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WOMEN AT CNPQ – AN ANALYSIS OF POSSIBLE MECHANISMS OF GENDER INEQUALITY IN FEDERAL FUNDING FOR ST&I

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Abstract: This work detected the presence of patterns of gender inequality when studying the financing provided by the main science funding agency in Brazil, the National Council for Scientific and Technological Development (CNPq). It was found that the absolute numbers of funding for women increased over time, but there is evidence of the presence of patterns of gender inequality in the form of underfunding of the value of research projects, especially in larger ones, and in the form of lower presence in leadership positions. It is clear that such patterns can be perpetuated by inequality in the distribution of genders among those most responsible for evaluating projects (Productivity Fellows).
Keywords: sexual discrimination, gender equality, women in science, evaluation of public policies, women in STEM, CNPQ.

INTRODUCTION

One of the main tools for long-term social improvement is public investment policy in education. Psacharopoulos & Patrinos (2018) estimate the economic return on this investment at more than 8% per year, in addition to finding that the return on female education is greater than that on men, that it is even greater in developing countries and that it is probably underestimated. However, patterns of gender inequality continue to present obstacles to students reaching their full potential.

If we consider just a single factor, gender remains the one that is most important in determining choices in school, employment, industry placement, salary, training opportunities received and taken advantage of, promotions, pension, and so on (LI et al., 2022). According to the United Nations, women represent 33.3% of all researchers, 12% as members of national science academies, 22% in cutting-edge areas such as artificial intelligence, tend to have shorter careers, with lower salaries, with lower representation and receive fewer promotions (International Day of Women and Girls in Science, United Nations, [n. d.]).

In the same sense, Coe et al. (2019) indicate the existence of a pervasive, persistent and harmful culture of harassment that limits the participation and advancement of women in science, technology, engineering and mathematics (STEM) and indicate that there must be a change in the culture and organizational climate to combat the fact.

If existing, such patterns of gender inequality would be an affront to the principle of equality of the Brazilian Federal Constitution of 1988 (BRAZIL, 1988). The Constitution, in its first article, brings the dignity of the human person as its foundation and in its 3rd article as a fundamental objective to reduce social inequalities, without prejudice based on sex, among others. Finally, article 5, considered a permanent clause, supports gender equality:

> Article 5: Everyone is equal before the law, without distinction of any kind, guaranteeing Brazilians and foreigners residing in the country the inviolability of the right to life, liberty, equality, security and property, under the following terms:
>
> I -men and women are equal in rights and obligations, under the terms of this Constitution; (...)
>
> XLI - the law will punish any discrimination that violates fundamental rights and freedoms; (BRAZIL, 1988)

For Coe et al. (2019), the only way to make progress in resolving the cultural problem of sexual discrimination permanently is through cultural change. For this to occur, the first step is to highlight the existence of discriminatory culture, and then promote voluntary and normative forms of cultural change (COE et al., 2019). The analysis that is carried out is that of equity and has the purpose of answering social questions such as positive or negative

effects on minority groups, as well as which social groups are benefiting and which are bearing the costs of the policy or instrument evaluated (SILVA, 2015).

CNPq is the Brazilian body responsible for "fostering scientific, technological and innovation research and promoting the training of qualified human resources for research, in all areas of knowledge" (CNPq, 2020). Therefore, of the federal bodies, the CNPq is the one that can best highlight the presence of patterns of gender inequality in research funding.

This research analyzed the possible presence of patterns of gender inequality, through an equity analysis at CNPq. After this introduction and brief introduction to the CNPq, it is specified how the data were collected and the first data on the presence of women in the CNPq are introduced. Financing is studied by range of values and areas of knowledge, to then promote the study of financing for research projects (APQ) and Productivity Grants (PQ grants), since the latter are the main leaders in the choice of financing. Finally, we present a conclusion.

THE CNPQ

The National Council for Scientific and Technological Development (CNPq) was created on January 15, 1951, by Law number: 1,310, and is considered one of the most solid institutions in the area of scientific and technological research among developing countries. The CNPq has "the purpose of promoting and stimulating the development of scientific and technological research in any field of knowledge" and "is a legal entity directly and immediately subordinate to the President of the Republic, will have its headquarters in the Federal Capital and will enjoy technical-scientific, administrative autonomy and financial, under the terms of this law" (Law nº 1,310). Although the law reports it directly to the President of the Republic, since the publication of Decree nº 91,146, of March 15, 1985, the CNPq has been linked to the Ministry of Science and Technology (MCTI). An important distinction is observed between the roles of CNPq and MCTI. While the first promotes science in the country, encouraging the formation of laboratories and the carrying out of scientific research through financing provided directly to researchers, the second establishes the ST&I policy in Brazil and promotes financing to institutions and large centers. The CNPq budget is around just over one billion reais annually, representing 0.04% of public spending.

Despite the relatively small budget compared to total public spending, the CNPq plays an important role in Brazilian science. The CNPq operates mainly by granting two types of financing, Scholarships and Grants, although its budget also comprises the administrative cost of the body, tax exemptions on imports of products intended for CT&I, among other minor items.

DATA COLLECTION

The data for this equity analysis were obtained through the CNPq open data portal, publicly available at http://dadosabertos.cnpq.br. The spreadsheets presented present the following data: Reference Year, Process, Beneficiary, Development Line, Modality, Category/Level, Call Name, CNPq Program, Large Area, Area, Subarea, Origin Institution, Origin UF Acronym, Origin Country, Destination Institution, Destination Institution Acronym, Macro Institution Acronym, Destination City, Destination UF Acronym, Destination Country, Amount Paid.

The tables for the years 2020 and 2021 were requested by this author and sent by the agency. The spreadsheets were downloaded and imported into the Postgree SQL relational database, which allowed several derived tables

to be assembled using the SQL programming language. These were imported into a spreadsheet and graphs generated.

It is observed, however, that in the imported spreadsheets there is no information about Sex or Race. Despite this, the spreadsheets contain the beneficiary's full name, so the gender can be deduced from that. To this end, a table was provided with the full names of more than seven million people, with gender information included by the user. This spreadsheet was taken from Lattes himself, so no error is expected. An SQL code was generated to compare the names of the two spreadsheets, attaching information about gender to the spreadsheets on the CNPq portal.

Throughout this text, "Women" refers to people who declared themselves to be Female, "People" to the total number of people without distinction of sex and "Men" to people who declared themselves to be "Male". Therefore, this study does not seek to address gender issues, treated here as a synonym for sex, since what is usually declared is the sex at birth.

DELTA

To study the issue, it is useful to calculate how much each gender receives, on average, per funded project. To do this, the Delta will be calculated by dividing the percentage of the amount received by women with twice the percentage of women benefiting (Equation 1). This concept of Delta will be repeated in several analyses, which is why it is detailed here.

$$Delta = \frac{\%\ of\ the\ amount\ received\ by\ women}{2 * \%\ Women\ benefited} = \frac{43\%}{108\%} \cong 0{,}40$$

Equation 1 - Elasticity

The application of Delta in this study derives from a study by Corak (2020) in which he proposes an elasticity measure to compare equity mobility between generations. Elasticity is an economics concept that measures the responsiveness of one variable to changes in another variable. Delta is, therefore, a measure of elasticity, consisting of a division of percentages (GREENLAW et al., 2017, section 5.1). In this study, we are using a factor of 2 more in the denominator, present only to facilitate visualization in the graphs that will be shown. Thus, an elasticity less than 0.5 indicates an inelastic relationship, elastic if greater than 0.5 and unitary if equal to 0.5.

In this example, Delta can be interpreted as, on a scale of 0 to 100, the share of resources that each person receives if the proportion financed between men and women is taken into consideration. As an example, above the Delta value is 40%, that is, women get a 40% share of the resources on average per project (Delta value) while men get 60% of this average. This means that women, on average, received per project only 80% of the resources that men received (double Delta), or that men receive 125% of what women receive ($0{,}8^{-1}$).

Thus, the greater the distance of Delta from its axis (0.5 or 50%), the greater the tendency towards inequality. It can be noted, therefore, that a Delta of 0.40 between the amount paid to women and the number of women who obtained financing is a possible indicator of the presence of patterns of gender inequality, as the financing granted to women is, on average, only 80% of that granted to men.

THE WOMAN AT CNPQ

Over the years, the CNPq has adopted a series of measures with the aim of combating any discriminatory culture against women. Among the measures found are the promotion of exclusive calls for the participation of women (Girls in Science, Future Scientists), extension of scholarships due to childbirth and/or adoption, inclusion in the Maternity Leave Lattes and encouragement of judgment criteria that favor women in cases of birth and/or adoption.

Furthermore, the CNPq has launched

criteria and calls that favor the presence of women (just as an example, Call number: 23/2022, InovaNióbio, highlights the presence of women in the research team).

According to the Brazilian Census carried out by IBGE, Brazil has a predominance of women, accounting for 51% of the Brazilian population. At the beginning of 2022, the Lattes Curriculum had 7,427,277 records, with women representing 70% of the registrations made. If we only consider resumes updated from 2020, we have 1,630,326 women and 916,105 men registered, so that women continue to predominate with 64% of registrations. If we check the proportion of women and men benefiting from any CNPq actions, we have a proportion of 54% women. However, when we check the amount granted to both genders, we see that women receive only 43% of the agency's resources.

FINANCING TO WOMEN OVER THE YEARS

To monitor the trend of existence, increase or decrease in inequality patterns, we separated the percentage of women's participation in terms of beneficiaries of the actions and participation in the resources raised, obtaining Figure 2.

In the figure, the lowest Delta value is 39% in 2007, that is, women get a 39% share of the resources on average per project (Delta value) while men get 61% of this average (women, on average, received by project only 78% of the resources that men received).

As for the percentage of women benefiting and the amount financed to women, to maintain equity, each line in the graph above must approach the value of 51% (IBGE sense). It is observed that the number of women benefiting increased from 2002 to 2021, rising from 45% to 53% and, therefore, indicating a strong tendency towards the elimination of any pattern of gender inequality.

The analysis of the financed value, or Delta, indicates the opposite. Eliminating the year 2021 from the analysis, to eliminate possible effects of the COVID-19 pandemic, we have that only 45% of resources were allocated to women, with Delta being just 0.44 in 2019. The Delta value indicates that Even in 2019, women received, on average, 14% less than men in each financing provided. Following the graph, it can be seen that from 2008 onwards, Delta got closer and closer to its axis of 0.5, but this approach ended in 2015, remaining almost linear from that date onwards or even showing a tendency to increase. of the distance from Delta to the axis.

Therefore, it can be concluded that, despite there being a reduction in any pattern of gender inequality in relation to the number of concessions to women, there is a pattern of gender inequality in relation to the amount paid on average per project and that this pattern is, since 2015, without any tendency towards improvement (the year 2021 was discarded, as it visually represents an inflection point, is an outlier and possible presence of bias due to the COVID-19 Pandemic).

WOMEN AT CNPQ BY VALUE RANGE

To analyze any mechanism of discrimination in more depth, we also need to analyze whether this occurs with high-value or low-value concessions. This way, we grouped the amounts granted by range and calculated the percentage of resources granted to women. The ranges were chosen to approximately represent the variation with which CNPq finances its actions and sought to be distributed according to the various financing carried out, such as, for example, in the range [0 – 10,000[which mainly consists of small financing such as Scientific Initiation scholarships for undergraduates (IC scholarships). Thus, carrying out the analysis,

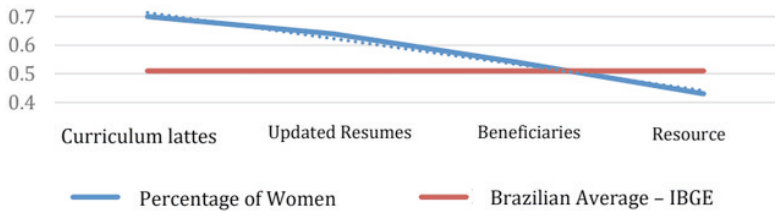

Figure 1: Percentage of Women in Science

Source: own authorship based on the open data portal (CNPq, 2022)

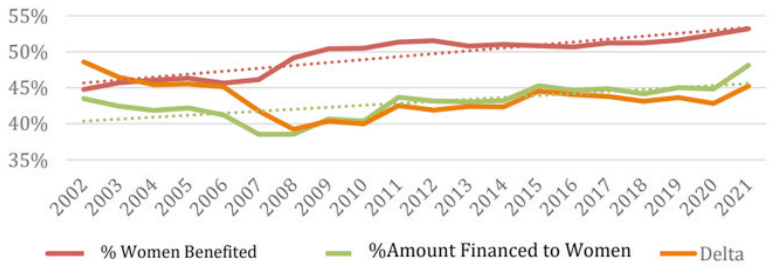

Figure 2: Participation of Women in CNPq Actions over time

Source: own authorship based on the open data portal (CNPq, 2022)

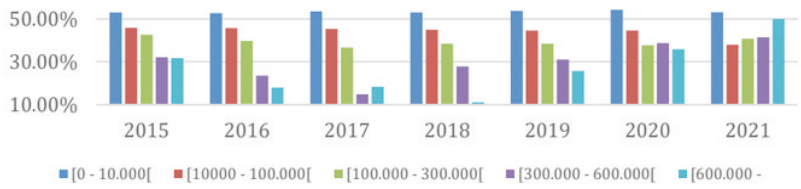

Figure 3: Percentage of Women included in the CNPq, by Value Range

Source: own authorship based on the open data portal (CNPq, 2022)

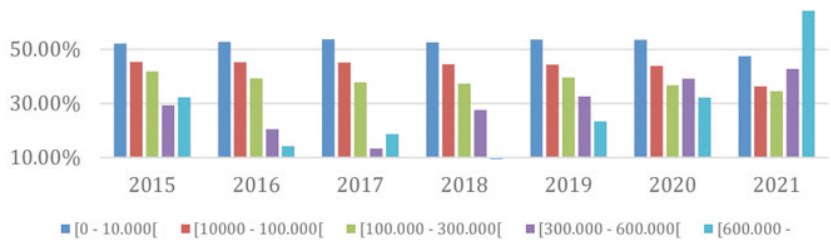

Figure 4: Percentage of Resources Granted to Women at CNPq, by value range

Source: own authorship based on the open data portal (CNPq, 2022)

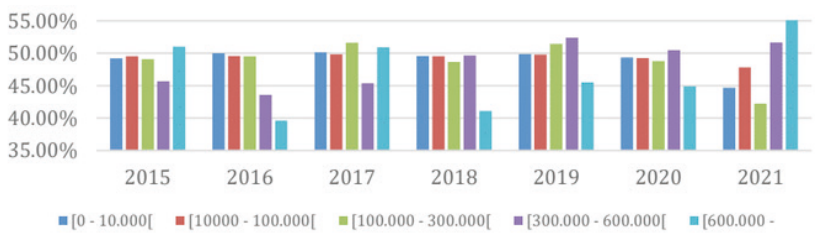

Figure 5: Delta, by range of values

Source: own authorship based on the open data portal (CNPq, 2022)

we have the following graph:

We can observe that, except in the first range, women were less frequently covered by financing in a systematic and continuous manner over time. It is also observed that, in general, although more women than men benefit in total, they received a greater number of financing only in the first range of values. Furthermore, we observe a tendency for this difference to be even more pronounced as the value of the bands increases.

If we do a similar analysis for the amount financed to women, we obtain the following graph:

Again, except for the first range, women received fewer resources than men, in all value ranges (the year 2021 was excluded). The graph follows, in a certain way, the previous one (Figure 3), making it necessary to analyze the Delta:

Removing the last value range for the year 2021 from the analysis, as it is an atypical point and occurred during the COVID-19 Pandemic, Delta is observed very close to the 0.5 axis (unit), with only slight tendency to be below this line. The exception normally occurs in high value projects (R$ 300,000.00 or more). Thus, it is observed that, for small projects and grants, there are apparently no mechanisms of inequality, but that these are concentrated in large projects, meaning that women receive, on average, fewer resources per project than men.

Thus, there is a double effect: women receive more small financing and less large ones. Furthermore, when they receive large financing (R$300,000.00 or more), they tend to receive a smaller share of it than men.

WOMEN AT CNPQ BY AREA OF KNOWLEDGE

At CNPq, areas of knowledge are divided into Large Areas, Areas and Sub-areas. The Major Areas are: Agricultural Sciences, Biological Sciences, Health Sciences, Exact and Earth Sciences, Human Sciences, Applied Social Sciences, Engineering, Linguistics, Literature and Arts and Technologies, with each Major Area having its Areas and Sub-Areas. This way, it is possible to study the presence of patterns of gender inequality in each Large Area, when making a comparison across these areas.

As already seen, the area of science, technology, engineering and mathematics (STEM) requires special attention, as it is historically recognized as being discriminatory against women. On the other hand, there is evidence that the opposite occurs for the human and health areas (GARCÍA-PEÑALVO et al., 2022). This way, we compared the number of concessions to women, in each Major Area of Knowledge:

Firstly, we can observe, from the graph above, that delta is inelastic (less than 0.5) in all areas, except Engineering, where the participation of women is only 42%, so that there is an apparent disadvantage to women in all areas. areas. Furthermore, two extremes can be seen: Health Sciences, with 70% of women's participation, and Exact and Earth Sciences, with 36% of women's participation.

For a better understanding, we separated only these two Large Areas and plotted the data for each Area:

Thus, in the areas of health, we can observe a female predominance, both in the number of concessions and in the amount received, except for the area of Physical Education. The exact opposite occurs for the areas of Exact and Earth Sciences, in which there is a clear male predominance, except for Oceanography and Chemistry, where there is a certain equity.

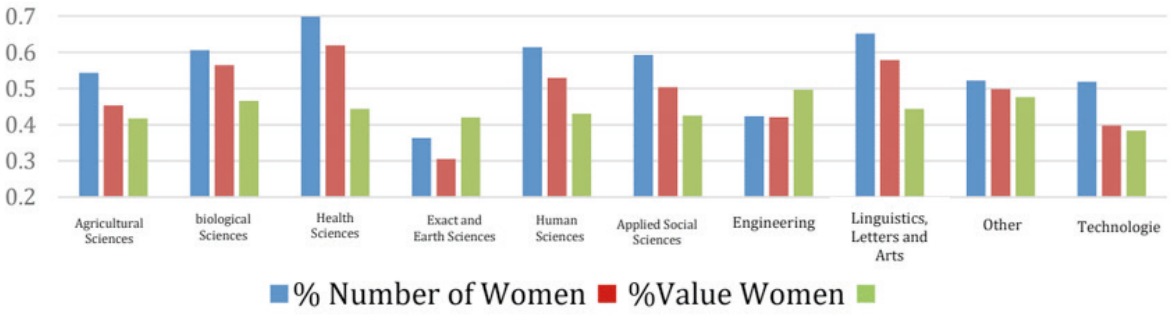

Figure 6: Women at CNPq by Area - 2021

Source: own authorship based on the open data portal (CNPq, 2022)

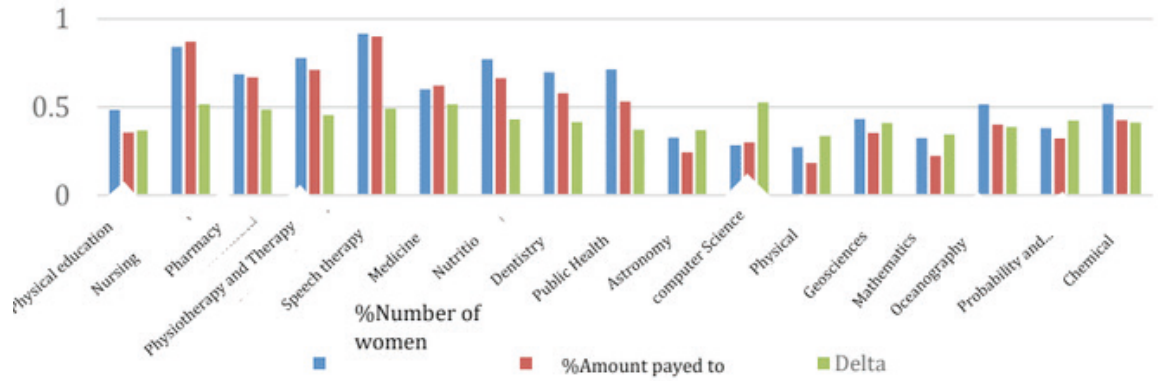

Figure 7: Participation of Women - Health and Exact Sciences - 2021

Source: own authorship based on the open data portal (CNPq, 2022)

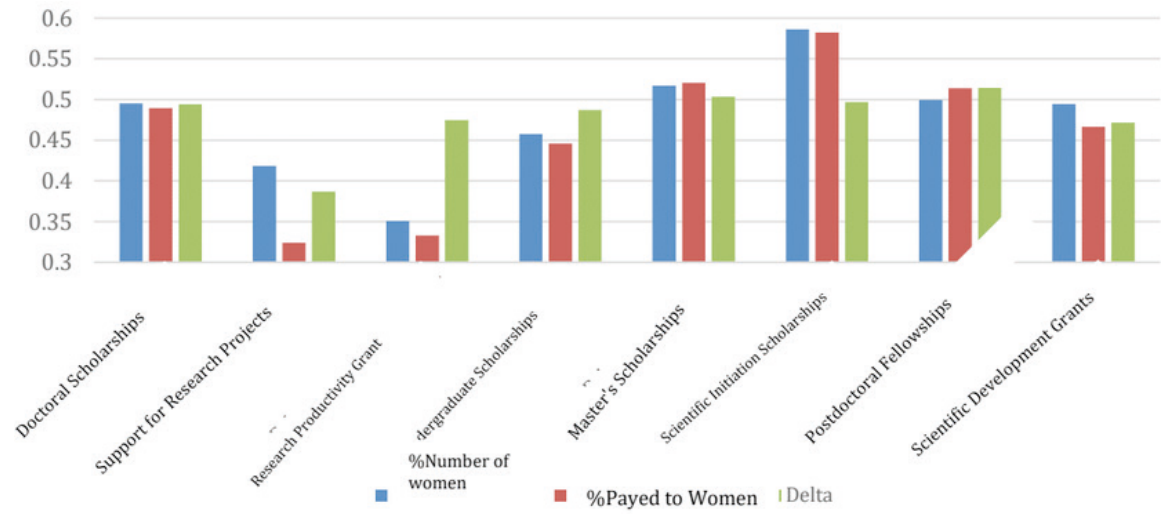

Figure 8: Participation of Women in CNPq, by Development Line - 2002 to 2021

Source: own authorship based on the open data portal (CNPq, 2022)

Furthermore, we observed Delta less than 0.5 in all areas, both Health, Exact and Earth, except for Medicine and Computer Science. However, in Computer Science we have a strong male presence.

PRESENCE OF WOMEN BY DEVELOPMENT LINE

Development lines are internal divisions of the CNPq that indicate different forms of financing. We have, as examples of lines, Undergraduate, Master's and Doctorate Scholarships, Support for Research Projects (APQ), among others. Therefore, it may be useful to analyze the funding lines to check whether there are mechanisms concentrated in one or another form of concession.

The analysis indicates that Doctoral, Master's and Post-Doctoral Scholarships are, as a rule, well distributed. There is a slight male predominance in Technological Development Scholarships (DTI, last group in the graph) and in Undergraduate Scholarships. However, the imbalance in Support for Research Projects (APQ) and Research Productivity Grants (PQ) is clear and strong. Therefore, a detailed analysis of these two modalities is necessary.

SUPPORT FOR RESEARCH PROJECTS (APQ)

APQ represents financing for research projects and, in addition to possibly grants, comprises the Costing and Capital items. Just as an example, the call with the highest financed value of the APQ line was the "Edital MCT/CNPq 02/2006 – Universal", with the total amount paid of R$ 127,835,754.00. This way, APQ represents one of the main tools for fulfilling the CNPq's institutional mission and is the second line of research that received the most funding, being responsible for 19% of the organization's expenses.

It is noted that the participation of women in APQ at CNPq is practically constant over time and approximately equal to 40% in recent years. Although slightly rising, the percentage of resources distributed to women rose from 30% to 35%, just 5% over 14 years, so that Delta never exceeded 45%.

PRODUCTIVITY SCHOLARSHIPS

The Productivity Grant (PQ) is "Aimed at researchers who stand out among their peers, valuing their scientific production according to normative criteria, established by the CNPq, and specific ones, by the CNPq Advisory Committees (CAs)" (CNPq Portal - RN-028 /2015). In this context, the CNPq PQ scholarship becomes a process of recognition from its peers and, therefore, a "sign of inter-recognition in the field, which places certain agents at the top of the academic hierarchy, and can be considered an important element of distinction" (OLIVEIRA et al., 2022).

PQ fellows are therefore considered an elite among Brazilian researchers and level 1 fellows would be the elite of this elite. Therefore, the presence of patterns of gender inequality among PQ fellows contributes to the maintenance of this culture throughout the CNPq:

> It is worth noting that the agents who accumulate the most accumulated capital in a given field [level 1A productivity scholarship holders] are also those with the greatest capacity to "deform" the order of the field, operating actively in determining the "rules of the game", tending to from orthodox positions that aim to maintain their positions of power. In the case of PQ fellows, this position becomes even more evident considering that only those at level 1, who are nominated by the academic community, can form advisory committees, thus having a more effective ability to change the rules of the game (OLIVEIRA et al., 2022, pages 192 and 193).

At CNPq, only 35% of PQ scholarships granted are to women with no tendency

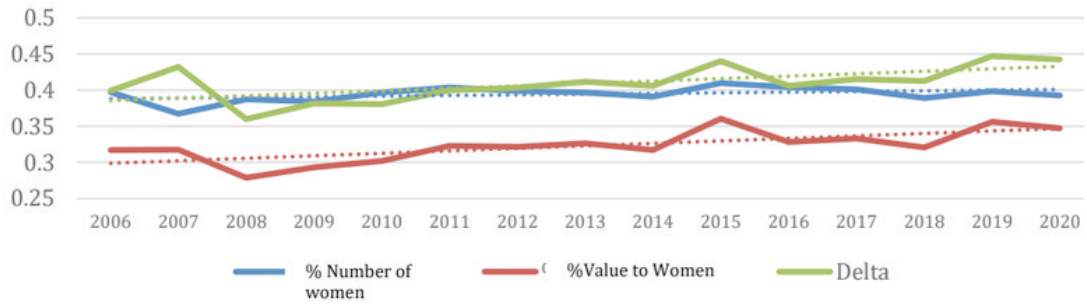

Figure 9: Participation of Women in APQ at CNPq, per year.

Source: own authorship based on the open data portal (CNPq, 2022)

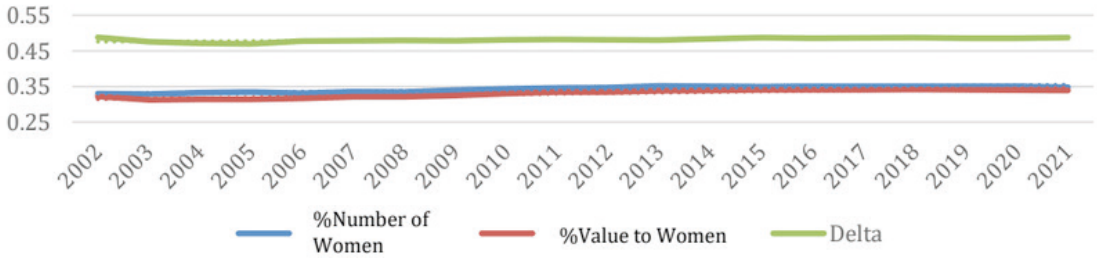

Figure 10: CNPq - Women and Scholarships Productivity per year

Source: own authorship based on the open data portal (CNPq, 2022)

towards gradual improvement over time. A more detailed study reveals that the proportion of level 1 PQ grants is even less equitable (OLIVEIRA et al., 2021).

CONCLUSION

The study made it possible to compare the financing carried out by CNPq from several different points of view. The growing number of concessions to women, which surpassed the 51% line, indicates a more equal distribution of concessions by the CNPq. There is an equal (or even predominant) female presence at the base (low value processes and grants in general, except PQ).

However, the growing increase in the number of women financed is not accompanied by a corresponding increase in the total amount financed per project: there is a tendency for women to receive fewer resources than men, especially where leadership is required (high-value projects, APQ and Productivity Grants). Thus, as said by Coe et al. (2019), there is evidence of a pervasive, persistent and harmful culture of harassment that limits the participation and advancement of women. However, it was also found that this culture is not limited to STEM areas, since women receive fewer resources (on average per project) than men, in almost all areas.

Coe et al. (2019) reinforces that there must be a change in culture and organizational climate to combat inequality. Since the advisory committees form the main advisory body of the CNPq and since they are mainly formed by Productivity Fellows, these are mainly those responsible for choosing which research projects will or will not be approved and for choosing the amount to be financed. Thus, the presence of patterns of gender inequality in Productivity Scholarships tends to lead to the perpetuation of these same patterns in the CNPq as a whole.

Thus, the first step towards reducing discriminatory mechanisms would be to correct equity in the body's main advisory body

(Productivity Fellows), which in itself could correct another point of strong divergence, funding for research projects (APQ), mainly in the higher value ranges. For Coe et al. (2019), inclusive leadership is necessary for institutional change. This change in leadership can be achieved through voluntary or legislative instruments. Among the voluntary instruments we would have voluntary goals and political activism. Of the three proposed methods, quota was the least preferred and voluntary targets, as well as public pressure and political activism, were considered most efficient. Despite this, if the instruments fail, quotas can be applied and studies in South Africa indicate that it is an efficient method in promoting gender equality (COE et al., 2019).

Finally, we noticed equal distribution between men and women, in terms of the number of financings carried out (or even favoring women). Therefore, any attitude directed towards the STEM area, in order to encourage greater female participation, must be accompanied by a policy to encourage male participation in the areas of health, biological, social and humanities.

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