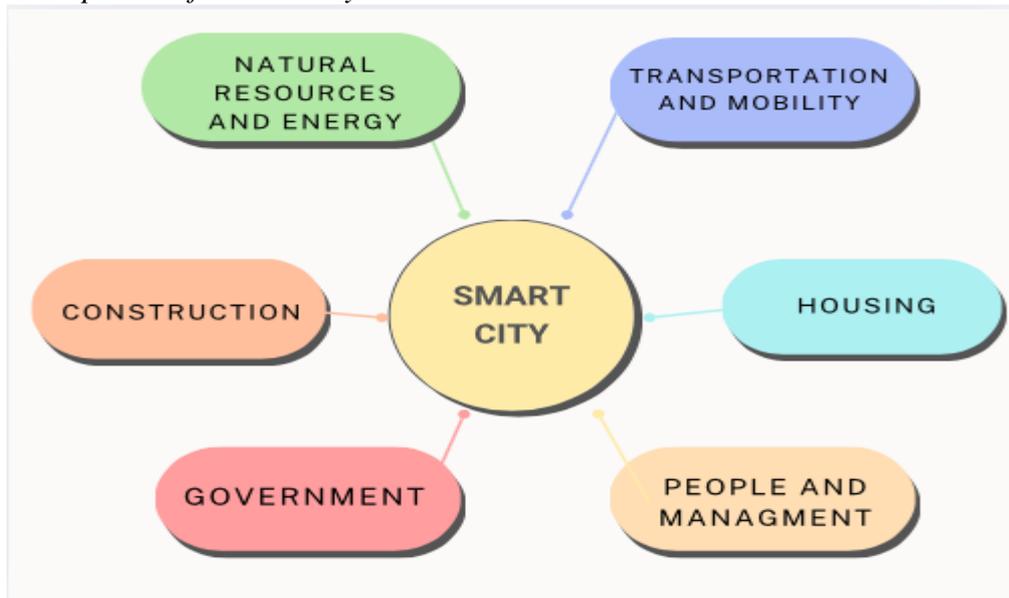
A sustainable and smart city is an innovative city that uses information, communication and other technologies to improve the quality of life, the efficiency of operations, urban services and competitiveness, while ensuring the needs of present and future generations regarding economic, social, and environmental aspects.

In a more concrete analysis, a smart city refers to an instrumented, interconnected and intelligent city in the sense of capturing, measuring and integrating citizen data, synchronizing this data and integrating this information with the various city services in the best possible operational way (Harrison et al., 2010). Some of the most popular concepts of so-called smart cities can be found in the literature, which foresee the use of Information and Communication Technologies (ICT), being able to monitoring and integrate the conditions of all its critical infrastructures, preventive maintenance and monitoring of security aspects and, at the same time, maximizing services for its citizens (Carvalho, Martin, Carneiro, Santos & Barbosa, 2020).

A Smart City to-be must be able to manage resources (natural, human, equipment, buildings and infrastructure), as well as waste generated by lifestyle, being sustainable and must

not harm the environment (Carvalho, Martin, Carneiro, Santos & Barbosa, 2020). With some exceptions, the main pillars of a smart city are (Höjer & Wangel, 2014):

Figure 1
Main pillars of a smart city



The definitions and pillars of smart cities are not standardized, and there are variations depending on each region, which also occurs in the way cities are officially recognized as smart cities. Thus, international standards enable cities to achieve appropriate techniques, environmental and social indicators that have a significant impact on the infrastructure, safety and lives of residents (Midor & Plaza, 2020).

Recently, the International Organization for Standardization (ISO) published seals that were developed by the World Council on City Data (WCCD), based on indicators to grant certificates to cities that obtain good results in the evaluations. After the application of ISO 37120, for the analysis of sustainable cities, ISO 37122 was developed, specifically to collect and analyze indicators, in order to grant smart city certification to cities, with its respective Brazilian version translated by the Brazilian Association of Technical Standards (ABNT), ABNT NBR ISO 37122:2020; corrected version: 2021 - Sustainable cities and communities - Indicators for smart cities (Abreu & Marchiori, 2023).

However, according to information from WCCD, the immaturity of ISO 37122 does not yet allow for more in-depth surveys to be carried out since there is still a lack of global coherence around the adoption of the concept of smart city. At the same time, there is no detailed definition regarding the benchmark parameters for a more concrete analysis of the development of cities year after year (WCCD, 2024).

The Patent System

The Patent System is often remembered when talking about inventions, and it is generally perceived that its existence has the sole function of granting protection to a materialized idea. However, like the entire legal system, the constitutional system, intellectual property also has an objective, and the patent system serves a specific purpose (Barbosa, 2010).

The Brazilian Federal Constitution, in its Article 5, Section 29, provides that the purpose of Intellectual Property is to promote the social, technological and economic development of the country. In the same sense, according to the American Constitution (U.S. CONST. art. I, § 8, cl.8.), the patent system has a mandatory objective, which is to promote the progress of science and useful arts (Merges, 1988).

In this way, we have that with the patent system, society is rewarded with advances in the state of the art, which results from the disclosure of the wording of the patent with the details of the invention, and with innovation, if the invention is developed and reaches the market (Garcez Júnior, Eloy & Santos, 2021). Still, according to Barbosa (2010), the purpose of Intellectual Property, as well as the patent system, is not to promote the development of humanity, nor of the community of peoples and, much less, of patent holders, but rather the development of Brazil.

A definition by the classic jurist from Alagoas, Pontes de Miranda, best known for his work *Tratado de Direito Privado* (Treaty of Private Law), and little mentioned around Intellectual Property, "Intellectual Property is not made to regulate or benefit the public, it is made to regulate competition" (Miranda, 1977). Now, remembering that an empty property is of no use, which is of no interest to anyone, in the same way, an unfounded patent application

without an innovative purpose is nothing more than a number that will serve only as statistical data and nothing more.

On the other hand, even if there are patent applications that will be archived due to nullity or lack of maintenance, it is undeniable that many patent applications demonstrates that a country is investing in a certain technological area, thus indicating potential economic development (Griliches, 1990). The growth in the number of patents can provide competitive advantages to their holders, since such technologies can generate economic returns (Silva, Felizardo & Dutra, 2020).

In Brazil, the term of protection for granted patents is 20 (twenty) years for invention patents (IP) and 15 (fifteen) years for utility model patents (UM) (National Institute of Industrial Property, 2024). In the United States, the term for both patent formats is 20 (twenty) years (United States Patent and Trademark Office, 2024). The terms are counted from the filing date, that is, from the date the application is filed with the competent Office.

It is through the results obtained from the exploitation of granted patents that economic benefits are enjoyed by society. This profitability arising from technological innovations protected by the patent system depends on the institutional, legal and economic environment, included in the intellectual property system, which strongly affects the technological progress of a country (Moura, Paes & Farias, 2014).

Economic Overview

In a scenario where technological innovations applied to a smart city are analyzed based on the patent system, it is essential to contextualize local economic development. While the New Institutional Economics is the basis of a knowledge structure about Institutions and their roles in the development of countries (Arwani & Priyadi, 2024), the Theory of Economic Complexity proposes a dynamic perspective on the interaction of these Institutions with complex systems (Balland, Broekel, Diodato, Giuliani, Hausmann, O'Clery & Rigby, 2022).

New Institutional Economics

As seen above, the patent system has a competitive purpose since its main purpose is the development of a country through the regulation of competition. In this line, it is up to the analysis of the New Institutional Economics, demonstrating that competition is also the key to

the institutional change so necessary for developing countries. It is the strength of competition between organizations that promotes continuous investment in new skills and knowledge whose purpose is survival (Farias, 2016).

Decentralized controls produce an efficient set of institutions that adapt and adjust to each need, forcing institutions to adapt their rules through competition to promote trade, consequently reducing transaction costs in economies (North, 1991). It is important to clarify that by studying the paths of the process of creation and consolidation of institutions, we realize that institutions have a history, the institutional history, understanding that this history causes a dependency, which is defined through the concept of “Path Dependence” (Neto, 2016).

All competitive and cooperative relationships that shape a society and, consequently, an economic order, are established by institutions. Within societies, institutions are the "rules of the game", a set of regulations, procedures and standards that limit the moral and ethical behavior of individuals (North, 1981). Through the analysis of path dependence, we can see the historical and legislative trajectories of countries such as Brazil and the United States, two countries that have basically existed for the same amount of time and that underwent a colonization process during their constitution, which allows us to see that the institutional matrix has a great influence on the technological development of these nations (Piaia, 2013).

The institutional matrix is the explanation for the difference between developed and underdeveloped (or in development) countries. Studies demonstrate that the development of a solid base of laws, rules and customs aimed at the development of productive economic activities is the difference between rich and poor societies (North, 1990; Gala, 2003).

The Brazilian urbanization matrix was marked by unequal growth, which occurred quickly and in an exclusive manner, based on income concentration and low wages. Thus, socio economic problems in Brazilian cities emerged, which are still visible today (Kazyki, Moura, Marin & Silva, 2021).

In this sense, Douglass North mentions that “the inability to develop mechanisms for enforcing contracts at a low cost is the most important source of historical stagnation and underdevelopment in the Third World” (North, 1990). In the United States, the culture of innovation is already institutionalized through laws dating back to the 1980s, such as the Bayh

Dole Act, and only the application of these laws is necessary for its regulation. However, Brazil is still facing a process of trying to build a culture of innovation, through late initiatives such as the Innovation Law No. 10,973, which dates to 2004 (Piaia, 2013).

Theory of Economic Complexity

As seen above through the concept of Path Dependence, history matters, leading to the understanding that small events influence long-term development. This is one of the definitions of Complexity, where the economic consequences of adopted innovations are permanent and can be analyzed in the technological evolution of a country (Camargo, 2004).

Thus, the Theory of Economic Complexity, developed by Hidalgo and Hausmann (2009), brings the understanding that the amount of knowledge needed to make a product can vary enormously from one good to another and that most modern products require more knowledge than a single person can contain (Hausmann et al., 2011). Therefore, to measure an index of economic complexity of a country, it must be understood that the amount of knowledge is demonstrated through its productive diversity, since when developing certain products, the knowledge necessary for this is developed (Hausmann et al.; Pedroso, Souza & Soares, 2021).

According to the Theory of Economic Complexity, the technological sophistication of countries can be measured by comparative analysis of the Economic Complexity Indexes (ECI), based on the analysis of countries' exports (Marca et al., 2021). Through the ECI observatory, results are obtained in accordance with the predictions of classical development economists regarding patterns of specialization in world trade, that is, rich countries tend to specialize in the production of manufactured goods, while poor countries in commodities (Marca et al., 2021).

Methodology

This is a qualitative and comparative study, which used bibliographic data and secondary data obtained from patent banks to carry out the analysis regarding the technological development of Brazil and the United States. The survey and research took place between July 13, 2024, and August 5, 2024.

These countries were chosen for their representativeness, since the intention was to conduct a survey between a developing country like Brazil, compared to a developed country like the United States. The choice of the developed country was due to three factors: having been the birthplace of the first patent application specifically developed to be applied in a smart city; also, having been a colonized country; having a date of discovery relatively close to Brazil, these last two factors being relevant in the analysis of the economic development of both nations.

A survey was conducted comparing patent applications published with the term “smart city”, “cidade inteligente” and its plural forms, which appear in the titles and/or abstracts of applications filed in the patent systems of Brazil and the United States. The keywords used were “smart cit*” AND patent* using quotation marks to search for the same set of words, and an asterisk was used to expand the search for the word to its plural or other variants. In Portuguese, the words “cidades inteligentes” and “cidade inteligente” were used in quotation marks, using “OR” between the expressions and using “AND” patent* with an asterisk for broader results involving the plural and other variants of patents.

The analysis covered patents published from 2015 to the present day, which is the year that the doctrine points out worldwide as having the greatest dissemination and adoption of the concept of smart cities.

In searches of databases that allowed for a comparative analysis of patent applications from Brazil and the United States, the following were used: Google Patents and Patentscope (from the WIPO platform). However, after collecting and analyzing the data obtained, the Google Patents platform search tool was discarded due to inconsistencies in the results generated, since with the “title” and “abstract” selection fields marked in order to delimit the study parameters, it was found that the results presented were not in accordance with this selection, showing patent applications that did not contain the terms “smart city” or “smart cities” in their title or abstract.

The qualitative analysis resulting from the results found was focused on identifying and comparing the evolution of technological innovation and progress in development, based on the

survey of the volume of published patents, that is, referring to technologies that were developed with smart cities in mind.

Results and discussion

There are numerous indicators for analyzing the technological development of a region, and it is generally agreed that the number of patents filed is often a widely used tool as one of these indicators.

By delimiting this analysis based on a recent concept linked to innovation, such as smart cities, we can have a current indicator directly related to technological and economic advancement, enabling the study to be expanded to use the analysis of the new institutional economy and to see if there is a break in path dependence in the current realities of countries such as Brazil and the USA.

Based on the table below, the results show that there is a large gap in the volume of patents being filed in the United States when compared to the applications filed in Brazil. There are more than 12 (twelve) thousand applications filed in the American Office compared to only 11 (eleven) applications filed in the Brazilian Office.

Table 1

World Intellectual Property Organization (WIPO): Patentscope

PATENT OFFICES	BRAZIL	UNITED STATES OF AMERICA
Keyword	"cidade inteligente" OR "cidades inteligentes"	"smart city" OR "smart cities"
Period	2015 to present	2015 to present
Results	11 Patent Application	12.869 Patent Application
Five principal applicants	SAMSUNG ELECTRONICS CO LTD 2 SMARTGREEN DESENVOLVIMENTO DE TECNOLOGIAS S/A AMANDA AMORIM RODRIGUES ANTONIO VALERIO NETTO	SAMSUNG ELECTRONICS CO LTD 5,004 HUAWEI TECH CO LTD LG ELECTRONICS INC CISCO TECH INC INTEL CO

	CAIO HENRIQUE MARQUES TEXEIRA	
Five principal Technological Areas	G06Q INFORMATION AND COMMUNICATION TECHNOLOGY [ICT] H04L DIGITAL INFORMATION TRANSMISSION H04W WIRELESS COMMUNICATION NETWORKS G05B CONTROL OR REGULATION SYSTEMS IN GENERAL A61H PHYSIOTHERAPY DEVICES	H04W WIRELESS COMMUNICATION NETWORKS H04L DIGITAL INFORMATION TRANSMISSION G06F DIGITAL DATA ELECTRONIC PROCESSING H04B INFORMATION TRANSMISSION BY CARRYING SIGNALS G06N COMPUTATION ARRANGEMENTS BASED ON SPECIFIC COMPUTATIONAL MODELS

Source: Developed by the Authors

The main applicant in both countries is SAMSUNG ELECTRONICS CO LTD., with only 2 (two) applications in Brazil and more than 5 (five) thousand applications in the United States, providing a strong indication of the gap that exists in the intention of Big Techs to protect technologies related to current fields of innovation when comparing a developed country to a developing country. Other big techs do not even appear in the ranking of the five largest applicants within the filters applied in Brazil.

While in the survey carried out by the American Office, only large technology companies appeared as the 5 (five) largest applicants of patents developed specifically designed for smart cities, in Brazil, except for Samsung, the other applicants in the top five places are individuals and a software development company.

This result shows that there is no interest from large technology developers in the Brazilian market, and this is a fact that deserves a more in-depth analysis when seeking to analyze which fields of attention in the search for technological development.

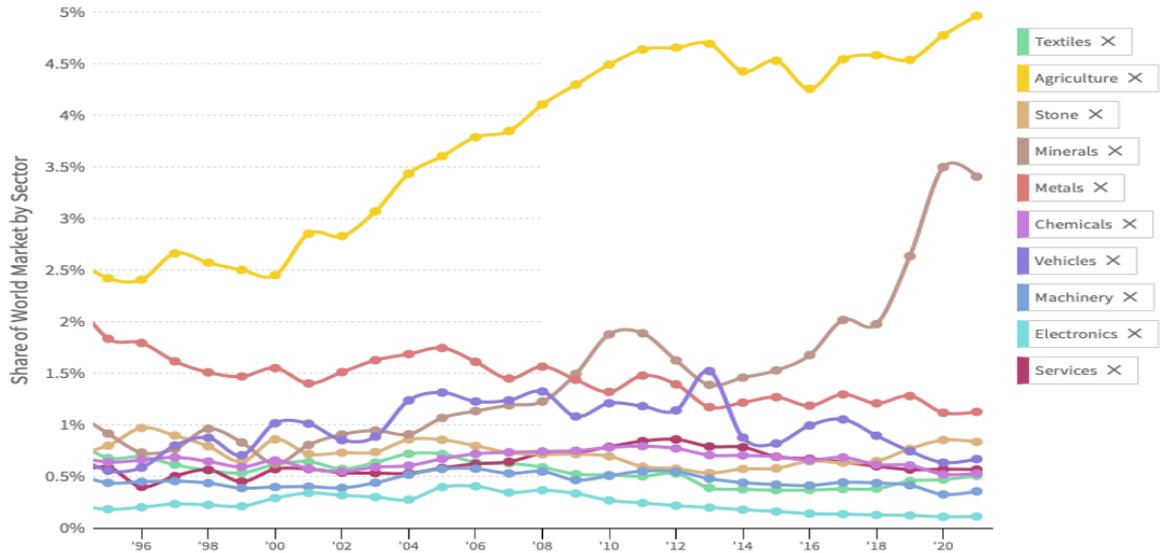
Bureaucratic obstacles, high tax burdens and lack of fiscal incentives are some of the items that weigh most heavily when analyzing the origin of the lack of interest in markets such as Brazil. However, these are issues that will not be resolved simply by creating new laws, but rather by strengthening existing Public Policies, with aggressive plans to encourage the development of new technologies, to engage the market and bring about a real break in the technological paradigm.

As seen, North's (1990) teachings demonstrate that for institutions to undergo changes, the convergence of several factors is necessary in addition to changing regulations, and that actors must evolve socially and culturally, mainly through the strengthening of contracts, which will result in a significant economic impact.

The results above demonstrate coherence with the economic analysis of technological development obtained through the Harvard ICE Atlas. The data demonstrates Brazil's total dependence on exports of products originating from agriculture and minerals and a virtually non-existent services and technological development sector, while in the US there is an exponential increase in exports of services and machinery, with very little exploitation of commodities.

Brazil has been going against the grain of technological development, following a path of technological regression and a decrease in the sophistication of its productive fabric over the last decade, which is demonstrated by the consonance between the results obtained in patent searches and the export rates explored below:

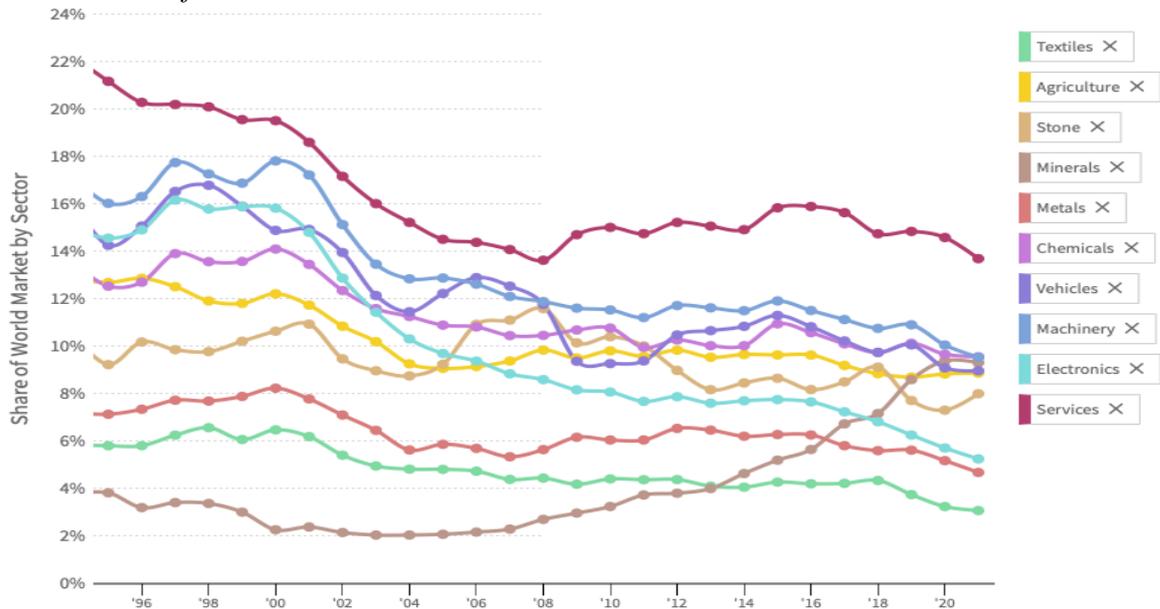
Figure 2
Brazil



Available at:

<https://atlas.cid.harvard.edu/explore/market?country=32&product=undefined&year=2021&queryLevel=location&productClass=HS&target=Product&partner=undefined&startYear=1995> (accessed October 30, 2024).

Figure 3
United States of America



Available at:

<https://atlas.cid.harvard.edu/explore/market?country=32&product=undefined&year=2021&queryLevel=location&productClass=HS&target=Product&partner=undefined&startYear=1995>

The data analyzed above show that in Brazil, only the Agriculture and Minerals sectors have export rates above 2% (two percent), and until 2018, only Agriculture was above this level. However, in the US, there is not a single sector with exports below 2% (two percent), demonstrating diversity in economic development, as well as emphasizing sectors of high technological complexity, such as services and machinery, which, despite the decline in recent years, do not appear below the 10% (ten percent) index of exports.

Therefore, when we use the patent system to verify the use of new technologies aimed at smart cities, it is possible to see that the results are consistent with those found when we draw a parallel analysis of economic development based on the comparison of the ICE of each country. In other words, patents are a robust and current system for analyzing economic development and continue to be an excellent indicator of the economic complexity index.

Final considerations

The guiding question of this work was to analyze, through the results obtained from searches in patent databases in Brazil and the United States, whether it would be possible to extract an indicator of technological development through a search command, which was defined by choosing the current and innovative concept of smart cities.

The indicators obtained were significant and demonstrated consonance with the economic reality of the selected countries, and it is relevant to study the origins that explain why there is a slow economic development in developing countries, even with laws that seek this objective.

It was found that the impact of the institutional matrix can be a strong indicator that demonstrates that path dependence is the explanation behind the repeated models of action of an entire society. These are cultural aspects that, to be changed, require an effort by the government not only to create safety regulations in relationships, but also to reinforce those already in existence through real incentives that impact acceptance by society, thereby breaking this cultural dependence.

Regarding the objectives of this article, it was possible to use patents with a restricted spectrum, but with great adherence to the theme of innovation, namely, smart cities, to demonstrate the existing technological advances, when comparing two countries with different economic realities side by side.

Thus, we can conclude that the results were satisfactory, but as an initial study model, it is recommended that, for future work, the theme of the New Institutional Economy together with the Theory of Economic Complexity be deepened to better understand the economic stagnation of developing countries. Other studies in order to analyze concrete indicators of models that enable the implementation of effective public policies that can lead to a break in technological path dependence, significantly boosting the economic development of a developing country like Brazil are also recommended.

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