



THE COMPETITIVENESS RANKING OF BRAZILIAN STATES AND AN ANALYSIS ON THE QUANTITY OF PATENTS AND THEIR PUBLIC POLICIES FOR THE INNOVATION PILLAR

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Abstract

Objective of the study: To evaluate in a statistical, temporal and comparative way, the competitiveness among states of the federation. Using as a metric, the volume of patents and public policies developed in the states. Being a reference for a practical and effective scenario, of solutions for a regional socio-economic development, with less discrepancies and a higher degree of solution. Having its base based on the innovation pillar of the competitiveness ranking among the states.

Methodology: The study was conducted on a base of scientific journals and statistical patent reports via the National Institute of Industrial Property and the Orbit system, in addition to the technology transfer contracts registered in Brazil. Also used was the copy of the year 2021 of the competitiveness ranking among Brazilian states.

Main Results: It was possible through the collected data the influence and importance measured through the innovation pillar for the competitiveness ranking among Brazilian states. The metric revealed the performance among the Brazilian federative units ranked there, identifying the possible correlation present between public policies for innovation, as well as the volume of production and patent protection. Three scales of observation were considered: 1) states in the best position in the ranking; 2) states in an intermediate position in the ranking, such as the state of Rio de Janeiro, currently seventeenth in the ranking; and 3) states in the worst positions, such as Acre and Roraima, currently twenty-sixth and seventh, respectively.

Theoretical/methodological contributions: We sought to contribute with studies based on statistical analysis, as well as the collection of legislation that promotes public policies for innovation. And contributions that generate opportunities for deeper analysis to search for solutions not only parallel to

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the concrete cases, but also to contribute to the Brazilian states, but that it is possible to gradually reduce their disparities among themselves, with regard to the search for the development of local innovation.

Contributions of the association/management: It is hoped that this research will contribute to the study and exploitation of new opportunities, as well as proposals and possible solutions that can contribute to the improvement of a national innovation scenario.

Keywords: ranking; federal states; innovation; patents; public policies.

O RANKING DE COMPETITIVIDADE DOS ESTADOS BRASILEIROS E UMA ANÁLISE SOBRE O VOLUME DE PATENTES E AS SUAS POLÍTICAS PÚBLICAS PARA O PILAR DE INOVAÇÃO

Resumo

Objetivo do estudo: Avaliar de forma estatística, temporal e comparativa, a competitividade entre estados da federação. Utilizando como métrica para tanto, o volume de patentes e políticas públicas desenvolvidas nos estados. Sendo referência para um cenário prático e efetivo, de soluções para um desenvolvimento socioeconômico regional, com menores discrepâncias e maior grau de solução. Tendo sua base pautada no pilar de inovação do ranking de competitividade entre os estados

Metodologia: O estudo foi realizado em uma base periódicos científicos e relatórios estatísticos patentários via Instituto Nacional da Propriedade Industrial e o sistema *Orbit*, além dos contratos de transferência de tecnologia registrados no Brasil. Igualmente foi utilizado o exemplar do ano de 2021 do ranking de competitividade entre os estados brasileiros.

Principais Resultados: Foi possível por meio dos dados coletados a influência e importância medida através do pilar de inovação para o ranking de competitividade entre os estados brasileiros. A métrica revelou o desempenho entre as unidades federativas brasileiras ali ranqueadas, identificando a possível correlação presente entre as políticas públicas de inovação, como também o volume da produção e proteção patentária. Foram consideradas três escalas de observação: 1) estados em melhor colocação no ranking; 2) estado em posição intermediária no ranking, como o estado do Rio de Janeiro atual décimo sétimo colocado; e 3) estados nas piores colocações, como o Acre e Roraima, atuais vigésimo sexto e sétimo respectivamente.

Contribuições teóricas/metodológicas: Buscou-se contribuir com estudos pautados em análises estatísticas, como também o acervo de legislações que promovam políticas públicas de inovação. E contribuições que gerem oportunidades de uma análise mais aprofundada para a busca de soluções paralelas não somente aos casos concretos, mas, sim contribuir para que os estados brasileiros, mas que seja possível diminuir gradativamente às suas disparidades entre si, no tocante à busca pelo desenvolvimento da inovação local.

Contribuições da associação/gerenciamento: Espera-se que esta investigação colabore para o estudo e aproveitamento de novas oportunidades, assim como de propostas e soluções possíveis que possa contribuir para toda uma melhoria de um cenário nacional de inovação.

Palavras-Chave: ranking; estados federados; inovação; patentes; políticas públicas.

EL RANKING DE COMPETITIVIDAD DE LOS ESTADOS BRASILEÑOS Y UN ANÁLISIS SOBRE EL VOLUMEN DE PATENTES Y SUS POLÍTICAS PÚBLICAS PARA EL PILAR DE INNOVACIÓN

Resumen

Objetivo del estudio: Evaluar de forma estadística, temporal y comparativa, la competitividad entre estados de la federación. Utilizando como métrica, el volumen de patentes y políticas públicas desarrolladas en los estados. Siendo una referencia para un escenario práctico y efectivo, de soluciones

para un desarrollo socioeconómico regional, con menores discrepancias y mayor grado de solución. Teniendo su base en el pilar de innovación del ranking de competitividad entre los estados.

Metodología: El estudio se realizó a partir de revistas científicas e informes estadísticos de patentes a través del Instituto Nacional de la Propiedad Industrial y del sistema Orbit, además de los contratos de transferencia de tecnología registrados en Brasil. También se utilizó la copia del año 2021 del ranking de competitividad entre los estados brasileños.

Principales resultados: Fue posible a través de los datos colectados la influencia e importancia medida a través del pilar innovación para el ranking de competitividad entre los estados brasileños. La métrica reveló el desempeño entre las unidades federativas brasileñas allí clasificadas, identificando la posible correlación presente entre las políticas públicas de innovación, así como el volumen de producción y la protección de patentes. Se consideraron tres escalas de observación: 1) estados en la mejor posición en el ranking; 2) estados en una posición intermedia en el ranking, como el actual estado de Río de Janeiro, que ocupa la decimoséptima posición; y 3) estados en las peores posiciones, como Acre y Roraima, actualmente vigésimo sexto y séptimo, respectivamente.

Aportaciones teóricas/metodológicas: Se buscó contribuir con estudios basados en el análisis estadístico, así como la recopilación de la legislación que promueve políticas públicas para la innovación. Y contribuciones que generan oportunidades para un análisis más profundo para encontrar soluciones no sólo a los casos concretos, sino también para contribuir a los estados brasileños, por lo que es posible reducir gradualmente sus disparidades entre ellos, en cuanto a la búsqueda del desarrollo de la innovación local.

Contribuciones de la asociación/gerencia; Se espera que esta investigación contribuya al estudio y aprovechamiento de nuevas oportunidades, así como propuestas y posibles soluciones que puedan contribuir a la mejora del escenario nacional de innovación.

Palabras clave: clasificación; estados federales; innovación; patentes; políticas públicas.

Introduction

When we propose to analyze the regional performance metrics of the Brazilian states, it is important to start with a point of concern: to do so without distancing it from national performance since the regional dimension is important and influences the national level (Howells, 2005). This research analyzed the competitive profile of Brazilian states, using the State Competitiveness Ranking as a data source. It took as its starting point the following question: Is the promotion of new research, as well as the patenting of scientific and innovative discoveries, related to public science, innovation, and technology policies?

Therefore, in order to better understand this regional performance, it is important to look at a proposed thematic division so that it is possible to generate a deeper and more comprehensive understanding of the 27 units of the federation (Ranking of Competitiveness of the States, [n.d.]). This division considered the fundamental indicators exposed for this evaluation, distributed into ten thematic pillars. These are: (1) Infrastructure, (2) Social Sustainability, (3) Public Safety, (4) Education, (5) Fiscal Solidity, (6) Efficiency of the Public Machine, (7) Human Capital, (8) Environmental Sustainability, (9) Market Potential

and (10) Innovation. In this context, this last segment is the subject of the study carried out by (Ranking of State Competitiveness, [n.d.]).

In this sense, one should expect the variability of regional economic policies (Nail et al., 2015), considering the regional differences between federal entities in their public policies. This movement, which studies and analyzes competitiveness rankings, has its genesis in the consolidation of the economic opening up of nations and the emergence of globalization theory in the 1980s and 1990s (Pessanha et al., 2021).

It is, therefore, understood that knowledge can be captured or incorporated into a patent when it comes to innovation. For example (OECD & Eurostat, 2018), when patents emerge as a reference to consider, it must be understood that the inventor and society are inseparable (Macedo & Barbosa, 2000). This truth has been so overestimated over time that the state grants these organizations temporary protection over an invention or utility model (Ferreira et al., 2009). Thus, patents and their respective technological contracts generate business. It is a possible indicator to corroborate innovation and, at the same time, indicates a criterion of competitiveness between the states of our federation.

From this study, it is important to note that in this comparative analysis, the initial attempt is to observe whether our recent public policies have brought a movement of change and development to the real scenario. In this discussion, this research considers that ranking systems collaborate with the development of the effectiveness and efficiency of public policies, as well as mapping the points of competitiveness -fragility of these public policies in our units of the federation, either in the evaluation of each one of them or as a whole (Ranking of Competitiveness of the States, [n.d.]).

The existing instruments in our national industrial property legal framework, which outline the process for patents and technology contracts (L9279, [n.d.]), are Federal Law No. 9.279/96 and the normative instruments related to public policies for innovation. These are exemplified in this study by the law that deals with incentives for innovation and scientific and technological research (L10973, [n.d.]) and the current Legal Framework for Innovation (L13243, [n.d.].d.) and the current Legal Framework for Innovation (L13243, [s.d.]), essential instruments for this analysis, because they need to be aware of these regional variations and adapt to them (Howells, 2005).

Therefore, implementing such policies that promote regional innovation and measure the volume created by technological capital are excellent contributors to the development of

patents (Nail et al., 2015). Hence, they can be considered favorable points for disseminating science, promoting research, and motivating vital changes in the sector.

The recently released State Competitiveness Ranking for 2021 shows the states of São Paulo, Santa Catarina, the Federal District, and Paraná in the top categories, following a trend shown in the previous year, in 2020 (Ranking of State Competitiveness, [n.d.]). In this context, this work aims to identify the possible correlation between well-defined public innovation policies and patent protection. To this end, the three scales considered are 1) states in the best position in the ranking; 2) states in an intermediate position in the ranking, such as Rio de Janeiro, currently in 17th place; and 3) states in the worst positions, such as Acre and Roraima, currently in 26th and 7th place respectively.

Thus, on the theoretical basis of innovation being a consequence of competitiveness among the players mentioned above, the volume of patents, the technology contracts, and the legal collection of data were observed, delving into the factors of competitiveness and the fragility of public policies in each state (Ranking of State Competitiveness, [n.d.]).

The premise of this work is to draw a parallel between the public innovation policies structured at the state level and the work on patent protection and technology transfer in these same regional scenarios. To this end, this research observed indices established in a ranking system to measure competitiveness between the states of the federation through the actions and strategies of their public leaders to create a concrete notion of this regional competitiveness. It is understood that a state's competitiveness is directly linked to the capacity of its public leaders to act (Ranking of State Competitiveness, [s.d.]). In this way, the relationship between innovation and the promotion of intellectual property was considered.

The research is important because, by taking a closer look at the innovation indicators that the *ranking* publishes every year, it has been possible to understand the relationship between public policies in the innovation sector and the implementation of technological initiatives. It combines with the fundamental fact that science can create and sustain wealth, producing many more social, cultural, and economic benefits (Howells, 2005). In this sense, the division seeks to provide a concrete understanding of the discrepancies in three data sets, which will contribute to new assessments of the chosen theme. Following this perception of innovation as fundamental to economic and social development, the state fosters an environment conducive to innovation in various ways (Confederação Nacional da Indústria, 2020), so ranking is one of the instruments that favors this analysis.

In conclusion, this study has made it possible to measure the factors of national competitiveness vis-à-vis the rest of the world once the connection between innovation, growth, and economic performance has been established. We also observed issues related to the great disparities that remain in innovative activity between regions, which makes clear the importance of the regional progress dimension for the positive contribution at the national level (Howells, 2005).

Theoretical Reference

Patents are considered important indicators that reveal the technological progress of a country or region and can thus measure government incentives to encourage innovation and scientific and technological development (Ramos & Sartori, 2023). These mechanisms aim to boost development, and the informational value offers advantages for generating new technologies (Pinto et al., [n.d.]).

Most importantly, patents are indicators of innovation in regions, nations, and organizations (Dallacorte & Jacoski, 2017). In this sense: "The number of patents filed is an important indicator of progress, reflecting the formation of scientific and technological knowledge and the possibility of obtaining a financial return on innovative efforts" (Dallacorte & Jacoski, 2018 apud Ramos & Sartori, 2023, p.315).

The patent scenario is an indicator of the innovation pillar in this ranking of Brazilian states, which has become vitally important in the study since patents are understood as how technology circulates in society (Araujo, 1984). The entire inventory of patents, documented in the files, provides information not found in a watertight form on the technical shelves. In this way, it also has an economic focus, thus representing an exceptional tool for generating wealth and regional and national development.

A brief historical chronology shows that institutionalized science and national financial problems have led Brazil to a slow and disorganized growth of Brazilian science (Moura et al., 2019). Given this reality, there is a disparity between the information the federal units provide, sometimes in a feasible way, sometimes conjugating a greater need to build a comparative parallel between the information. It becomes a counterpoint to assess because, theoretically, there is recognition that innovation, knowledge, and economic growth are connected (Howells, 2005).

Methodology

Inspired by the work of (Moura et al., 2019) and (Fagundes et al., 2014), the qualitative study is adequate as the methodology for analyzing patent filings for the innovation pillar. Based on the data provided in the State Competitiveness Ranking, this research considered the national legal framework for innovation and any variations in scenarios in these interstices.

This explanatory study used the statistical method to confirm the hypothesis that the Legal Framework would increase the number of patents at the national and state levels.

The research was carried out on the *Orbit* database from 2004 to 2020, being limited to this time interval because, as cited by (Scartassini et al., 2020), the Brazilian Innovation Law was instituted in 2004 (L10973, [n.d.]) and aimed to stimulate technological innovation and inter-institutional collaborations between the academic and productive sectors in Brazil. In this study, these two sectors combined came as a starting point, adding to the contributions on the subject of innovation through the Legal Framework for Innovation in 2016 (L13243, [n.d.]).

Orbit Intelligence was the platform of choice because it is one of the most recognized tools for searching and strategically analyzing information contained in patents. Through this tool, it is possible to analyze technological panoramas and carry out patentability studies, among other functions (UNESP, 2020).

For the purposes and observations pertinent to the criteria established in the competitiveness ranking, the four states at the top of the ranking and the middle and bottom two were classified. The statistical analysis of this vehicle is based on the innovation pillar, which has five indicators. These are (1) Investments in R&D; (2) Patents; (3) Master's and Doctoral Scholarships; (4) Innovative Enterprises; (5) Scientific Research. Hence, the team paid attention to the patents indicator (Ranking of State Competitiveness, [n.d.]) by developing it. The metric is updated to the 2021 standard and includes a preliminary statistical analysis of these patents by the states mentioned (Instituto Nacional da Propriedade Industrial, [n.d.]). Data was extracted from the monthly bulletin issued by the INPI, gathering information on technology contracts (Portal Brasileiro de Dados Abertos & Instituto Nacional da Propriedade Industrial, [n.d.]).

The main feature of this research was a quantitative approach through the convergence of statistical resources. Due to the large volume of data obtained, as was done by (Bochi &

Moura, [n.d.]), Price's Law of Elitism was used, which states that if k represents the total number of contributors in a discipline, \sqrt{k} represents the elite of the area studied, as well as the number of contributors who generate half of all contributions (Alvarado, 2009). This quantification methodology considers the published works, giving rise to the calculations needed to measure productivity (Silva et al., 2014).

The advanced search feature of the *Orbit* platform provided the patent search. The keywords used in the search were: "Technological innovation" and "Brazil" in the entire context of the patent, using the "Full Text" filter. The definition of these words as key to the research came from the statistical object present in the innovation pillar of the ranking, which necessarily starts from the premises of public policies for innovation without confusing it with patents per se and the geographical delimitation of the research. In addition to those, the filters "Patents published in (patent authorities)", BrasilBR in the "Numbers, dates and country" field, and the filter "63 authorities (full text only) displayed in the individual country (full text)" were used.

The Brazilian patent filing data obtained was aligned in a chronological order column chart to analyze and understand the evolution of these filings over the years. Next, the data was filtered according to the states of the federation that filed the patents and arranged in a bar chart. At this stage, it was possible to observe and understand the ranking of patents by state over the last 18 years. In order to refine the data, the team employed Price's Law of Elitism, in which the number represented the value of the elite in the area studied. Based on the interpretation of this value, an inference emerges about Brazilian patent production, which was then accumulated and compared with the data from the ranking and government platforms.

A behavioral analysis was carried out by redoing the survey and dividing the period under study into three intervals of 5 years each, which are 2004 to 2009, 2010 to 2015, and 2016 to 2021. Based on this new analysis, it was possible to tell whether the behavior of patent filings and technology contracts by state has changed over time or remained static. Innovation legislation provided us with a referential effect. This new study has provided the basis for an in-depth critique of how the nation's states encourage technological innovation and their possible advances or setbacks.

After processing and evaluating all the data using statistical tools, inferences emerged alongside conclusions about the subject at hand. In addition, it was possible to analyze

whether Price's Law of Elitism proved to be a good tool for estimating the quality and quantity of Brazilian patents after the Brazilian Innovation Law of 2004.

Results obtained

By starting from the 2021 competitiveness ranking benchmark itself, with an indication of the consistency of the states in the top ranking positions, a constant trend emerged when analyzing previous editions: the state of São Paulo remained in first place, followed by Santa Catarina in second position, the Federal District in third, and Paraná in fourth (Ranking of Competitiveness of the States, [n.d.]). In order to make a comparative analysis, the 2018 and 2019 rankings are shown in Figures 1 and 2.

Figure 1

Comparative ranking 2020/2021 (State Competitiveness Ranking, [n.d.]).

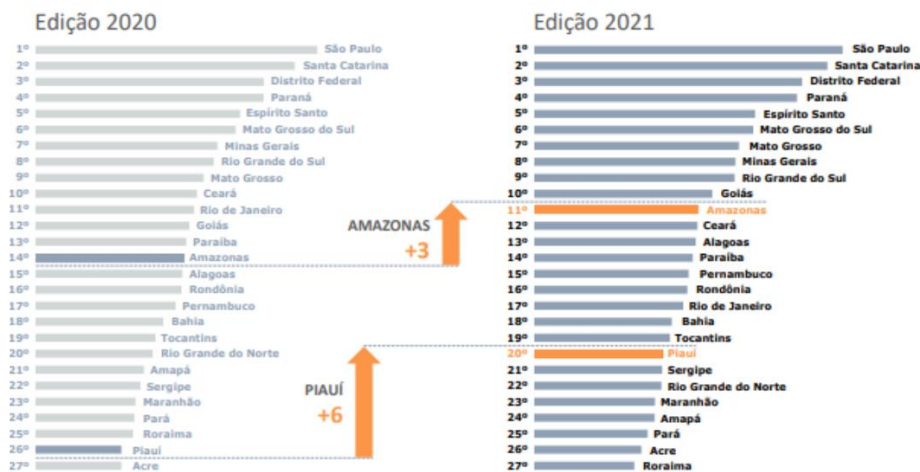


Figure 2

Comparative ranking 2018/2019 (Ranking of State Competitiveness, [n.d.]



In this exhibition, the federal units in the plan under study remain in the top four positions by observing the *ranking* between 2018 and 2021. However, the state of Rio de Janeiro fluctuated, ranking 3rd (2018), 13th (2019), 10th (2020), and 11th (2021), as did Roraima, which recorded influence in 18th (2018), 21st (2019), 25th (2020), and 27th (2021). The state of Acre is ranked (2018), 27th (2019), 27th (2020), and 6th (2021).

It is worth mentioning that within the methodology of the ranking in its overall count, the innovation pillar adds up to a score of 6.9% of the total, one of the lowest percentages. There is an increasing scale among the other sectors of society: Market Potential (7.5%); Efficiency of the Public Machine (8.1%); Human Capital (8.2%); Environmental Sustainability (8.4%); Education (11.2%); Fiscal Solidity (11.7%); Social Sustainability (12%); Infrastructure (12.6) and Public Safety (13.5%). These register according to Figure 3.

Figure 3

Weight of the Pillars/2021 (Ranking of State Competitiveness, [n.d.]



Looking at the patent indicator, the ranking measures total patent grants as one of the most significant pillars ("Invention Patent", "Utility Model", and "Certificate of Addition") concerning GDP. As Figure 4 illustrates.

Figure 4

Innovation Indicators /2021 (Ranking of State Competitiveness, [n.d.]



Regarding the patents indicator, and in parallel with the federation units observed, it is worth noting that the state with the best performance at this level was none of those listed above. The state of Rio Grande do Sul stands out, according to the data in Table 1.

Table 1

Innovation Pillar Score 2015 - 2021 (State Competitiveness Ranking, [n.d.])

Dados Normalizados		2015	2016	2017	2018	2019	2020	2021
Acre	AC	1,4	1,4	1,2	1,2	16,9	9,7	18,9
Alagoas	AL	6,8	7,7	10,2	10,0	45,6	17,2	21,9
Amazonas	AM	11,6	11,8	14,8	22,9	55,2	64,4	75,6
Amapá	AP	0,0	0,0	0,0	1,8	30,7	6,2	3,2
Bahia	BA	14,9	15,7	18,5	22,1	8,4	32,2	33,2
Ceará	CE	16,1	16,8	22,6	26,1	21,8	29,7	38,2
Distrito Federal	DF	44,7	45,4	47,1	43,8	31,9	55,3	50,1
Espírito Santo	ES	14,9	16,0	15,2	15,5	15,4	42,4	53,1
Goiás	GO	11,3	11,8	11,7	12,6	16,6	24,6	33,3
Maranhão	MA	7,9	7,6	9,5	10,0	0,0	15,3	13,8
Minas Gerais	MG	42,6	44,5	43,7	47,4	44,6	54,6	59,1
Mato Grosso do Sul	MS	22,8	23,7	29,8	24,7	46,8	77,4	46,6
Mato Grosso	MT	8,6	8,8	9,5	13,5	46,2	33,2	19,7
Pará	PA	8,6	9,5	11,1	8,1	19,3	11,0	16,7
Paraíba	PB	29,5	31,0	33,1	38,4	53,3	62,8	47,8
Pernambuco	PE	19,8	20,9	25,0	26,3	32,4	53,7	55,6
Piauí	PI	5,7	6,6	7,2	13,0	26,2	30,5	32,4
Paraná	PR	56,0	58,1	60,4	63,4	87,9	82,9	88,7
Rio de Janeiro	RJ	60,2	60,9	60,9	58,6	55,0	56,9	55,3
Rio Grande do Norte	RN	22,5	24,6	26,2	28,0	34,2	47,0	48,9
Rondônia	RO	7,0	6,7	7,1	0,0	29,7	29,1	28,4
Roraima	RR	1,0	1,0	8,6	7,4	20,6	6,4	0,0
Rio Grande do Sul	RS	75,8	77,9	75,3	75,1	93,6	92,3	100,0
Santa Catarina	SC	62,3	64,9	62,2	65,5	90,8	85,4	92,9
Sergipe	SE	10,3	12,0	12,2	15,6	26,1	35,3	32,5
São Paulo	SP	100,0	100,0	100,0	100,0	100,0	100,0	97,0
Tocantins	TO	5,3	6,1	6,2	5,9	9,6	0,0	15,6

The data presented in Table 1 display the *ranking of* the country's federal units between 2015 and 2021 in terms of the innovation pillar. It is worth highlighting the state of São Paulo, which from 2015 to 2020 has had the highest score and stable data over this period. It was only in 2021 that there was a 3% drop in the percentages, which led to the state of Rio Grande do Sul losing first place in the *ranking* in the innovation pillar. Another federative unit in the country that stands out for its performance is Santa Catarina, where, from 2015 to 2018, its scores were stable in the 62 to 65 range and a significant improvement in the *ranking* from 2019 onwards, with a 42% increase in its score in the comparison between 2018 and 2021. The Federal District has had average results over the years, shown in Table 1, with average scores in the 40 to 50 range. Paraná has also seen an increase in its results since 2015. This growth was more consistent between 2015 and 2018, with an average increase in its score of 4%. However, in 2019, this rate jumped to 39% and was corrected in 2020 with a drop of 6%. In 2021, it began to expand again, reaching its maximum score.

The state of Rio de Janeiro shows average scores throughout the period, with small drops from 2017 onwards. However, for the innovation pillar, the performance of the state of Rio de Janeiro is still well above the performance of the Federal District in this pillar. The state of Roraima performed poorly between 2015 and 2016 but performed well in 2017 and 2018. Between 2019 and 2021, the score declined in this area, reaching the point where, in 2021, it scored 0.0 as a reference. The analysis also shows that the state of Acre scored very poorly between 2015 and 2018. In 2019, it improved considerably compared to previous benchmarks. In 2020, the score was again low but still better than those recorded from 2015 to 2018, and the year 2021 recorded its highest score in the entire period.

The four best performers in the innovation pillar in 2021 are Rio Grande do Sul, São Paulo, Santa Catarina, and Paraná. The Federal District is only in 10th place. Rio de Janeiro is in 8th place, repeating its previous feat in 2020, but still far from its best position of 4th place, which it achieved between 2015 and 2017. The state of Roraima had the worst performance, ranking 27th, and the state of Acre ranked 22nd in 2021, improving on its position from 2020 when it was 24th.

Table 2

Innovation Pillar Ranking 2015 - 2021 (Ranking of State Competitiveness, [n.d.]

Posições

		2015	2016	2017	2018	2019	2020	2021
Acre	AC	25	25	26	26	22	24	22
Alagoas	AL	22	20	19	21	10	21	20
Amazonas	AM	15	17	15	13	5	6	5
Amapá	AP	27	27	27	25	15	26	26
Bahia	BA	13	14	13	14	26	16	16
Ceará	CE	12	12	12	11	19	18	14
Distrito Federal	DF	6	6	6	7	14	9	10
Espírito Santo	ES	14	13	14	16	24	13	9
Goiás	GO	16	16	17	19	23	20	15
Maranhão	MA	20	21	20	20	27	22	25
Minas Gerais	MG	7	7	7	6	11	10	6
Mato Grosso do Sul	MS	9	10	9	12	8	5	13
Mato Grosso	MT	19	19	21	17	9	15	21
Pará	PA	18	18	18	22	21	23	23
Paraíba	PB	8	8	8	8	7	7	12
Pernambuco	PE	11	11	11	10	13	11	7
Piauí	PI	23	23	23	18	17	17	18
Paraná	PR	5	5	5	4	4	4	4
Rio de Janeiro	RJ	4	4	4	5	6	8	8
Rio Grande do Norte	RN	10	9	10	9	12	12	11
Rondônia	RO	21	22	24	27	16	19	19
Roraima	RR	26	26	22	23	20	25	27
Rio Grande do Sul	RS	2	2	2	2	2	2	1
Santa Catarina	SC	3	3	3	3	3	3	3
Sergipe	SE	17	15	16	15	18	14	17
São Paulo	SP	1	1	1	1	1	1	2
Tocantins	TO	24	24	25	24	25	27	24

Concerning the states with the best ranking in this pillar of innovation, in terms of the patents indicator measured using raw data, i.e., the metric considering the number of invention patent registrations, utility models, and certificates of addition as a proportion of GDP in billions of reais, the state of Rio Grande do Sul continues to stand out in this 2021 ranking, followed by Santa Catarina, Paraná, and São Paulo. The latter state was, until then, ranked 3rd in this indicator in 2020. The Federal District is in 11th place, down four positions from the previous year. The state of Rio de Janeiro is 6th in the *ranking*, down one position from 2020. The state of Roraima is 24th in the *ranking* for this patent indicator, up two positions from the previous year. The state of Acre is 12th, a position it maintained compared to 2020.

Table 3

Innovation Pillar Ranking by patent indicator 2021 compiled from (Ranking of State Competitiveness, [n.d.]

Acre	AC	12°
Distrito Federal	DF	11°
Paraná	PR	3°
Rio de Janeiro	RJ	6°
Roraima	RR	24°
Santa Catarina	SC	2°
São Paulo	SP	4°

Based on the *ranking* data, specifically considering the patents indicator, having employed the filter in a search carried out on the *Orbit* platform, as described above, 333 technological innovation patents approved since 1980 in Brazil emerged. Given the above, a first refinement took place, where the data was extracted into Excel *software* and processed using a dynamic table with the year variable filtered from 2004 onwards. It resulted in 301 patents approved after the Brazilian Innovation Law. In other words, around 90% of innovation patents were approved after the publication of this law, which shows that public policy has indeed boosted this benchmark.

In order to gain a better understanding of the behavior of technological innovation patent approvals, the team constructed a time series graph, as shown in Figure 4. The result of the 301 patents obtained, having employed Price's Law of Elitism, was 17.

Figure 4

Time series graph of technological innovation patents from 2004 to the present day

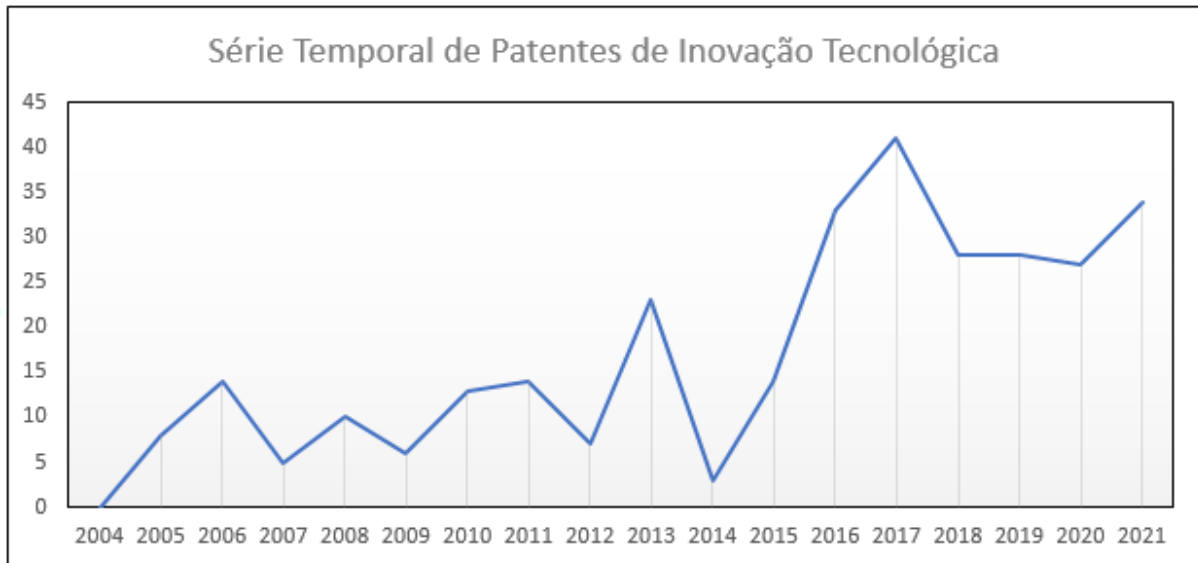
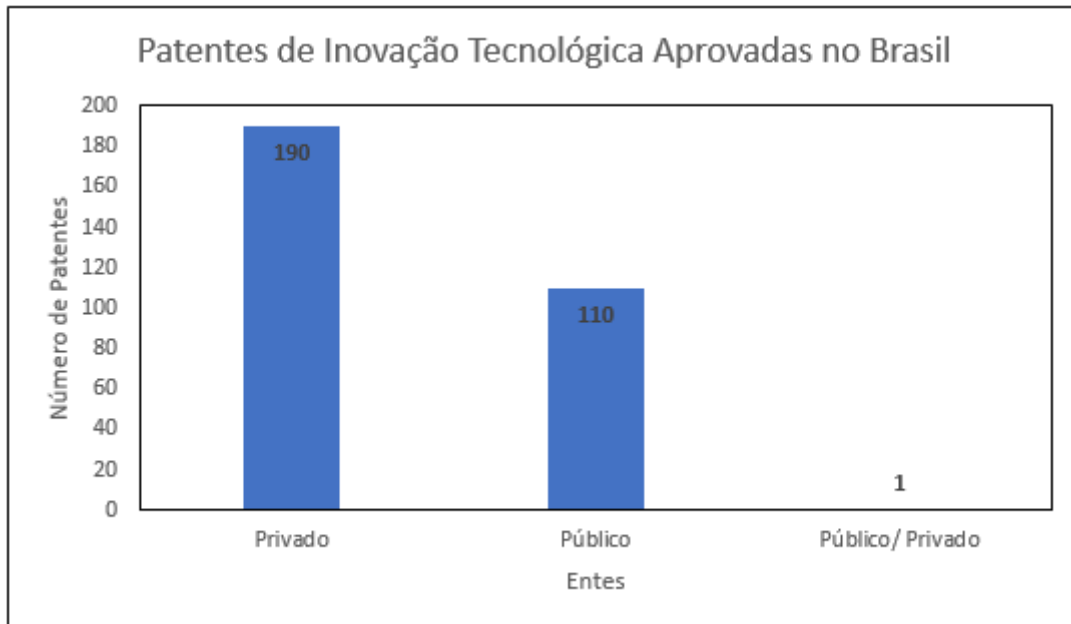


Figure 4 shows an increase in the approval of technological innovation patents from 2015 onwards, with an upward trend until 2017, a slight drop in 2018, and stagnation until 2020. It is worth noting that, of the number of patents returned after research, 110 are from public initiatives (36.5%), 190 from private initiatives (63.2%), and one from a public-private initiative (0.3%). It is because the public sector began to play a leading role from 2014 onwards, approving more technological innovation patents than the private sector in subsequent years. The important point is that almost all of these patents were filed by universities, technology centers, or research centers.

Figure 5

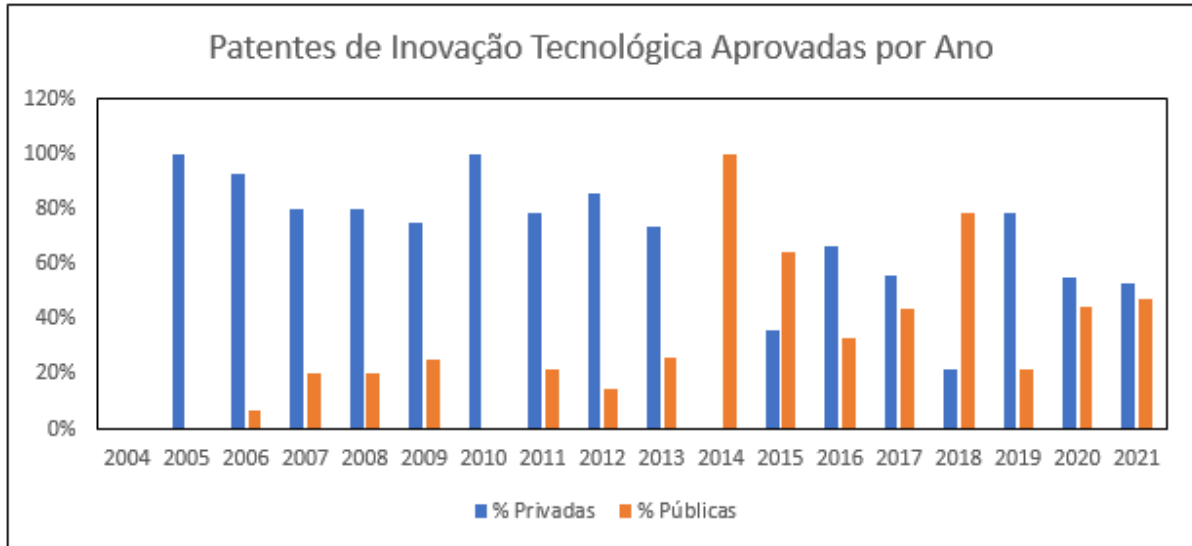
Distribution of patent approvals from 2004 to today according to the entities and their authorship



When analyzed in more depth, one infers that even with the publication of the Brazilian Innovation Law of 2004, public entities had timid participation in the first decade of the 2000s, and only from the second half of the 2010s did their participation become more effective. Figure 5 compares the number of patents for technological innovation authored by public bodies versus those authored by the private sector annually. It shows that in 2014, 100% of approvals came from the public sector. It is important to note that only three patents were applied for that year, with the lowest number of filings since 2005.

Figure 6

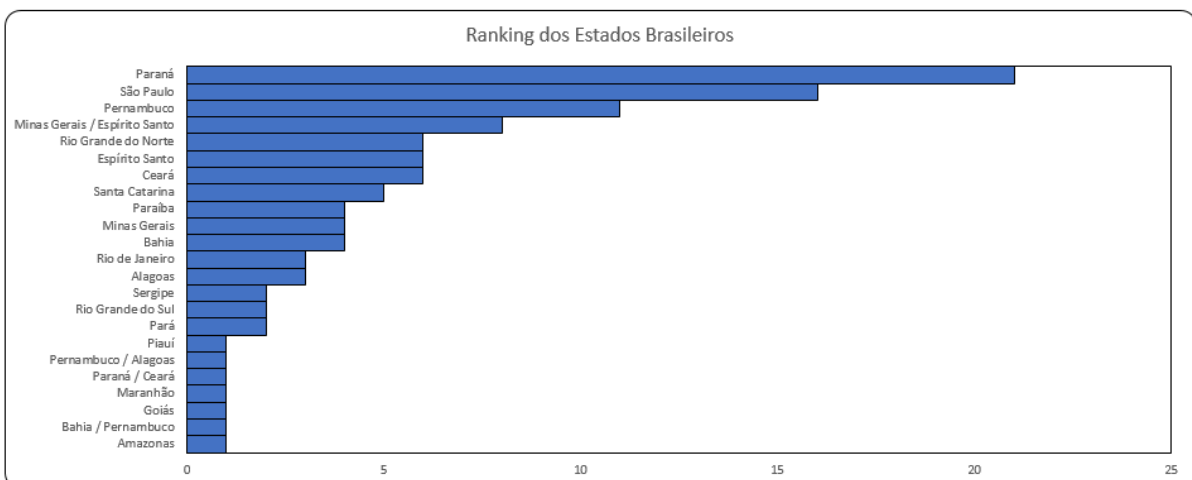
Column chart of technological innovation patents approved by year from 2004 to the present day



The 110 patents filed by public entities were aligned in a column chart with the ranking by state of the federation, as shown in Figure 6. As displayed, Paraná has the highest number of approved patents, followed by São Paulo and Pernambuco. Most of these patents belong to public universities. In this scenario, the absence of the Federal District, Roraima, and Acre is worth mentioning.

Figure 7

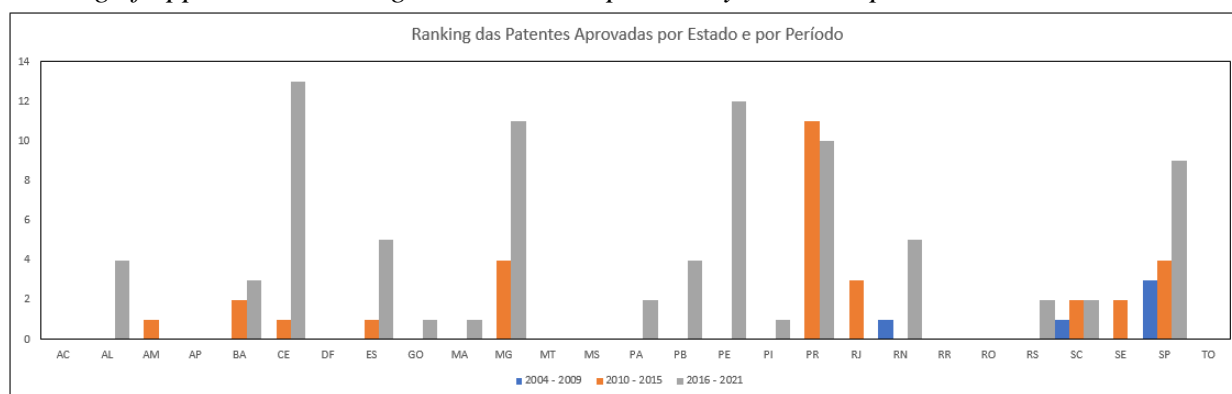
Ranking of approved patents by Brazilian state



There has been an increase in the production of work by public bodies since 2015, with a significant percentage in 2018. Over the years of the study, the South and Southeast regions were consistent in their patent approvals. The Northeast, on the other hand, began timidly in 2009 and gained prominence in 2016. In the region, the state of Pernambuco stands out with 12 patent approvals, followed by Rio Grande do Norte and Ceará with six each.

Figure 8

Ranking of approved technological innovation patents by state and period



Based on the analysis in Figure 8, the Northeast region states are more productive between 2016 and 2021, with Alagoas, Ceará, Pernambuco, and Rio Grande do Norte standing out. The only state with growing production is São Paulo, with a 33% increase between 2010 and 2015 compared to 2004 and 2009 and a 125% increase in the final period compared to the intermediate period. Except for Rio de Janeiro, all the states in the Southeast region show an increase in patent approvals, which is close to the current intermediate ranking position for Rio de Janeiro and the ranking position for the state of São Paulo. The country's southern region stands out in patent filings, especially the state of Paraná. Furthermore, except for Rio Grande do Sul, the states in this region show continuity in their data over the studied periods, demonstrating the perspective present in the ranking. Finally, the Central-West and Northern regions still have incipient production with few patents filed. More specifically, in the Northern region, the states of Roraima and Acre prove the estimate presented in the ranking.

In this respect, applying Price's Law of Elitism results in a value of 10 for the 110 patents approved by public entities. By analyzing this result, the state of Paraná again stands out, as it maintains an average of 10 publications per studied period, as illustrated in Figure 7.

Given these results, one may say that this federation unit is resilient in its patent production, given the perenniality in the number of its filings and the value corroborated by Price's Law of Elitism.

In terms of regulations, it is worth considering that of the federal units that are the subject of this research, the state of São Paulo promulgated Decree No. 62.817 of September 4, 2017, regulating the Innovation Laws - State Policy for Science, Technology, and Innovation (Decree No. 62.817, of September 4, 2017, [n.d.]). The state of Santa Catarina has Law 14.328 of 2008 (Lei No. 14.328, of January 15, 2008, [n.d.]), which provides incentives for scientific and technological research and innovation in the productive environment at the federation unit level and adopts other measures - this normative instrument was regulated by Decree 2.372 of June 9, 2009 (DEC-002372, [n.d.]).

The Federal District published Law 6.620 of June 10, 2020 (Lei no 6620 DE 10/06/2020, [s.d.]), which provides for mechanisms, measures, and projects to stimulate scientific development, research, scientific and technological qualification, innovation, and the creative economy in the Federal District. It also creates the District Policy for Science, Technology, and Innovation, establishes guidelines for the Master Plan for Science, Technology, and Innovation of the Human, Smart, Sustainable, and Creative City, and makes other provisions. The state of Paraná, ranked fourth in terms of competitiveness, published Law No. 20,541 of April 20, 2021 (Lei No. 20541 DE 20/04/2021 - State - Paraná - LegisWeb, [s.d.]), which sets out a public policy to encourage innovation, research, and scientific and technological development, the promotion of new businesses, and integration between the public and private sectors in a productive environment in the state of Paraná. This law incorporates the updates made by the New Federal Legal Framework (L13243, [n.d.]), as previously in force was Law 17.314 of September 24, 2012 (Ordinary Law 17.314 2012 of Paraná PR, [n.d.]), known as the state innovation law of the state of Paraná.

As for the four best-placed countries in the overall competitiveness ranking, all have their legislation. The Federal District was the last to incorporate local legislation to develop and foster science, technology, and innovation.

The other states covered in this research include the state of Rio de Janeiro, with Law No. 5361, of December 29, 2008 (Lei 5361/08 | Lei no 5361, de 29 de dezembro de 2008, Governo do Estado do Rio de Janeiro, [s.d.]), which provides incentives for innovation and scientific and technological research in the productive environment within the scope of the

state of Rio de Janeiro, and makes other provisions. This legislation is regulated by Decree No. 42.302 of February 12, 2010 (Decree No. 42.302 of February 12, 2010, [n.d.]). At the time of this research, the state of Rio de Janeiro was discussing a new state legal framework represented by Bill No. 278/2019 ("RJ State Innovation Framework Bill (ALERJ)", [n.d.]), now converted into state law in 2022 (Law No. 9809 DE 22/07/2022, [n.d.]).

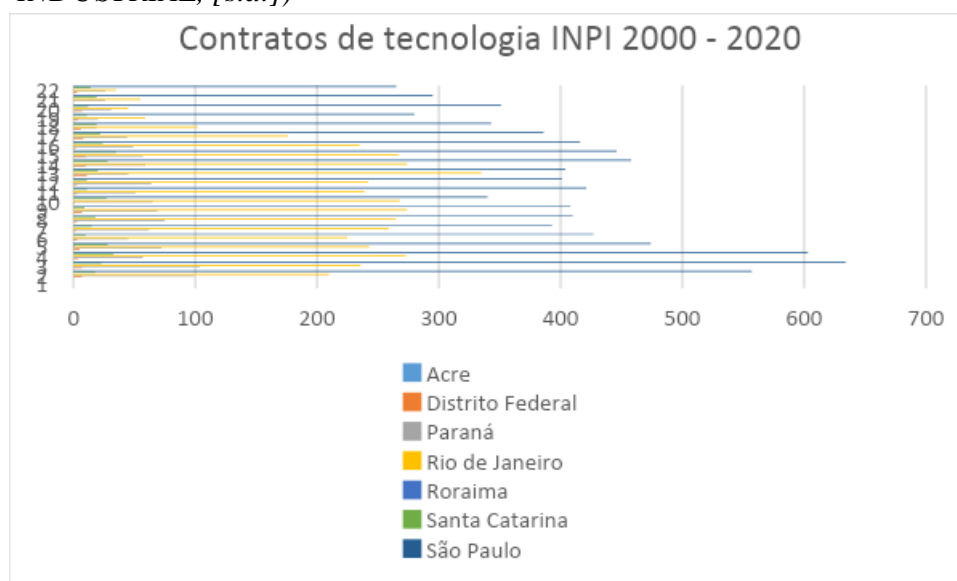
The states of Roraima and Acre fail to have a legal framework for innovation instituted in their territories. However, the state of Acre instituted Law No. 3,387 of June 21, 2018 (Government of the State of Acre, [s.d.]), which institutes the State System of Science, Technology, and Innovation of Acre (SisTec-AC), creates the State Program for Promotion of Research, Development, and Innovation (PROINOVA), and amends the Scientific and Technological Development Fund - FDCT.

Based on the above, the states with their legal frameworks defined have competitive advantages over other regions that do not have regulations. This study considers that they have legislation already aligned with Federal Law 13.243/16, or even those that do not have this law aligned with the new legal framework.

In this sense, looking at the indicators presented, we can reaffirm the scenario presented so far when we analyze the number of technology contracts produced, with the registration duly launched by the National Institute of Intellectual Property.

Figure 9

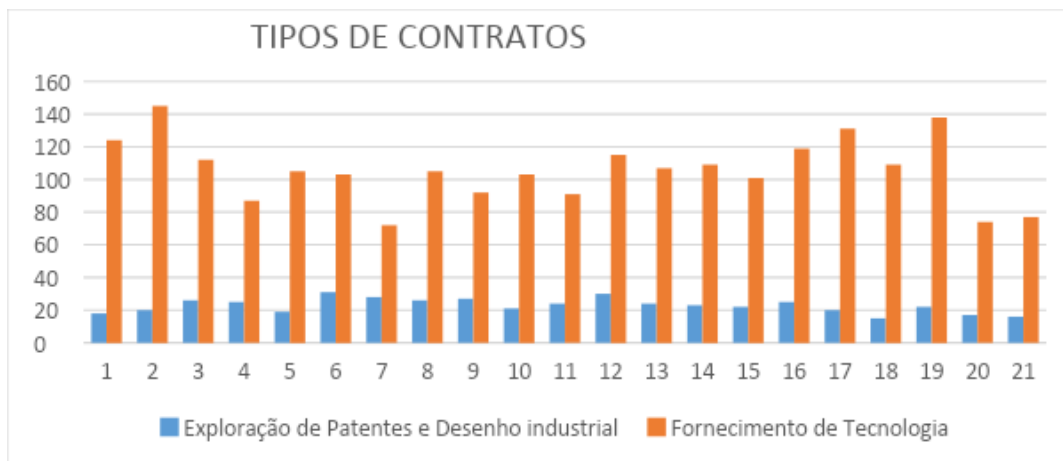
Prepared by the authors, source: (*INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL, [s.d.]*)



The graph, shown in Figure 9, confirms what the competitiveness *ranking* showed concerning the federative units included in this research, with the latter being more relevant in the overall *ranking*, such as Roraima and Acre. The statistics provided by the INPI compose a segment by type of contract, in which case the items considered are: (1) Exploitation of Patents and Industrial Designs; (2) Supply of Technology; (3) Franchising; (4) Technical Assistance Services and (5) Use of Trademarks. This research concentrated the data on the exploitation of patents and industrial designs and the technology supply.

Figure 10

Prepared by the authors, source: (INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL, [s.d.]



Based on the data collected, 479 contracts involving the exploitation of patents and industrial designs and 2,088 technology supply contracts have been registered with the INPI. This statistic, however, considers not only national registrations but also those originating from foreign companies interested in our domestic market. Nevertheless, based on the data presented above on national patent statistics by *Orbit*, the information is parallel; they complement each other, demonstrating that there is still a long way to go if regional discrepancies are to be minimized. It will enable states to compete on more equal terms, not just in the innovation pillar but in all the others.

The results obtained contributed to the initial analysis of the progress of technological initiatives in Brazil, thus understanding that the promotion of Public Innovation Policies contributed to the development of ideas and initiatives in the sector. Interestingly, the data

used in the analysis is associated with the regions that received the most government incentives. This research also observed that after the enactment of the Legal Framework, there were more ventures in this area of knowledge, indicating that regions that already have their public policy in place have more opportunities for promotion and consequent development.

Final considerations

The objectives proposed in this work have been fully achieved. Concerning the first objective, there was a correlation between the public policies developed by the states and the federation as necessary tools for developing initiatives linked to the pillar independent of whether they are of a patent nature. Moreover, there is a great influence on the patent protection part of this framework, which becomes clear when we look at the top of the list. The dichotomy with the federation units in the intermediate zone and at the bottom of the ranking further ratifies the proposed premise.

In this sense, in relation to the other sections of the objective, as in the first case and comparison, it is clear that the ranking corroborates with the states, whether in the intermediate zone or at the bottom of the list, in the last positions. It shows the reflection of public policies for innovation, combined with the necessary patent protection and the purposes of contracts for technology transfer.

It is worth mentioning that the methodology chosen included the preparation of a critical and statistical analysis, precisely in order to compare it with what the ranking prescribes and thus conclude what is needed from these cases in order to make a more assertive and, why not say it, efficient contribution to reducing regional discrepancies.

Thus, we have identified that after the creation of legislation linked to this pillar, or even revisions to existing legislation, the number of patents filed by public institutions increases proportionally, and the states' positions in the *ranking* follow this trend. It corroborates the need for a scenario of improvement for national competitiveness externally and for the federal units to have a more uniform and more significant competitiveness scenario.

Thus, one can infer relevant facts about the South and Southeast regional dominance in light of the *ranking* of patent filings and public policies in the innovation pillar. As far as the Southeast is concerned, the state of São Paulo stands out from the rest. The dominance of this federal unit in the pillar in question is evident when one critically analyzes the results

shown in Table 1. It is because, for six consecutive years, the state ranked the highest score.

For clarity, the study focused on the top four states in this general ranking: São Paulo, Santa Catarina, the Federal District, and Paraná, and aimed to observe their activities and metrics in the innovation pillar, specifically patents. At the same time, data on the state of Rio de Janeiro, in the middle position, and those last in the ranking, Roraima and Acre, were considered. In this way, it was possible to understand the discrepancies in patent protection, agreement volume with technology contracts, and the promotion and development of innovation in these regions.

Another important point to mention is that the states in the South have shown a growing improvement in their performance and are now competing with São Paulo for first place in the *ranking*. It is significant compared to the innovation-related patent filings researched on the *Orbit* platform. The critical analysis of the results shows similar behavior for patent filings and public policies in the innovation pillar, given that both Paraná and Santa Catarina state laws relate to the current federal law. In addition, it corroborates that the Southern region, with its policies linked to the legal framework for innovation, has shown consistent growth in its intellectual productions linked to the same thematic segment. Price's Elitism Law was a very valuable tool in this thesis. Paraná was the state that showed the best performance in filing patents related to innovation. This good performance appeared in all the scenarios studied.

Although the Northeast region has seen a more pronounced increase in innovation-related patent filings since the second decade of this century, its public policies in the innovation pillar are still very incipient. This fact is elucidated in this article when it comes to ranking the competitiveness of the states.

The North has the highest number of worst positions in the *ranking*, and the states of Acre and Roraima are in the last two positions in 2021, respectively. As it is a less developed region compared to the South and Southeast, the North still needs more public policies that bring this geographical area closer to the legal framework and foster technological innovation. As such, this region has potential for growth in the innovation pillar, given that a critical analysis of the *ranking* shows that the pillar is being explored in an embryonic way in these places, according to their occupation.

The separation of powers, being a dogma, gives states the freedom to take measures related to their regions without interference from the Union so that each one considers its

idiosyncrasies (Bonavides, 2013). Through the research, it becomes clear that it is possible to set local development targets in these states, as in the case study for innovation.

The necessary follow-up to this work is to monitor the *ranking*, identifying its variations, public policies, and advances in development and patent protection. One of the factors for future research is the unfolding of competitiveness in this environment at a local level, i.e., in the municipalities, as well as the broad variation, observing Brazil's performance in global rankings, consolidating how development at a local and regional level affects Brazil's development in this competitive environment.

Finally, we understand that the individual evaluation of each federal unit as a statistical point is the basis for the proposed examples. Regarding competitiveness, it should be more fruitfully studied so that technical and legal solutions can be effectively proposed to help build a local innovative scenario. Furthermore, the subject of innovation is mentioned in our federal constitution (Constitution of the Federative Republic of Brazil of 1988, [n.d.]) concerning competencies in articles 23 and 24. It clarifies the need for all federal entities to be committed and relevant to these ends.

AUTHORS' CONTRIBUTIONS

Contribution	SBG	BSL	ETAf	MMP
Contextualization	X	X	---	---
Methodology	X	X	---	---
Software	---	---	---	---
Validation	X	X	---	---
Formal analysis	X	X	---	---
Investigation	X	X	---	---
Resources	X	X	---	---
Data curation	X	X	---	---
Original	X	X	---	---
Revision and editing	X	X	X	X
Viewing	X	X	---	---
Supervision	X	X	X	X
Project management	X	X	---	---
Obtaining funding	-----	-----	---	---

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