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INNOVATION NETWORKS IN THE PERIPHERAL-IMMATURE CONTEXT: AN ANALYSIS OF DATA ON PATENTS GRANTED IN MARANHÃO, BRAZIL

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ABSTRACT

The present study analyzes innovation networks in the peripheral context, discussing the challenges and opportunities for technological and social development in regions with less infrastructure and resources. Data were collected from patents filed in the state of Maranhão and other states in northeastern Brazil between 2011 and 2021. The data were collected from the National Institute of Industrial Property. The text addresses the dynamics of innovation in peripheral spaces, considering structural, institutional and cultural factors that influence the formation of these networks. Strategies used to overcome limitations are highlighted, such as collaboration between local actors, the use of accessible technology, and the adaptation of innovation models traditionally applied to urban centers. The study contributes to the understanding of the potential of innovation in the peripheries, emphasizing the importance of institutional support and the development of public policies to strengthen these networks.

Keywords: Peripheral innovation. Innovation networks. Technological development. Regional cooperation. Maranhao.

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INTRODUCTION

The debate on innovation takes place in several dimensions and, for this reason, it is important to highlight that this work focuses on peripheral and immature systems in Brazil, which indicate a reality of less global impact, meeting technological bottlenecks of a local-regional nature. Thus, when debating innovation networks in the Brazilian context, it is observed that the connections with the mature globalized world are particular and generally related to specific circumstances.

In this scenario, this article aims to demonstrate the reality of the connections established by Brazilian public organizations in innovation networks. In the Brazilian context, these connections are already few and rarefied, but the situation is even more serious when it comes to organizations in the Northeast region, as it is a peripheral macro-region of Brazil, which lags even further behind the global knowledge economy. In short, this region is practically acting on specific and frugal demands in the logic of innovation.

Taking the production of patents as a variable, the issue of innovation is even more critical – both in Brazil and in the Northeast – because the main organizations that produce patents are the public ones, the so-called Science and Technology Institutions (ICT). Even with the Innovation Law (Law No. 10,973/2004), ICTs face great difficulties in promoting technical-commercial relations in the development or even in the licensing of patents or utility models.

Another point that delays the development of patents or utility models is the Brazilian logic of prioritizing the evaluation of researchers for the publication of scientific articles in comparison with requests for these property titles. All this places Brazil, more specifically the Northeast, in a different reality in relation to what has been practiced at the frontier of the knowledge and innovation economy.

Analyzing the national production of invention patents, in the period from 2011 to 2021, it is observed that the Southeast region occupies the first position, accounting for 83% of all Brazilian production; in second place is the South region, which accounts for 23% of the total. The Midwest contributes with 2% of the patents produced, while the Northeast and the North hold, respectively, only 2.67% and 0.70% of the national total of invention patents. This macro-regional disparity highlights the asymmetries that exist in the Brazilian territory with regard to innovation and technological development in the country.

Likewise, asymmetries in the context of technological innovation are also perceived among the states of the Northeast region. In the regional ranking of patent grants, Bahia

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leads with 31% of the patents granted; followed by Ceará, with 21%, and Pernambuco, with 19%. However, when analyzing Maranhão within this geographical perspective, it is observed that its share is only 4.4% of the concessions made in the same period, with the highest number recorded in 2021.

This panorama highlights the urgency for the State to develop initiatives in the area of innovation, focusing on the best practices of actions and negotiations related to patents and utility models in public organizations. This would make it possible to strengthen the partnership between universities and companies not only at the state level, but also nationally and even internationally, expanding opportunities for collaboration and boosting technological and economic progress.

METHODOLOGY

The research adopts a qualitative approach, based on literature review and documentary analysis of studies that address innovation in peripheral contexts. And it uses the state of Maranhão as a spatial cut. Data from patents filed in the state of Maranhão and in the other states of the Brazilian Northeast between 2011 and 2021 are used. The data were organized in graphs and collected from the National Institute of Industrial Property, through the Intellectual Property Statistical Database.

The collected patents were organized in the form of networks for the visualization of technical associations and cooperation nodes among researchers. Based on these data, 27 questionnaires were sent with 16 returns on questions related to the relevance of geographic proximity. The graphs of the networks were elaborated using the UCINET and NETDraw software.

RESULTS

INFORMATION, KNOWLEDGE AND INNOVATION

The production, acquisition and dissemination of knowledge are increasingly seen by many as fundamental characteristics of the competitive and emancipatory dynamics in various areas. However, long before this debate became popular, scholars already manifested a deep interest in distinguishing different types of knowledge.

Authors such as Polanyi (1987) distinguished two types of knowledge: one that could be effectively expressed through symbolic forms of representation – explicit or

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codified – and the other, tacit knowledge[3], expressed in forms that challenge this formal representation. Although information and knowledge are correlated, they are not synonymous. For this reason, it is also necessary to distinguish two types of knowledge: the codifiable and the tacit. The first is the one that, when transformed into information, can be reproduced, stored, transferred, acquired, commercialized, etc. For the second, on the contrary, the transformation into signs or codes is extremely difficult, since its nature is associated with learning processes totally dependent on specific contexts and forms of social interaction (LASTRES; FERRAZ, 1999).

Tacit knowledge has been recognized as a central component of the learning economy, key to innovation, as well as a main determinant of the geography of the activity that produces knowledge and innovation. Its central role in the learning process, through interaction and consequent access to information and knowledge, tends to reinforce, in many circumstances, the importance of the local context and its interference with the global one.

The decoding of tacit knowledge in various environments has been a recurring debate in which the roles of telemediation over long distances in the face of face-to-face and other everyday elements provided by geographical proximity are discussed. The covid-19 pandemic (2019-2022) forced the world to adapt to new ICT-mediated remote work structures. However, it is always necessary to highlight the differences in the production of knowledge in different geographical contexts, which exposes roughness in the distance treatment. For a growing number of scholars, this explains the permanence and deepening of geographical concentration in an increasingly fluid world, relativizing, at times, increasingly cheap and widespread information and communication technologies (GERTLER, 1995, 2003; POLANYI, 1987).

Information, on the other hand, can be understood, from a functional point of view, as a resource that reduces uncertainties. It is part of the various symbols, data and signs shared daily in human socialization and communication, and is also understood as a fundamental and prior component in the production of any knowledge. According to Fujino, Ramos and Maricato (2009, p. 215), "access to information is the first step towards

[3] According to Gertler (2003), perhaps the easiest way to define tacit knowledge is to specify what it is not. The performance of skills such as swimming, disembarking from an airplane, identifying a person's face, riding a bicycle or baking bread, for example, are of the order of tacit. In each case, the good performance of a skill depends on the observance of a set of rules that are not clearly known.

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communication that will provide the sharing and exchange of research results and that gives communities the effective opportunity to participate in the information society".

For Lastres and Albagli (1999), the new role of information and knowledge in the contemporary world has been causing significant changes in the relationships, form and content of work, which assumes an increasingly informational character. Therefore, the capacities of transport, transfer, production and acquisition of information and knowledge become central aspects in the production of material and immaterial resources necessary to maintain a series of social needs. It can be said that information contributes to the construction of knowledge, which, in turn, is a fundamental part of the production of innovation.

Innovation is understood as the result of a collective and systemic action in which various panoramas interact (scientific, educational, technological, technical, economic, social and institutional – formalized or not) that allow companies, organizations and people to learn, use and accumulate skills and competences, in addition to developing new products, goods and processes. Thus, according to Fernandes (2004), it is evident not only the production of new technologies and the discovery of new materials and/or products, but also the adoption, both by the company and by the State and civil society, of a new process and new organizational practices. To this end, innovation strongly depends on the ability to exchange information, produce and absorb knowledge, especially scientific knowledge.

Fernandes and Lima (2006) state that innovation is a collective, interactive, cumulative, non-linear and systemic process. It is collective because today there are many agents involved – and not an isolated inventor; interactive because the exchange of knowledge between different agents involved in the development of innovation is fundamentally indispensable for it to occur, in view of the impossibility of a single agent having all the knowledge and all the information necessary for the process. It is cumulative, because the accumulated knowledge provides the basis for the development of new knowledge over time; it is non-linear because it is processed in several steps, and not necessarily in sequence from the laboratory to the factory; and systemic because the innovation process results from the action of several agents and the relationships between them.

For Cassiolato and Lastres (2005), these are the main assumptions of innovation: knowledge; learning; company and learning, training and innovation processes. The authors explain that *knowledge* is the basis of the innovative process. Its creation, use and

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diffusion feed economic change, presenting itself as an important source of sustainable competitiveness, associated with long-term transformations in the economy and society; Meanwhile, *learning* can be understood as a key mechanism in the process of accumulating knowledge. In the innovation process, the *company* is considered the most important point, although it has the contribution of several actors, holders of different types of information and knowledge, inside and outside the company. Finally, the authors define the *processes of learning, training and innovation*, as a series of procedures and actions that influence and are influenced by the socioeconomic and political environment in which they develop.

In this way, there would be a wide range of essential information and knowledge that favors the generation and incorporation of innovations. Such processes and their elements are made up of continuous trials, errors, feedbacks, assimilation, use and dissemination, which require constant cooperation and, in many cases, geographical proximity.

GEOGRAPHICAL PROXIMITY AND INNOVATION

At the outset, it is essential to determine what the understanding of "geographic proximity" is for this work. Here, the term "proximity" is used both in the literal sense of geographical distance, and in the spatial sense of sharing language, modes of communication, work structure, customs, conventions, regionalisms, routines, symbolisms, trust, and social norms.

Although there is a strong influence of physical distance, geographic proximity cannot be understood considering only this variable. Dynamic, this concept is associated with the notion of spatial structuring. Geographical proximity is, therefore, the product of a historical construction and an accumulation of infrastructures of transport, communication, work and diverse meeting places, both material and virtual. It also starts from the formation of territorially delimited spaces, with social, institutional, political and economic dimensions (LAGENDIJK; LORENTZEN, 2007).

In this way, geographical proximity is considered as an element that enables interactions, connections and work between actors who, in a collaborative conjuncture, can increase results in various sectors of daily life.

Despite the recent and significant advances in communication technologies, geographical proximity – often relativized or even disregarded – continues to be relevant, especially in reducing uncertainties, enhancing work and expanding collective learning,

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allowing greater support for connectivity and positioning of agents (GERTLER, 1995; MORGAN, 2004).

Gertler (1995) emphasizes that spatial proximity would act as a facilitator of the sharing of codes of communication and cooperation, in addition to facilitating the construction of a common legacy of social practices and institutions. For the author, proximity seems to facilitate the formation and maintenance of high-quality relationships that require intense interaction, in addition to providing a greater and freer flow of information between the actors.

In the same direction, Allen (2000) shows that the ongoing organizational routines and social practices of collective work involved in common enterprises are more easily strengthened by daily interactions. To this end, spatial practices produce dynamics that, in some cases or circumstances, are possible to be carried out at a distance, although they maintain significant face-to-face importance.

Being in person at certain times with the members of a network not only facilitates interaction, coordination and communication between them, but also enhances the levels of social proximity and, consequently, a greater exchange and understanding of codes and signs, in addition to the construction of bonds of trust. The greater the tacit character of knowledge, the more necessary and important face-to-face contact is.

When addressing communication mediated by technologies, Nohria and Eccles (1992) argue that the structure of face-to-face contact offers an unusual possibility of interruption, repair, feedback and learning. Face-to-face interaction enables simultaneous sending and receiving of messages. The interruption, feedback and repair cycle, possible in face-to-face interaction, is so fast that it is practically instantaneous.

In the words of Polanyi (1987, p. 4): "we know more than we are capable of communicating". Therein lies the power and richness of face-to-face communication, as it makes it possible to decode not only intentional messages, but above all unintentional ones, those that can only be decoded from eye contact.

FaF contact – a component of geographic proximity – eliminates anonymity; increases the probability of good choices about the abilities of others when one cannot know, at first, his capacity for industriousness; it can also make individuals more capable of signaling to others their abilities and levels of industriousness. It is a way to make this type of information transparent and low-cost, although it also allows, in the first FaF contacts, certain people to join and remain in the group (STORPER; VENABLES, 2001, 2004).

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Similarly, Polanyi (1987) argues that scientific knowledge is produced by individuals who impregnate their search for new knowledge with deeply personal contents, the results of various interactions and particularities. That is, scientific knowledge would not be just an articulated set of axioms, rules, algorithms, and statements. These, in some cases, cannot be understood through phone calls, chats, emails, web conferences, servers and other technologies.

In other words, even with electronic media, knowledge does not flow so easily. This is because its transmission is most common through face-to-face interaction between partners who already share basic spatial issues: same language, common codes of communication, shared conventions and norms, personal acquaintance based on a past history of successful collaboration or informal interaction. These similarities serve the vital purpose of building trust between partners, which facilitates the local flow of tacit knowledge between them (GERTLER, 1995; MORGAN, 2004).

Torre and Rallet (2005, p. 53) also argue that even with the current communicational explosion, or "the omnipresence promoted by communication and mobility – physical and virtual", certain resources and relationships remain spatially rooted. They also state that the proportion of rootedness of face-to-face face-to-face contacts varies according to the activity, "but that in all of them, we would still find a spark of the need for daily face-to-face spatial production".

Even with technological advancement[4] that often relativizes the importance of geographical proximity for the production of knowledge and innovation, it remains relevant. Its role has been reformulated as new processes are restructured in the face of different contexts, with elements that reduce uncertainties, especially in transactions of high complexity and ambiguity (MORGAN, 2004). In this sense, STORPER AND VENABLES (2001, p. 32) highlight particularities of FaF communication:

> Mutual presence – being close enough to touch each other – allows for visual "contact" and "emotional closeness", the basis for the construction of human relationships. FaF communication, more than just an exchange, is a performance by which discourse and other types of actions and contexts come together to exercise communication, in a very complex way, at many different levels at the same time.

[4] The process has intensified even more with the covid-19 pandemic, declared by the World Health Organization in March 2020. According to Agência Brasil (Nitahara, 2021), there was a significant increase in the use of digital technologies in Brazil, with the proportion of households with internet access growing from 71% in 2019 to 83% the following year. This is equivalent to 61.8 million households with some type of connection to the network.

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For Storper and Venables (2001), the possibility of researchers "being here" and communicating face to face at certain times makes cooperative work more dynamic. In other words, being physically close to the members when forming a team or carrying out a project facilitates the accomplishment of the work itself, in addition to the insertion of new members in the group.

Other authors, such as Boschma (2005), summarize the idea that the innovation process does not occur only as a function of geographical proximity, but also as a function of other dimensions: cognitive, social, institutional and organizational, which come together to reduce uncertainties and problems in the production of knowledge.

The four dimensions cited by Boschma (2005) and summarized by Fernandes *et al*. (2023, p. 11) are: a) *cognitive proximity*: constituted from a minimum common knowledge base without which there is no communication, capacity for absorption and exchange of knowledge between agents; b) *organizational proximity*: coordination capacity to organize the exchange of complementary parts of knowledge accumulated by different actors inside and outside an organization; c) *social* proximity: social ties between agents, such as trust, friendship, common experience, kinship, etc., which reduce uncertainties in relationships, especially in the exchange of tacit knowledge; and d) *institutional proximity*: formal (norms, rules or laws) and informal (habits, routines, established practices, cultural parameters) sets of mechanisms that regulate the relationships between people, groups and companies and affect the exchange of knowledge and interactive learning.

It is worth questioning whether such proximities, presented as complementary, would not, in fact, be part of the geographical proximity itself. If proximity is to be understood within a historical and geographical context that produces spatial continuities, bringing actors together based on common variables and uses, it must be considered that cognitive, social, institutional, and organizational aspects are included in a much broader geographic framework.

However, it is worth highlighting the arguments of Fernandes *et al*. (2023), which point to the loss, even if not statically, of the importance of geographical proximity in some situations, such as: when the tasks to be performed are well defined and coordinated; when partners share a necessary common knowledge base; when tacit knowledge exchange requires sporadic face-to-face contact, and when knowledge networks are sustained by social constructs that exclude strangers.

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NETWORKS AS INNOVATION OPTIMISATION FRAMEWORKS

Dias (2003) highlights that networks have the property of connection, that is, through the connection of their nodes, the network, simultaneously, has the potential to solidarize or exclude, to promote order or disorder. In addition, the author shows that the network is a particular form of social, technical or natural organization, and, in the context of the processes of integration, disintegration and spatial exclusion, "it appears as an instrument that enables [...] two strategies: to circulate and to communicate" (DIAS, 2003, p. 147).

The reflection on the current contours of networks – anchored in the technological and informational structure – points directly to Manuel Castells' conception of "network society", according to which modern society is characterized by the predominance of the organizational form of the network in all fields of social life.

For Castells (1999), the reasons for the success of the use of the concept of network, fundamentally, would be linked to the development of information, processing and communication technologies, enabling the existence of connections where there was previously isolation. For Castells (1999), digital communication networks are the backbone of the networked society, just as power networks (or energy networks) were the infrastructure on which industrial society was built.

In this context, the paradigm of electronic mediation is the material basis – system of objects – for the pervasive expansion of technological networks in the structure of contemporary society. "Networks constitute the new social morphology of our societies, and the diffusion of the logic of networks substantially modifies the operation and results of the productive processes and of experience, power and culture" (CASTELLS, 1999, p. 497).

While traditional territorial institutions may be more hierarchical and rigid, ICTs tend to privilege transversal modes of relationship and more fluid structures, in greater harmony with the network structures that characterize social and political processes in modern democratic societies. In this sense, "interactions happen with several people, connections change between multiple networks and hierarchies can be reduced and recursive" (WELLMAN, 2001, p. 227).

Networks facilitate the improvement of performance, that is, an increase in the results produced, in addition to enabling the autonomy of the partners and increasing their learning capacity, thus expanding the possibilities of innovative processes. According to the type of network and the objective of the activity to be developed, instantaneity and

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practicality allow actors from different transversal levels to act together through technological mediation, which should be considered as an important telecommunication support.

With the ICT apparatus, networks can be simultaneously adaptable and hybrid, thanks to their ability to decentralize performance and connectivity between autonomous components, while remaining able to coordinate the entire process of an activity in a decentralized way. This without losing the possibility of sharing among the group the decision-making at various points, at different or simultaneous times, streamlining the results and methodological procedures of work processes.

Actors have the opportunity to connect to their networks instantly, glimpsing sounds, images and interacting all at the same time. Unlike the connections established by the telegraph, for example, in which the nodes of the network were only points in a geographical continuity, electronic networks allow the construction and transmission of numerous social particularities – the points are no longer points, they are people – and, to a certain extent, the transmission of these aspects helps significantly in maintaining interactivity by all nodes.

Electronic telemediation, via processing, information and communication technologies, combines the advantages of the two previous systems, while allowing reciprocity in communication and the sharing of a context between the various members of the network. Such dynamics have been appropriated by the actors in the most diverse activities, including scientific research.

If the production of new knowledge demands the exchange of ideas and the circulation of information among the peers involved, there is nothing more appropriate than scientific research to use the structure in the form of networks, since it enables two basic strategies, circulation and communication, as Dias (2003) points out. This possibility of collaboration, based even more on communication technologies, indicates significant transformations in the production of scientific knowledge.

Science is an eminently collective and social activity, built through social relations between researchers. Its advances or setbacks can be evaluated, to a certain extent, by the forms of interaction between agents. This interaction is one of the assumptions for the development of knowledge, therefore, innovation. The connection between the various actors that produce knowledge, building an environment of network interaction, is a

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significant step towards the construction of innovations and, subsequently, innovation systems.

The construction of an innovation system (IS) has a strong link with the territorial structure to which it is subjected. In other words, in the creation of ISs, power relations are structured strongly based on cultural, symbolic, political and economic aspects and values of a specific area. In this way, the territory amplifies the sectoral possibilities of innovation systems through the various institutional arrangements it encompasses, namely: firms, interaction networks between companies, government agencies, universities, research institutes, company laboratories, activities of scientists and engineers.

Such arrangements are articulated with the educational system, the productive sector, financial institutions and even the political system[5], completing the circuit of agents responsible for the generation, implementation and dissemination of innovations aimed at solving problems in various areas.

In peripheral contexts where there is an absence of institutional arrangements or fragility in their collaborative functioning, the construction of innovation systems faces significant challenges, which methodologically leads to the search for the distinction of countries with mature systems from those with immature systems. Among the latter, the author included Brazil, along with India, South Africa and Mexico.

DISCUSSION

INNOVATION NETWORKS BASED ON PATENTS IN MARANHÃO

As a country whose innovation system is immature, Brazil is characterized by sporadic interactions between researchers, universities, research institutes and companies, with more intense interactions in more technologically dynamic regions and in more knowledge-intensive productive sectors. Therefore, despite all these elements being connected, what exists in the country are small spaces of interaction with specific sectors, such as the Southeast, and much less dynamic regions, such as the Northeast, as explained by Fernandes, Souza and Silva (2011, p. 341):

> [...] in regions understood as peripheral to the already late Brazilian system, as is the case of the Northeast, interactions are even rarer: the creation of scientific and

[5] The political system has the power to both drive and delay the actions of the innovation system, since all policies need to go through parliament, influencing and modifying laws, such as: the legal framework for Science, Technology and Innovation, the Information Technology Law, the Good Law, among others. These laws are fundamental for the creation of a mature and systemic innovation system in the country.

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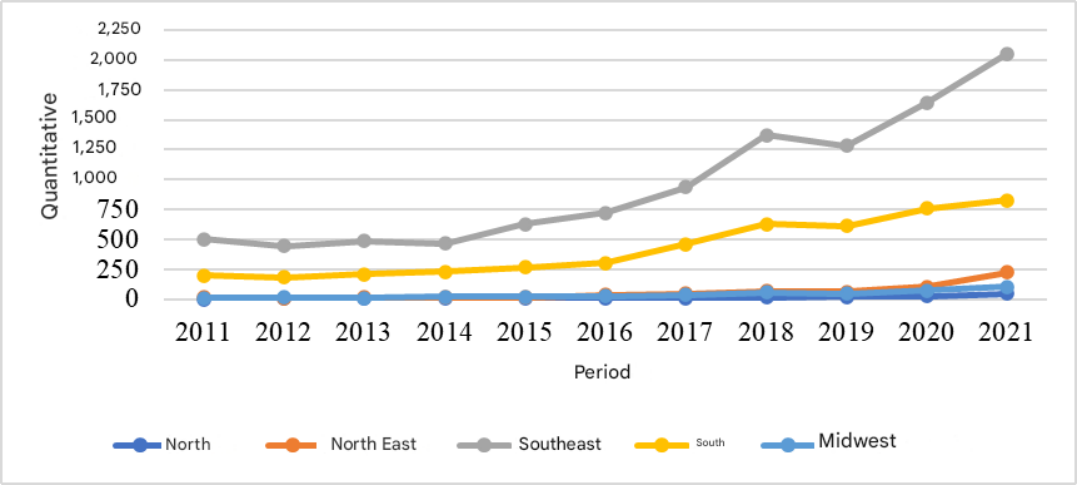
> technological institutions is even more recent, the regional financial system has virtually ceased to exist and, faced with a productive structure based on traditional sectors, only recently exposed to external competition, the motivation for interactions is even more limited [...]. [This] would result more from the incentive structure made available by the State to both firms and academia, than from the other variables that determine the establishment of relations between universities and industries.

The authors' understanding of the topic is important, since technological innovation is at the heart of economic change. When observing the general data on the production of invention patents, utility models, and addition certificates granted by the National Institute of Industrial Property (INPI), between 2011 and 2021, the disparities in technological capacity between the regions of the country are observed.

Graph 1 – Invention patents in Brazil, divided by region (2011-2021)



Source: National Institute of Industrial Property, Economic Affairs Advisory, Intellectual Property Statistical Database (2023). Org. The authors (2024).

In comparative terms, of all the concessions authorized in the period in question, the Southeast region is responsible for 83% of all patents in the country, followed by the South region, with 23%. The Midwest accounts for 2%, while the Northeast is responsible for only 2.67%; and the North, for 0.70% of the patents in the national framework.

From this perspective, it is pointed out that the backwardness of the Northeast, from the scientific and technological point of view, can also be understood from the low demand for research and development by the regional productive structure, which leads to few stimuli to the interaction between researchers, research institutions and companies.

In Maranhão, historically, higher education institutions are concentrated in the capital São Luís. Until the end of the 2000s, there were no private institutions of higher education in the interior of the state, and the existing public universities were focused on teacher

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training, through licentiate courses, to meet internal demands and those of the neighboring states: Piauí, Tocantins and Pará.

It was only in 1995 that the State Secretariat for Science and Technology (SECTEC), currently the State Secretariat for Science, Technology and Innovation (SECTI), was created to formulate and coordinate the state policy for scientific and technological development. The secretariat was linked to the following bodies: State University of Maranhão (Uema), Maranhão Research Support Foundation (FAPEMA) and Maranhão Agricultural Research Company (EMAPA).

Three years later, in 1998, SECTEC, FAPEMA and EMAPA were extinguished and incorporated into the Management of Planning and Economic Development, causing damage to the already fragile stimulus to scientific and technological research in the state. Later, in 2003, FAPEMA was restored as an organ linked to the State Secretariat of Science, Technology, Higher Education and Technological Development (SECTEC). And it was only in 2017 that the first autonomous public university outside the capital was created, the State University of the Tocantina Region of Maranhão (UEMASUL).

These recent processes of construction of Science, Technology & Innovation structures in Maranhão represented and still represent obstacles to the current process of development of state innovation, as can be seen in Graph 2, which presents the number of patents certified in the Northeast region, divided by state.

Of the total patents registered in the Northeast region, the state of Bahia holds 31% of the concessions, followed by Ceará, with 21%, and Pernambuco, with 19%. These three states alone hold 71% of all patent grants in the region. Maranhão registered only 4.4% of the total patents in the period analyzed, with emphasis on the year 2021, which recorded the highest number of concessions in the historical series presented.

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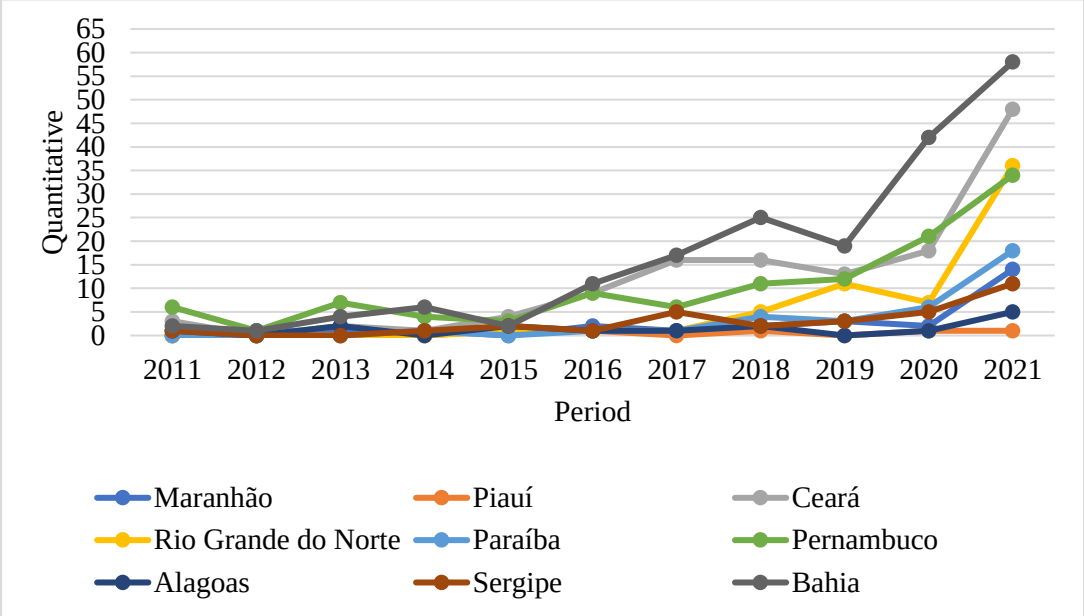
Graph 2 – Invention patents in northeastern Brazil (2011-2021)



Source: National Institute of Industrial Property, Economic Affairs Advisory, Intellectual Property Statistical Database (2023). Org. The authors (2024).

Among other factors, the scenario seen in Maranhão is the result of both a low demand for research and development on the part of the productive base and the fact that the process of development of ST&I institutions in the state is recent. Such factors result in limited technical capacities for the development of knowledge, procedures and processes that generate innovations, but also in the low capacity to incorporate connections with diverse researchers (Figure 1), who, in addition to low cooperation, have expressive local roots in networking.

Each of the points presented in Figure 1 represents a patent published by a researcher, or group of researchers, linked to one of the public or private research institutions in Maranhão. The colors allow you to identify the geographical origin of members who participated in the process that resulted in the application and approval of the patent.

In addition to the small number of patents granted, as shown in Figure 1, it is worth noting that there are only interactions between Maranhão and 4 states in the country (São Paulo, Ceará, Rio de Janeiro and Mato Grosso), in only 8 established networks. Of the 28 grants, 50% of them are made up of isolated institutions, with no connection to external actors, and 11% (3 networks) come from networks established between institutions and researchers exclusively within the state.

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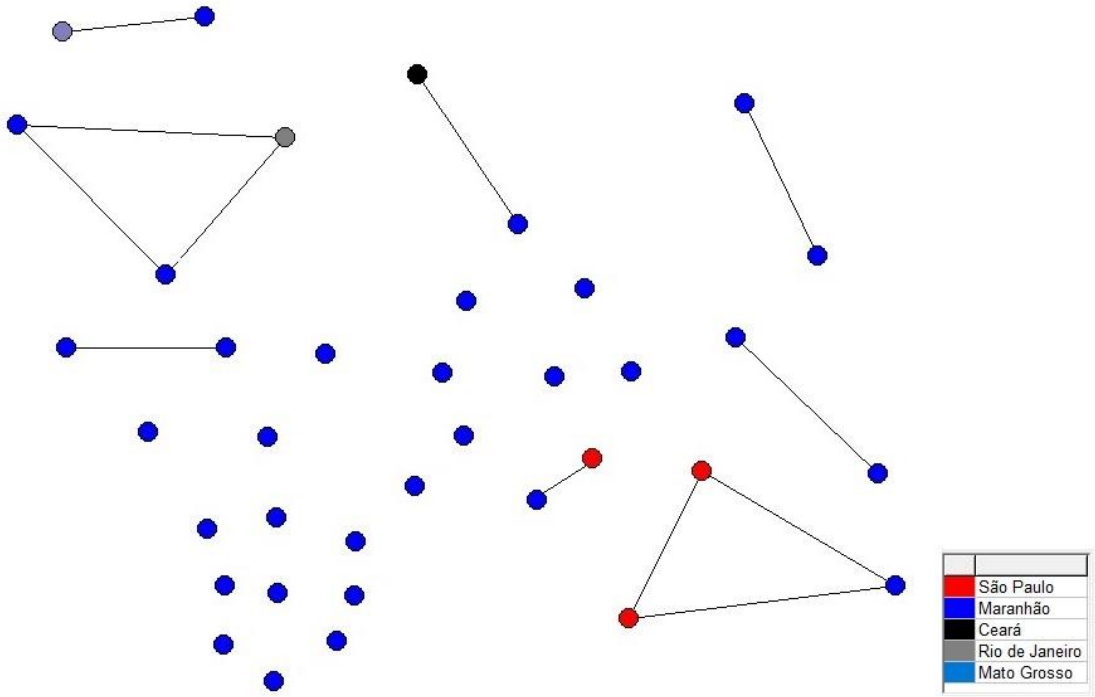
The data show a small number of patents produced in Maranhão, even compared only to other states in the Northeast. There is both an inexpressive number of collaborative relationships capable of promoting network research and an expressive geographical concentration of the various research agents. In this context, researchers tend to focus on activities within their own universities.

Figure 1 – Innovation networks that resulted in patents in Maranhão (2011-2021)



Source: National Institute of Industrial Property, Economic Affairs Advisory, Intellectual Property Statistical Database (2023). Org. The authors (2024).

Given the questions expressed in the data that point to strong local rootedness in the relationships that resulted in patents, 1 questionnaire was sent to each of the groups of researchers that make up the networks, totaling 27 questionnaires. There were 16 questionnaires returned. The results are summarized in Chart 1.

Although the questions presented do not represent a deepening of the situational picture of the state, given the limitation in the number of questions and even the low feedback from the researchers, they suggest reflections based on the data presented above.

The first aspect deals with the relevance attributed to personal contact with another researcher. The majority of the interviewees (75%) considered that it is relevant to know the researcher with whom one is working in a network in person, which suggests that

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proximity, here, is more than merely physical, it is a proximity established by relationships of trust that, for the specific case, are perhaps more easily built on a daily basis.

The majority (87.5%) also answered that geographical proximity reduces uncertainties in the research process. And, in this sense, everyone believes that electronic communication is not an effective substitute for face-to-face communication, suggesting that, even during the period of the recent covid-19 pandemic, there is still relevance in face-to-face. Thus, most of the respondents (87.5%) said they believe it is important to research with those who are geographically close.

Table 1 – Issues on geographical proximity

Questions raised	Yes	No	Irrelevant
On the importance of meeting the researcher personally	75%	12,5%	12,5%
On the importance of geographic proximity to reduce uncertainties in research processes	87,5%		12,5%
Electronic communication is considered to be an effective substitute for face-to-face communication		100%	
On the importance of researching with those who are close geographically	87,5%		12,5%

Source: The authors (2023).

Geographical proximity in peripheral contexts represents not only an element of understanding about the reduction of uncertainties or the continuous processes that are spatially constructed and can be better absorbed face to face, as in the case of tacit knowledge. It represents a historical process of scientific and technical temporalities that express levels of deepening and technological emancipation of regions and social groups, with different connectivities and degrees of scientific development. Such issues reflect on the formulation of articulations with institutions or people who are geographically distant or in different spatial contexts and also express difficulties in building new intra- and inter-regional arrangements.

CONCLUSION

The debate and practice on innovation are part of the current world reality, as the knowledge economy that generates innovations changes the status quo of a particular company, locality, region or country. For developing countries, this reality occurs in less intensity and with less interference on world connections, because their innovations are more incremental, or even frugal, meeting a local-regional reality.

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The debate on patents and utility models is relevant to understand the development of innovation, as it is associated with the logic of industrial property that generates changes in the reality of an organization, causing a positive chain effect in the locality, region or country, depending on the impact of this product on the market and whether it will meet global demands.

In Brazil, it is verified that the filing of patents and utility models is mainly associated with public education, research and innovation (ICT) organizations. This scenario generates difficulties in the patenting process and, more specifically, in the process of negotiation and technology transfer. The situation is aggravated in the case of the Northeast macro-region, a peripheral region in a peripheral country, in which the dynamics of innovation is still very incipient and, when it exists, it is in incremental or frugal demand.

The data indicate that the Northeast region holds only 2.67% of the patents granted in the country, while the Southeast is responsible for 83% of the total. This reality indicates that the Northeast, as well as the North and Midwest, find it very difficult to generate patents.

Maranhão illustrates this scenario well: the state holds only 4.4% of the patents granted in the Northeast. A positive point is that the best concession year, in the period analyzed, was 2021, indicating a possible evolution of the state in this process. All the conditions indicate a negative scenario for Maranhão with regard to the patenting process, making it difficult to change the economic logic of reference, since innovation does not occur in a systemic or systematic way in the state.

In parallel with the characteristics of the productive base, the weaknesses in the economic and historical formation of the state, as well as the concentration of research in the capital, also affected Maranhão's capacity in the area of scientific research. These aspects invariably hinder the construction of new intra- and inter-regional arrangements, focused on more sophisticated innovation patterns. On the other hand, turning to the demands of local society and economy can inspire full development and good technical and innovation practices for the insertion of the state in a new level of technological development.

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