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Young Women Researchers: Are your times competitive for the Public Financing System?

Investigadoras jóvenes: ¿Son tus tiempos competitivos para el sistema de financiamiento público?

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Abstract: The objective of this research is to identify the characteristics of young graduates, who apply for public funds to initiate scientific research in different areas of knowledge and the factors that affect their allocation. Public statistics were used, applying hierarchical cluster analysis methods and the Heckman model. Three profiles were identified. Two profiles of researchers (54.3%) with and without doctoral scholarships that manage to enter the system, and a third profile (45.7%) with doctoral scholarships that does not enter the system. All these profiles have gender gaps. On average, women who enter the financing system take, almost three years and the longer time it takes to obtain their doctoral degree negatively influences their integration. It is concluded that the scientific development of men and women takes different times, a fact that should be considered in future policy designs if the competitive model continues.

Key words: scientific career, scientific public policies, gender biases, insertion research, Chile.

Resumen: El objetivo de esta investigación es identificar las características de los y las jóvenes graduados que aplican a fondos públicos de inicio a la investigación científica en las distintas áreas del conocimiento y los factores que afectan su asignación. Se utilizaron estadísticas públicas, aplicándoles métodos de análisis de conglomeración jerárquico y el modelo Heckman. Se identificaron tres perfiles: dos de investigadores/as (54,3%) con y sin beca doctoral que logran insertarse en el sistema, y un tercer perfil (45,7%) con beca doctoral que no se inserta. La totalidad de dichos perfiles presenta brechas por sexo. Las mujeres que se insertan en el sistema de financiamiento demoran, en promedio, casi tres años, y el mayor tiempo en obtener su grado doctoral influye negativamente en su

inserción. Se concluye que el desarrollo científico de hombres y mujeres tiene distintos tiempos, hecho que debiera considerarse en futuros diseños de políticas si el modelo competitivo continúa.

Palabras clave: carrera científica, políticas públicas científicas, sesgos de género, inserción en investigación, Chile.

Introduction[1]

Science policy and technological development aim to improve competitiveness, economic growth, and development in various countries (Nerad, 2011). However, these policies and strategies have led to participation gaps between men and women, particularly with regards to accessing public funding for research. This gap is crucial for scientific career progression and evaluation. Differences in funding success rates between genders in research may trigger a vicious cycle in which reduced funding leads to lower scientific productivity. Furthermore, this can result in less competitive funding applications (European Commission, 2021). Such policies align with a neoliberal approach adopted by various nations, exacerbating the inequalities and gender gaps within competitive processes (Morley, 2016).

Like in other countries, science policy in Chile is based on the paradigm of the knowledge economy (Souza *et al*., 2019). The primary objective is the formation of human capital via a significant increase in scholarships granted for graduate studies at both national and international levels (González and Jiménez, 2014). Moreover, public funds for research are also being provided competitively at an individual level, as well as to universities and research centers (ANID, 2022b). However, the policy for human capital formation did not include modeling labor market conditions for graduate fellows (González and Jiménez, 2014; Chiappa and Muñoz, 2015), let alone addressing it from a gender perspective.

Although European statistics recognize that 48.1% of women obtained their PhD degree in 2018, there persists a low level of female participation in many academic fields, including STEM (Science, Technology, Engineering, and Mathematics) at all stages of the scientific

1 This article was made possible by the data provided by the Budget Directorate (DIPRES) of the Ministry of Finance of Chile, derived from the Evaluation of Government Programs (EPG) for Researcher Integration conducted by the National Agency for Research and Development (ANID) of the Ministry of Science, Technology, Knowledge, and Innovation (CTCI) of Chile in 2022.

career. Additionally, there are gender biases in accessing research funding (European Commission, 2021). A comparable scenario is observed in Chile, where 43% of females earn a doctoral degree. Moreover, when taking into account solely STEM disciplines, 37% of that aggregate are women (Chilean Ministry of Science and Technology, 2023). This divide is widening in the process of integrating into the research funding system (Chilean Ministry of Science and Technology, 2022a). Gender biases exist in the assessment of applications that are not directly associated with conventional indicators of scientific productivity (Wijnen *et al*., 2021).

In the 2000s, a study revealed that the participation rate of female scientists in public research funds averaged 20% (1988-2005) while their scientific productivity averaged 26% (1999-2002). Furthermore, the study identified a productivity gap for women between the ages of 30 and 40, with the females producing only half the publications as their male peers (Rebufel, 2007). Based on these findings, affirmative actions were developed and implemented in various instruments for allocating public research funds (Rebufel, 2009). At present, the disparity in female participation has been narrowing, with an average increase to 36% in female participation and 37% in scientific productivity (Ministry of Science and Technology of Chile, 2022b). It is unclear whether the decline in the gap can be entirely attributed to the affirmative actions taken to aid women who have given birth during the assessment period of a proposal's scientific productivity (Rebufel, 2009). This is due to the lack of continuous records of female researchers taking advantage of this benefit (DIPRES, 2022) and no assessment of its effectiveness (Rebufel, 2018).

Despite the above, institutional efforts to address the gaps between men and women in the National Innovation System are recognized, such as: 1) the implementation of gender roundtables, institutional funds to address gender biases and carry out actions to resolve them (InES-Gender), where 28 universities are implementing this initiative; 2) the equal awarding of doctoral and master's scholarships; 3) the application of the blind curriculum in the selection process of individual research projects (ANID, 2022b); and 4) Law no. 21.369, enacted on September 15, 2021, which regulates sexual harassment, violence and gender discrimination in higher education (Biblioteca Nacional del Congreso de Chile, 2021), achieved through the efforts of feminist movements in

academia. The effects of the results of all these initiatives can only be evaluated in the medium term.

In an effort to bridge gender gaps in research participation, various factors hindering the inclusion of women and men in the system have been identified in the international literature. The study proposes a methodology to identify factors that manifest from the start of a scientific career. This involves cross-referencing data on young PhD graduates with public fund awards for research initiation. Everyone will be isolated using a unique ID and segregated by sex.

This intersection offers the opportunity to analyze the defining traits of the young individuals who receive or are denied access to the funds that facilitate the onset of their scientific careers. It also aims to identify the factors that impact their integration into this system. The present inquiry is solely quantitative and pertains exclusively to the management of public policy. It does not take into account gender imbalances and inherent biases present within Higher Education Institutions (HEIs), as discussed by various authors on a national and international level (Baeza and Lamadrid, 2019; Jabbaz *et al*., 2019; Orellana, 2020; Eren, 2020; Guzmán-Valenzuela *et al*., 2023). However, it is acknowledged that these biases directly affect the number of applications women scientists submit to these funds annually.

Theoretical Framework

The concept of gender is understood as a cultural construction that is not inherent to the biological sex with which the subject is born. The cultural construction results from how the subject is configured within his or her society, i.e., how he or she is socialized, how he or she is constructed according to his or her belonging to a society and what role he or she has to fulfill in it. It is argued that "being a woman" or adopting a "feminine gender identity" is not necessarily derived from the biological sex of being female. As such, it would be illegitimate to exclude women from tasks that are considered part of human endeavor.

However, why does this exclusion of women in certain human tasks occur? "Gender elaborations on women are always defined in terms of inferiority with respect to the masculine and always in a relationship of otherness where they are defined as 'the other' of them" (Osborne and Molina, 2008: 150). In other words, there is a prevailing paradigm where women are in a state of subalternity before men, in which they are "the

other" with respect to them, who are human par excellence and by default. This prevailing paradigm is patriarchy, understood as:

> The presence of a macrostructure functioning as a hegemonic system and unevenly allocating resources between genders is apparent. It is impossible to comprehend the unjust acquisition of resources by men without acknowledging the existence of the patriarchal domination system that has persisted for centuries and systematically marginalized women (Cobo, 2008: 100).

From this dominant paradigm, women in numerous and diverse domains are frequently subjected to men, leading to situations where they are deprived of the same privileges and opportunities as men based solely on their sex, which is viewed as a "disadvantage". This is due to their potential to bear children, which is considered an obstacle and distraction to their careers and productivity in general. According to the patriarchal view, women's potential for motherhood would diminish the quality of their labor force participation, leading them to be excluded from certain jobs and areas where they are fully capable of performing. This exclusion is widely recognized as a form of gender inequality:

> Social inequality based on gender refers to the confinement of women to the domestic sphere and their marginalization from the public arena, and the unfair distribution of essential social resources such as income, employment, property, health, education, physical integrity, and personal safety. This encompasses the unequal allocation of resources, workload, and economic compensation for comparable work performed by males, among other things (Lampert, 2014: 2)

In the globalized context of academia, power inequality is reflected in institutions and structures related to science (Borrell, 2015). These intra-actions manifest in horizontal and vertical segregation, as well as in the sexual division of labor. Many women are dedicated to teaching and administrative work, while men often focus on research and scientific productivity (Guzmán-Valenzuela *et al*., 2023). This stance perpetuates academic identities that hinder the success of the global research economy because it associates female academics with a role that is influenced by academic culture, which in turn impacts their work, career paths, relationships with colleagues, and salaries (Morley, 2016; Guzmán-Valenzuela *et al.,* 2023).

Then, the lack of gender equality in science is not only a problem that affects women, but also it hinders the development of a country, which is why gender equity addresses how legal frameworks and public policies should be configured to allow such equality to become

a reality. Gender equity is a means where programs must be designed to achieve equality (Lampert, 2014).

Gender-sensitive science policies in the public funding system

Examining the policies and strategies crafted to reduce the participation gaps of women in different European Union (EU) countries:

> The Commission acknowledges that obtaining research funding is vital to research careers and performance evaluation. It therefore encourages the development of initiatives to enhance gender balance through measures such as providing coverage for team members taking maternity or adoption leave and ensuring quotas for women's participation in institutional applications (European Commission, 2021: 3 and 11).

Meanwhile, in the United States, they focus on:

> Closing the gender disparities in STEM fields can be achieved by promoting gender equality and equity, fostering innovation, and utilizing the talents and resources of individuals of all genders. This would help in meeting future challenges, with a particular emphasis on women and girls (White House, 2021: 33).

Chile has implemented a National Policy on Science, Technology, Knowledge, and Innovation, as well as a National Policy on Gender Equality in Science, Technology, Knowledge, and Innovation (Ministerio CTCI de Chile, 2020 and 2021a). These policies were developed and implemented following the establishment of the Ministry of Science, Technology, Knowledge, and Innovation (MINCTCI) in 2018 (National Library of Congress of Chile, 2018). The National Gender Equality Policy aims to foster a more diverse and inclusive scientific, technological, and innovative national system. This is achieved by providing financial support for the development of scientific careers and ensuring equal opportunities, growth, and leadership for women in all social organizations that contribute to the creation, dissemination, and application of knowledge (Ministry CTCI of Chile, 2021a). However, it does not take into account the distinct roles of men and women in research institutions or the gaps that emerge in the provision of public goods and services that promote knowledge generation.

From this same approach, the MINCTCI of Chile designed a Talent Development Plan, which states the need to "expand the critical mass of researchers in R&D, linking them with challenges in Science, Technology, Knowledge and Innovation (STKI) faced by the country and its regions" (Ministry of STKI of Chile, 2021b: 50), which also

does not consider the differences between women and men researchers in different territories. For the insertion of these talents in academia, it is committed to overcome the obstacles that prevent the development of labor trajectories in CTCI topics, in order to strengthen capacities in these areas (Ministry of CTCI of Chile, 2021b), through the improvement of the already existing insertion funds and the redesign of instruments that enable emerging labor trajectories.

In this context, the Chilean scientific career model is implicit, but individuals can identify four stages based on available funding: 1) Training human capital to support the development of doctoral studies and medical specialties at both the national and international levels. 2) Providing post-doctoral funding for research conducted nationally or internationally. 3) The program offers funding for researchers to be installed in academic institutions for the purpose of conducting research. 4) The initiation to research is an instrument available to young individuals who are already part of academia and in the early stages of their scientific career (ANID, 2022a) (Table 1[2] y Figure 1). Under this model, eligible researchers can apply freely to any research instrument available. In other countries, the model follows a similar structure with an orderly scaling system that starts when the researcher attains their doctoral degree and progresses through recognized researchers[3], established researchers[4], and culminates with leading researchers[5]. Public funds are available at each stage to apply for in an organized manner (European Commission, 2021).

Scientific Productivity in Research Funding Accessibility, Disaggregated by Gender

Regarding scientific productivity, various studies observe that public resource support depends on the evaluation of research results, in addition to productivity metrics to establish the economic impact and public value of investments in R&D (Reinhart, 2009; Lane *et al*., 2015; Way *et al*., 2019). In this regard, it was found that academic publications, research, and postdoctoral citations are pivotal factors in influencing the trajectories of individuals entering academic positions, but they also reveal notable differences between men and women (Webber and

2 Figures and tables can be found in the Annex at the end of this article.

3 Doctors or equivalents who are not yet completely independent.

4 Researchers who have developed a level of independence.

5 Researchers who lead in their area of study.

González, 2018; Way *et al*., 2019). Given these differences, research funding policy contributes minimally to closing gender gaps in the allocation of public funds, both in entering the funding system and in the development of a scientific career (Lawson *et al*., 2021), as the instruments are designed under neoliberal competitive parameters (Morley, 2016), without considering the diverse characteristics of researchers as recipients of public goods and services that incentivize the generation of new knowledge.

These situations reflect that quantitative measures of scientific production have been introduced in research funding systems, as well as in the performance evaluation of scientists at the academy (Berlemann and Haucap, 2015; Morgan *et al.,* 2021). Reinhart (2009) noted that decisions of public funding agencies for basic research are linked to the future success of publication of applicants. Thus, financial support has a strong association with the impact of the event (Yan *et al*., 2018; Way *et al*., 2019).

Early research funding effectively incentivizes scientific productivity and career growth among junior researchers (Farrokhyar *et al*., 2016). However, Mendoza-Denton *et al.* (2017) discovered a significant discrepancy in publication rates between men and women, placing the latter at a disadvantage when competing for postdoctoral and faculty positions. This could result in lasting disadvantages for women, as evidenced by their lower publication rate (Hatch and Skipper, 2016). Such a disparity in scientific productivity is partially attributed to the inadequate support provided to women in their academic milieu (Jaksztat, 2017; Morgan *et a*l., 2021). In this regard, Franco *et al.* (2021) argue that the number of publications of applicants is critical for success in a grant application, suggesting that the gap between men and women in the proposals responds to the fact that they have more published articles, because they do not have the same domestic responsibilities as women in raising children. This would generate a spiral that is reproduced, because by having more publications, they are likely to be more successful in applications for new grants. For their part, Lawson *et al*. (2021) evidenced that researchers involved in administration are more likely to apply for funding and some are also more productive.

The evaluation of the Science and Technology Fund Program (Fondecyt)[6] indicates that there has been an increase in the number of publications as well as the allocation of funds for research, showing a positive and significant impact (DIPRES, 2013; Benavente *et al*., 2012). Despite the positive results, these evaluations are not disaggregated by sex. Benavente *et al.* (2012) only suggest that future revisions to the program should focus on the quality of scientific production, the evaluation of impacts on the academic career progression of researchers and on the training of doctoral students.

Based on international evidence, a study conducted by the Chilean Ministry CTCI (2022a) revealed that in the period from 2000-2019, men and women had an average of 13.4 and 7.4 accumulated publications respectively at the time of their application. Moreover, men had an average of 4 citations and women had an average of 2.4 citations during the year before applying, while the accumulated citations amounted to 31.8 for men and 17.1 for women. The rise in demand for public research funding has made the individual Fondecyt competitions increasingly competitive. Women, who have fewer publications, appear to apply at a relative disadvantage. In proportional terms, this situation aligns with that observed in the Rebufel (2007) study.

Bias factors in access to research funds, disaggregated by sex

Different studies indicate a low likelihood for female researchers at all career stages to receive funding (Bautista-Puig *et al*., 2019; Burns *et al*., 2019; Way *et al*., 2019; Wijnen *et al*., 2021). In investigating potential sources of bias in the allocation of doctoral and postdoctoral research funding, the identified variables included institutional affiliation, major field of study, level of education associated with first-generation university attendance in the family, applicant experience, gender (Bornmann and Daniel, 2005; Farrokhyar *et al*. 2016), and career stage (Van den Besselaar and Sandström, 2015). Additionally, other differentiating factors in initial funding include prior work experience, age at completion of PhD, obtaining a PhD from prestigious institutions, and having children at the time of the PhD (Vinkenburg *et al*.). 2020). Studies by Van der Lee and Ellemers (2015), Bol *et al.*

6 This fund falls administratively under ANID's Research Sub-Directorate, which was established under the auspices of the Chilean Ministry of Science, Technology, Knowledge, and Innovation (CTCI).

(2022), and Tamblyn *et al.* (2018) provide evidence of gender and scientific domain biases in evaluation processes, resulting in lower application scores for female applicants in applied sciences.

Female academics with young children may face a "motherhood penalty" in research impact-quality estimates due to limited time for research development or promotion (Morgan *et al*., 2021). Similarly, Vinkenburg *et al.* (2020) found that female researchers who have children during their first post-Ph.D. job are less likely to consistently progress in government compared to non-mother researchers. For their part, Lawson *et al*. (2021) found a certain level of self-selection in female scientists because they do not apply for funding.

Fiorentin *et al*. (2022) discovered two occurrences of the "Matilda" effect that exacerbate biases over time: 1) women face greater obstacles to initial selection than their male colleagues due to entry barriers, and 2) these barriers persist when only researchers are funded. This effect is most prevalent in fields of science, technology, engineering, and mathematics. Consequently, female researchers are required to submit a larger volume of proposals to attain equivalent grant levels as their male peers. This trend was also observed in a recent study completed in Chile (Chilean Ministry of CTCI, 2022a).

Finally, Vinkenburg *et al*. (2020) conclude that women's research careers develop differently than men's, which is observed in research funding success rates, and thus suggest reconsidering the importance of resumes and gender assumptions in selection decisions, as well as discipline for career patterns.

Objective and research questions

This research investigates the integration of young researchers into their scientific careers by examining the supply of public funds to support initial research. We analyze regulations and statistical data to describe access requirements, researcher characteristics, and factors contributing to their inclusion in the public funding system. The study's questions are as follows:

- Are the public funding measures and affirmative actions in place adequate for the inclusion of young postgraduates, particularly women?
- What are the traits of young individuals, both male and female, who seek funding opportunities to pursue a career in science?

- What are the determinants impacting the allocation of public research funding to young researchers, regardless of gender?

Research methodology

This study focuses on examining the regulations and characteristics of young graduates, categorized by gender, who apply for public research funds, and the factors that impact the distribution of these funds for scientific research. The data sources were publicly available databases detailing the distribution of major funds supporting the inclusion of young PhDs, disaggregated by gender, in higher education institutions (ANID, 2022a).

Consequently, this is a quantitative research that in order to answer the questions posed the following strategies were implemented: 1) a documentary collection and exploration of the different instruments available for the insertion of young people and their initial development in the scientific career in academia; 2) a statistical collection of graduated scholarship holders for the period 2009-2021, disaggregated by sex; and 3) a statistical collection of application and awarding of funds for doctoral studies, insertion projects and start-up in the scientific career in academia for the period 2015-2022, disaggregated by sex.

Based on the collected materials, the areas of interest in regulations were organized while taking into account the characteristics of the instruments, access requirements, and potential gender interventions. Additionally, mixed databases were utilized with statistical figures to combine information on recent graduates with various funding allocations, each researcher being identified through a unique identifier and disaggregated according to sex. The outcome of the breeding experiment underwent structuring procedures to visualize pertinent variables, utilizing references from the international literature (Bornmann and Daniel, 2005; Van den Besselaar and Sandström, 2015; Jung *et al*., 2018; Farrokhyar *et al*., 2016; Lawson *et al*., 2021) and identifying novel ones.

The aforementioned literature has identified variables relating to the year of attaining a doctoral degree, the location of the graduate program, whether public funding was obtained for the program, the duration of funding for degree attainment, and the gender of each researcher. The amount of financial awards provided by various public funds that assist in the placement of young researchers, the accreditation

duration of the university where the researcher is placed (prestige), the research location within the country's region, the academic discipline of the research area, and the process for obtaining award funds to secure the placement.

After constructing the mixed databases, we adapted the methodology employed by Hendrix (2009) and Souza *et al*. (2019) to conduct hierarchical cluster analysis. This analysis implements an exploratory multivariate analysis technique that groups variables homogeneously based on one or more shared characteristics. Ward's method was employed to minimize the square of the Euclidean distance to the cluster averages (Souza *et al*. 2019). Subsequently, this study examined the variables that contribute to the clustering of researchers into specific placement categories within the academic research funding system. Finally, a Discriminant Analysis was conducted to confirm the existence of resulting clusters. The study adhered to variables cited in international literature (Bornmann and Daniel, 2005; Van den Besselaar and Sandström, 2015; Jung et al., 2018; Farrokhyar *et al*., 2016; Lawson *et al*., 2021), the analyzed factors included: funding system insertion, gender, doctoral scholarship status, location of doctoral studies (in Chile or abroad), time needed to complete their PhD, time to receive insertion funding, field of study, length of accreditation of host institution (prestige index in Chile), insertion region, and duration of awarded projects in months.

Likewise, to ensure predictability in the analysis of other methodologies, we have opted to utilize Heckman's model (1979). This model was chosen since databases may have selection biases, as funding agencies do not fund research proposals randomly, but instead fund projects of the utmost quality and potential for producing articles with the highest citations (Materia *et al*., 2015). Also, there may be differences in allocations between disciplines, keeping in mind the emphases of scientific policies (Yan *et al*., 2018).

The Heckman model comprises two equations. The initial equation corresponds to Ordinary Least Squares (OLS), whereby the method employed by Kabo and Mashour (2017) was modified. The OLS dependent variable is the logarithm of the funding amount obtained by the grant. The second equation corresponds to a probit equation (Wooldridge, 2015), utilizing a dichotomous dependent variable indicating the inclusion or exclusion of researchers in the public research funding system. The model's independent variables were consistent

with those used in the previous analysis and cited in the literature. Additionally, the model included variables for the time of the individual's doctorate completion and the length of time it took for her to establish herself.

It is worth noting that scientific productivity variables, impact indicators, and publication citations were not taken into account in the application of these models. This is due to their endogeneity in the awarding of funds, as these factors are already incorporated in the evaluation structure of proposal selection (refer Table 1). Therefore, they cannot be considered independent with respect to the dependent variable.

Results and Discussion

Integration policies, programs, and instruments

In accordance with the National Scientific and Gender Policies and the Talent Plan, Table 1 depicts the essential traits of the research insertion tools. It is evident from the table that a doctoral degree is a prerequisite for all instruments. For the Grant to the Academy, the applicant must earn a doctoral degree within a specific timeframe. If an applicant has taken maternity leave, an additional year will be added to the timeframe. This policy is tailored towards the number of children the researcher has had during the same curricular evaluation period within which the grant proposal is submitted.

For postdoctoral and initiation funding proposals, an affirmative action policy is applied to evaluate scientific productivity (ANID, 2022b). This promotes accessibility to these funds by factoring in productivity as a percentage (ranging from 20% to 30%) of the applicant proposal evaluation rubric. It is noteworthy that beginning in 2006, these policies have been continuously applied and modified (Rebufel, 2009). However, there are no ongoing records to assess the potential impact that such action may have had on women's fund accessibility (DIPRES, 2022); only 265 women are known to have selected this benefit between 2006 and 2017 (Rebufel, 2018).

While it is acknowledged that funding is available to enhance productivity, promote future scientific leadership of young researchers (Table 1), and strengthen the field, the instrumental offer (Figure 1) falls short in terms of providing a defined escalation towards career

development, as is available in other nations (Vinkenburg *et al*., 2020; European Commission, 2021), in regard to early scientific career design. There is no particular hierarchy in practice as both men and women who recently obtained a doctoral degree can simultaneously seek funding for postdoctoral opportunities, academic appointments, or career initiation (ANID, 2022a). However, this has led to a saturation in the evaluation and administrative procedures for resource allocation in order to prevent duplication (DIPRES, 2022).

For this reason, the scientific career model remains implicit as it is discernible only through the conception and execution of public programs and tools that are fiercely competitive and geared towards newly-minted PhD-holders. These instruments provide access provisions for young women that are solely linked to the year of degree acquisition and productivity assessment during periods of gestation. However, they fail to consider other critical aspects such as time required to fulfill childcare responsibilities for children up to six years old, care for elderly family members, and recognition of other roles that women perform within the Institution of Higher Education (IES). Guzmán-Valenzuela *et al*. (2023) describe these factors in detail.

Participation in the application and allocation of funds, disaggregated by sex

From the point of view of the demand for resources in the current model, the starting point of the gap in female participation with respect to male participation in public funds is manifested from the request for support to obtain doctoral degrees to the awarding of funds for the initiation of researchers in academia (Graph 1 and Table 2), since women self-select themselves when applying for funds, taking care to comply with the requirements of the offer, especially from the doctoral scholarships (Lawson *et al*., 2021).

The findings indicate that there is an average of 59% male and 41% female applications to the various funds. The findings indicate that there is an average of 59% male and 41% female applications to the various funds. Other previously mentioned authors also contribute to this discussion. Studies by Baeza and Lamadrid (2019) and Orellana (2020) focus on these disparities in the Chilean context, while Eren (2020) examines them in the international arena. 2) The analysis shows a steady decrease in the disaggregated awarding between men and women from scholarships abroad to the awarding of the research initiation fund.

Table 2 demonstrates that the speed of decrease is slower in men than in women, indicating the presence of the leaky pipeline effect (Borrell *et al*., 2015; Eren, 2020). Some researchers refer to this phenomenon as the Matilda effect (Fiorentín *et al*., 2022; Chilean Ministry of CTCI, 2022b), which also involves women mainly participating in co-investigator roles (Rebufel, 2007).

Although it is acknowledged that the variance in women's participation initiates with the submission for doctoral study assistance, it is a reflection of various disincentives fostered within tertiary education institutions that impede young women from pursuing scientific careers (Eren, 2020). However, some Chilean public universities are addressing gender imbalances in STEM fields by implementing gender quota policies for admission to tertiary education in these types of careers (Bastarrica *et al*., 2018).

Visualization of the profiles of young scientists, disaggregated by gender

With the use of hierarchical clustering methods (Hendrix, 2009; Souza *et al*., 2019), the analysis reveals three distinct profiles (Figure 2). These clusters are labeled as follows: 1. "Scholarship recipients in the process of or completed insertion", 2. "Non-scholarship recipients in the process of or completed insertion", and 3. The result underwent verification procedures, including Fisher's discriminant function analysis, which indicated a 99.9% predictability probability of the classification coefficients for the clusters in relation to the original groups (refer to Table 3).

Table 4 displays the traits of three profiles. Cluster 1 comprises young male and female scientists who gained access to individual public funds for research initiation and account for 26.0% of the overall population studied[7]. They also represent 36.3% of the grantees financed by the Chilean State[8]. On the other hand, Cluster 3 is distinguished by its failure to attain inclusion in the system of individual public funds for research initiation. Cluster 1 comprises 45.7% of the total number of individuals and 63.7% of the grantees. Meanwhile, Cluster 2 makes up 28.3% of the sample. Although Cluster 2 did not receive scholarships funded by the Chilean State, they did secure research initiation

7 N Total: 7,857: male gender: 4,630 (58.9%) and female gender: 3,227 (41.1%).

8 N Total scholarship graduates: 5,634 unique IDs. Male gender: 57.0%; female gender: 43.0%.

funding. The number of PhD holders who did not receive state support and were unable to secure public funding, as well as whether obtaining the degree involved private effort or support from Chilean universities incentivized by HEI and PhD program accreditations granted by the Chilean National Accreditation Commission (CNA Chile), which periodically monitors and evaluates their quality, are important considerations.

In terms of distinctions between the clusters, the key difference between group 1 and group 2 lies in their receipt of financial assistance from the State for their doctoral studies. However, both groups share the ability to participate in the public financing system in their research fields, during HEI accreditation, and in their geographic regions. On average, female representation among scientists is 37.0 percent, while in engineering, it is around 5.8 percent in both clusters. In cluster 2, the participation of women in engineering is 1.8 percentage points higher than in cluster 1.

Cluster 3 consists of scholars who received scholarships for their studies, but no record was found of them being incorporated into the Chilean research start-up financing system. This group exhibits comparable characteristics to cluster 1 in terms of the location where they pursued their graduate studies and research discipline. However, they differ from cluster 1 in their duration of scholarship to achieve their degree, with cluster 3 having an average of 5.0 years, as opposedto 4.8 years for cluster 1. This group comprises 45.5% women and 55.5% men. In comparison to the other two profiles, this group has the highest number of individuals who received State-funded training.

It's worth questioning whether the fellowship selection process design is the most suitable for identifying the candidate with the strongest research inclination. Additionally, the intense competition for academic positions suggests that the current demand outweighs the supply of public resources, with an abundance of PhDs vying for limited opportunities.

Other options to which those with a recent doctoral degree could resort are: 1) to choose other funds of a more technological nature; 2) to opt directly for consolidation funds in academic research, given the freedom of application of any stage; 3) to opt for funds for science and technology-based ventures; 4) to choose a different professional development, associated with industry or public or private institutions; or 5) to be hired by consulting firms or international organizations, and

from that space to make their research contribution. These alternatives become new research questions that we intend to address later on.

From a gender perspective, Cluster 1 indicates that young researchers need an average of 2.7 years to be granted an initiation research fund. The time is slightly longer for female researchers. The minimum and maximum wait times range from 0 to 9 years for men and from 0 to 10 years for women. The results suggest that young scientists typically must apply multiple times before receiving funding, and that women tend to wait longer. It is not possible to inquire about the number of unsuccessful applications as the records are unidentified. There is no record of this time in groups 2 and 3.

Factors affecting the insertion of young people, disaggregated by sex

To generate predictive values and expand upon the existing results, we utilized the Heckman model (1979), which has been previously employed by Materia *et al.* (2015), Kabo and Mashour (2017), and Yan *et al*. (2018). The results of the Heckman model, presented in Table 5, are broken down by sex. As Kabo and Mashour (2017) argue, this model obtained a value of ρ=0.85 with a chi2=49.76 and p-value=0.0000 for males, and a value of ρ=0.93 with a chi2=81.79 and p-value=0.0000 for females. The results suggest that the Heckman model is appropriate for understanding the factors that affect the award of funds contingent on a successful proposal (Kabo and Mashour, 2017).

Upon observing the coefficients of the Heckman model, a situation similar to the one mentioned by Lawson *et al*. (2021) was discovered regarding the factors that contribute to insertion in the system. This is expressed in the logarithm of the resources awarded, which is the dependent variable. For men, statistically significant factors included the number of years since insertion (3.7%), the accreditation of the academic institution associated with the prestige of the HEI or Research Center (2.9%), the discipline of natural sciences and engineering (25.3%), the type of national grant (6.45%), and the duration of the research project in months (4.26%). However, the number of years it takes to obtain a doctorate did not show any statistical significance. Additionally, the location of the academic institution, which is given a value of 1 when located in the Metropolitan Region, had a negative impact (-5.82%).

For women, the factors that significantly contributed to insertion were: the time of insertion measured in years (4.2%), which is higher

than that of male researchers, the discipline of natural sciences and engineering (25.0%), the type of national grant (7.1%), and the months of research associated with the project (4.3%). The time required to obtain a doctorate, measured in years, had a significant negative impact on the inclusion of women, reducing it by 3.4%. Accreditation and geographical location of the academic institution were found to be insignificant factors.

The coefficients for the probit selection equation do not have a direct interpretation, as they are values that maximize the likelihood function (Kabo and Mashour, 2017). However, it can be stated that for men, the discipline coefficients have a positive contribution, while the year of PhD graduation has a negative contribution. The time of obtaining the PhD is not statistically significant. For women, the time it takes to obtain a doctorate and the year of graduation have a negative impact on their ability to enter the workforce.

When comparing the two methods of analysis, it is evident that the time factor affects the insertion of women into the system as they take longer to obtain their doctorates and receive research initiation funds. In contrast, men obtain their doctorates and enter the public funding system in a shorter time.

Conclusions

The National Science, Technology, Knowledge, and Innovation Policy, the Gender Policy, and the Talent Plan, recently designed within the framework of the creation of the Ministry of Science, Technology, Knowledge, and Innovation, are embedded in a neoliberal model. These policies and the plan aim to encourage the generation of new knowledge, promote gender equality, and strengthen the critical mass, all of which are positively valued. However, this approach does not involve the development of new strategies or instruments for implementing an articulated design. Instead, it focuses on redesigning existing strategies and instruments that have been masculinized. Affirmative actions are incorporated to reduce the access gap between men and women in public start-up funds. However, these actions have not been sufficient to reduce the participation gap between male and female researchers in the public financing system.

Female participation in public funding for research start-ups is approximately 38%, according to the Ministry of Science and

Technology of Chile (2022b). However, when analyzing funds that contribute to the independence of male and female researchers, female participation gradually decreases (see Figure 1 and Table 2), indicating the presence of *the leaky pipeline* phenomenon. This phenomenon has also been identified by other authors, including Borrell *et al.* (2015), Eren (2020), and Franco *et al*. (2021).

Public funding allocations include scientific productivity as an endogenous variable because of its relative weight in the evaluated proposal items. Currently, selection systems for women who have been mothers have become more flexible. However, the design of strategies and programs has not yet recognized that women's scientific productivity is lower than that of men, particularly in the 30-40 age range (Rebufel, 2007; Ministry of Science and Technology of Chile, 2022a). This data is essential for redesigning the requirements for applying for funds, particularly if we aim to achieve a more equitable selection process between men and women. This is especially important if the allocation model remains competitive.

From a funding perspective, the academic initiation into research for scientific careers is implicit and lacks a clear escalation in the financing system. Additionally, it fails to meet the demand for young graduates, particularly women, seeking to enter the field. The design of this system employs a competitive logic that only partially addresses the factors affecting its award. It applies affirmative actions that consider scientific productivity during the period of childcare, but it does not take into account other bias factors that may be present in higher education institutions (HEIs).

The study revealed three profiles of young doctors, regardless of gender. These profiles include those who are part of the public funding system for academic research, with or without a state grant, and postgraduate scholarship recipients who have not yet been able to establish themselves. The number of individuals who were not hired raises concerns about the fate of these human resources who were trained and funded by the state. González and Jiménez (2014), Chiappa and Muñoz (2015), and Nerad (2011) have all highlighted the issue of poor job placement at the international level.

The profiles of young researchers indicate a greater inclination towards obtaining doctoral studies at the national level rather than abroad. This tendency could lead to the creation of networks that facilitate the initial integration of young researchers in their home

country. Additionally, the profiles reveal a gender imbalance in the participation of women across various disciplines, particularly in STEM fields.

In the profiles of young researchers, variables such as the place of training, institutional accreditation, and discipline contribute to the insertion of men. These variables are tacitly incorporated into the selection processes, as confirmed by various authors, including Van den Besselaar and Sandström (2015) and Way *et al*. (2019). In addition to the characteristics mentioned above, there are other statistically significant factors that affect the allocation of resources. For instance, female researchers take longer to enter the competitive funding system compared to their male counterparts. Furthermore, the time it takes for women to obtain a doctorate also affects their ability to obtain public resources for research.

Both methods revealed that the factor of time has a direct impact on female researchers, hindering equitable access. This leads to the conclusion that the scientific development milestones achieved by women and men researchers differ in this model. These findings prompt us to consider new designs with gender equity to address these differences.

Consequently, based on the results obtained in this research, decision makers are urged to consider: 1) the design of a scientific policy oriented towards the development of a scientific career, focused on the differences between women and men researchers, which also considers the differences in the time required of each one and orders in a scalar way the funding system for start-up research; 2) a redesign of affirmative actions with a view to eliminating access barriers such as seniority in obtaining the degree, especially considering that the time of insertion in the system is longer in women; 3) a quota policy in the selection processes, as applied by various European agencies (European Commission, 2021); 4) the application of parity evaluation panels, although this requires the application of training to promote gender equality in these panels (European Commission, 2021); 5) the recognition that scientific productivity differs between men and women, and to work on this fact for the redesign of requirements in the case of continuing with a competitive model; 6) the consideration of incompatibilities to avoid duplication in the applications and not saturate the evaluation systems; 7) the management of an increase in public resources to allocate more funds for research insertion and

initiation, taking the recommendation of Yan *et al*. (2018) to focus the allocation on researchers without active financial support, instead of allocating to those with multiple financial supports; 8) the updated registry of those who avail themselves of the affirmative actions offered in the different funding instruments to evaluate their effect and eventually redesign, if this effect does not turn out to be as expected; 9) the inquiry of those PhDs (men and women) who fail to insert themselves in this system to know in what sphere they make their contribution to society; and 10) the design of professional doctoral programs that aim at a labor field other than the academy.

Finally, this research has limitations because it does not provide a narrative of young men and women about their processes of insertion in the research. It only relies on secondary information. To address this limitation, further research will be conducted, particularly on those men and women with doctoral degrees who have repeatedly applied but have not received public funds for research or insertion in a unit with academic hierarchy.

Other questions arise, such as: Are there other factors that hinder the allocation of resources? What is the employment status of the young people who have obtained funding? Have these doctors who were inserted continued to advance in this system of public funds? What level of scientific productivity is required to receive insertion funds, by discipline? All of these questions are based on the need for a scientific career design that is focused on the researcher. To achieve this, it is necessary to build a model from the state that generates order in the funding system and creates equal opportunities for men and women who have a vocation for generating new knowledge.

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Annex

Table 1

Key Features of Support Funds for the Integration of Young Chilean Researchers into Research. (Excerpt from Competition Guidelines 2022)

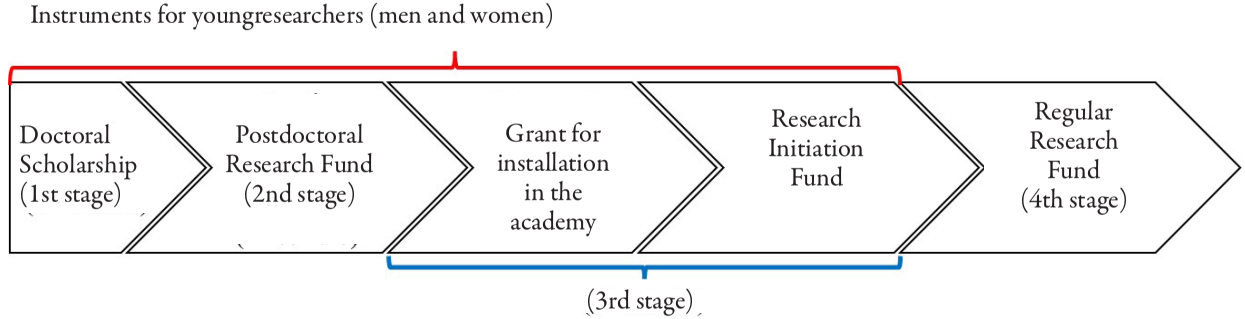
INSTRUMENT	OBJECTIVE	EVALUATION	AFFIRMATIVE ACTION
POSTDOCTORAL POSITIONS	To enhance the productivity and future scientific leadership of young scholars holding Doctoral degrees, we will execute research projects that aim to facilitate their integration into academic or other related fields. These projects will be carried out through enlisting them in established research groups that will not only promote their scientific advancement but also strengthen the groups' research capabilities with their participation.	Quality, feasibility, and scientific or technological novelty make up 80% of the proposal's criteria, while the applicant's academic and research career accounts for the remaining 20%.	Access: Female researchers can have the year of obtaining the degree prior to the one required by regulations taken into account if they have had children. Evaluation: Researchers who have had children within the last 5 years are permitted to add productivity for each child, selecting from the previous three years when reporting their scientific productivity. Likewise, researchers who have been granted the care of a child or adolescent during the same period may also enjoy this privilege.
GRANT FOR INSTALLATION IN THE ACADEMY (BEFORE: INSERTION INTO THE ACADEMY[1]	Offer a full-time academic position which must lead to promotion within a maximum of 18 months from the start of the grant.	Capacities and strengthening needs of the academic unit account for 40% of the project, while the Installation Project and trajectory of the academic to be installed make up 30% each.	For researchers who have had children within 7 years prior to the application deadline, an additional year per child will be considered in addition to the maximum time required since obtaining their doctoral or postgraduate degree in a primary or derived specialty as described above.

INSTRUMENT	OBJECTIVE	EVALUATION	AFFIRMATIVE ACTION
RESEARCH INITIATION	To promote excellence in scientific and technological research and support young researchers, research projects in all areas of knowledge will be funded. These projects must receive sponsorship from universities, professional institutes, technical training centers, and both public and private institutions within the country.	Quality, feasibility, and scientific novelty of the proposal account for 75% of the evaluation, while the applicant's academic and research career contribute 25%.	Access: The year in which female researchers obtained their degree prior to the one required by the regulations will be considered if they have had children. Evaluation: For researchers who have certified the birth of a child within the last 5 years, they will receive the benefit of adding one year of productivity for each child. In cases where researchers have certified the birth of more than one child, they may select from two years before to receive the benefit. Likewise, researchers who have been granted guardianship, care, or adoption of minors during the same period will have this privilege.

1 In 2023, no competition existed for this particular instrument.

Figure 1

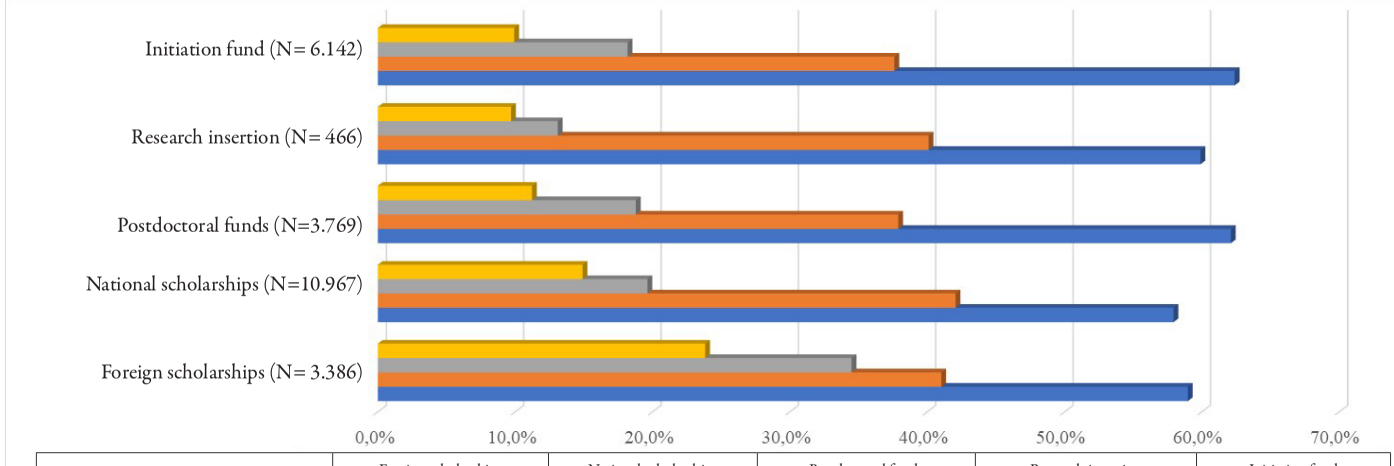
Model of Progression in the Scientific Career of Young PhDs in the Academic Environment, through the Offer of Public Research Funds (Chilean case).



Source: Author's elaboration based on information obtained in ANID (2022b).

Graph 1

Participation in Training Programs and Involvement in Research, broken down by Gender.



	Foreign scholarships (N= 3.386)	National scholarships (N=10.967)	Postdoctoral funds (N=3.769)	Research insertion (N= 466)	Initiation fund (N= 6.142)
% Adjudication women	23,8%	14,9%	11,2%	9,7%	9,9%
% Adjudication men	34,5%	19,6%	18,8%	13,1%	18,2%
% Female application	41,0%	42,1%	37,9%	40,1%	37,6%
% Men application	59,0%	57,9%	62,1%	59,9%	62,4%

Source: Author's elaboration based on information obtained from ANID (2022a).

Table 2

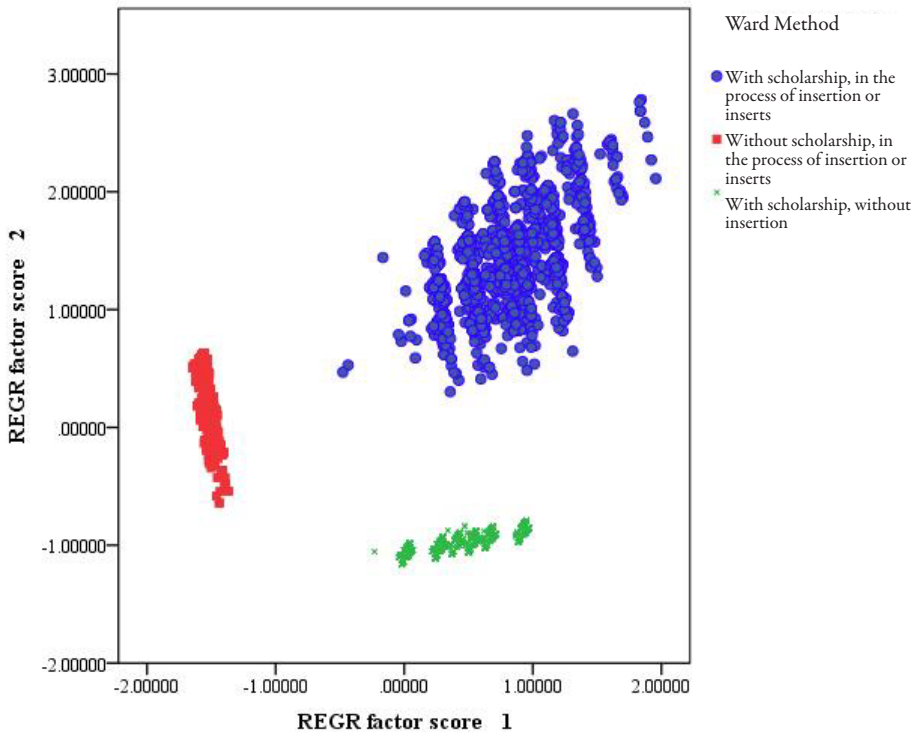
Rate of Public Resource Allocation for Young People's Research Insertion, Disaggregated by Sex.

Funding type	% Female allocation/ total female application	% Male allocation/ total male application	% Female allocation/ total allocation participation	% Male allocation/ total allocation participation,	% Female allocation/total applications	% Male allocation/ total applications
Foreign scholarship	58.1%	58.5%	40.9%	59.1%	23.8%	34.5%
National scholarship	35.4%	33.9%	43.2%	56.8%	14.9%	19.6%
Academy insertion grant	24.1%	21.9%	40.1%	59.9%	9.7%	13.1%
Postdoctoral	29.6%	30.2%	37.4%	62.6%	11.2%	18.8%
Initiation	26.4%	29.1%	35.3%	64.7%	9.9%	18.2%

Source: Author's elaboration based on information obtained from ANID (2022a).

Graph 2

Conglomeration Map of the Insertion of Young People with Doctorates in the Public Financing System



Source: Author's elaboration based on information obtained from ANID (2022a) and DIPRES (2022).

Table 3

Hierarchical Cluster Ranking Coefficients for the Insertion of Young Researchers into the Public Funding System

Variables	Ward method		
	With scholarship, in the process of insertion or inserted	Without scholarship, in the process of insertion or inserts	With scholarship without insertion
Were you included in the financing system? YES=1 No=0	10.745	15.329	1.537
What is your gender? Female=1 Male=0	2.680	1.706	3.018
Did you study with a doctoral scholarship? YES=1 NO=0	2,618.709	5.359	2,622.696
Where did you study for your doctorate degree? Chile=1 Foreign=0	7.341	1.426	9.262
How long did it take you to obtain your doctorate?	3.414	0.027	3.029
How long did it take to award an insertion fund?	15.421	1.973	1.885
What is your discipline?	0.705	1.160	0.926
How long is the accreditation period of the university where you were placed?	11.969	11.997	0.271
Is the university where you are located in the Capital Region of Chile? YES=1 NO=0	8.772	10.712	1.942
(Constant)	1,379.819	51.466	1,325.098
Fisher linear discriminant functions			

Source: Author's elaboration based on information obtained from ANID (2022a) and DIPRES (2022).

Table 4

Shows the Researcher Profile for Training and Inclusion in the Public Funding System for Research, Disaggregated by Sex

CLUSTER	1: With scholarship, in the process of insertion or inserted(26,0%)		2: Without scholarship, in the process of insertion, or inserted (28,3%)		3: With scholarship, not inserted (45,7%)	
GENDER	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
No. OBS.	1,258	787	1,417	806	1,955	1,634
TPO. WITH DOCT SCHOLARSHIP [1]	Average: 4,81 years. Minimum: 1. Maximum: 10	Average: 4,79 years. Minimum: 0 Maximum: 11	-	-	Average: 4,87 years Minimum: 0 Maximum: 11	Average: 5,09 years. Minimum: 0 Maximum: 11
PLACE OF POSTGRADUATE STUDIES	37,6% Chile; 23,9% Foreign	25,2 % Chile; 13,3% Foreign	-	-	31,3% Chile; 22,9% Foreign	27,7% Chile, 17,8% Foreign
INSERTED OR IN THE PROCESS OF INSERTION	61.5%	38.5%	63.7%	36.3%	54.5%	45.5%
TPO. INSERT [2]	Average: 2,72 years. Minimum: 0. Maximum: 9	Average: 2,87 years. Minimum: 0. Maximum: 10	-	-	-	-

CLUSTER	1: With scholarship, in the process of insertion or inserted(26,0%)		2: Without scholarship, in the process of insertion, or inserted (28,3%)		3: With scholarship, not inserted (45,7%)	
GENDER	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
DISCIPLINE [3]	29.3% Nat. Sci.; 18.6% Soc. and Hum. Sci.; 7.6% Eng. and Tech.	16.1% Nat. Sci.; 14.9% Soc. and Hum. Sci.; 3% Eng. and Tech.	26.1% Nat. Sci.; 20% Soc. and Human Sci.; 11.3% Eng. and Tech.; 6.4% Other disc.	11.9% Nat. Sci.; 14.5% Soc. and Hum. Sci.; 3.6% Eng. and Tech.	21.4% Nat. Sci.; 17.9% Soc. and Hum. Sci.; 7.6% Eng. and Tech.	15.7% Nat. Sci.; 19.2% Soc. and Human Sci.; 2.6% Eng. and Tech.; 8% Other disc.
LOCATION UNIVERSITY	28.6% Regional University; 32.8% Metropolitan Region University	16.5% Regional University; 22.1% Metropolitan Region University	29.1% Regional University; 34.6% Metropolitan Region University	15.5% Regional University; 20.7% Metropolitan Region University	-	-
ACCREDITATION	40% in accredited university between 6 to 7 years. Average: 6.05 years	25.1% in accredited university between 6 to 7 years. Average: 6.1 years	42.2% in accredited universities between 6 to 7 years. Average: 6.13 years	22.4% in accredited universities between 6 to 7 years. Average: 6.08 years	-	-

Source: Authors' own elaboration based on information obtained from ANID (2022a) and DIPRES (2022).

Table 5

Presents the Heckman Selection Model applied to the Insertion of Researchers, Disaggregated by Sex

VARIABLES	MALE				FEMALE			
	Obs.: 3.207				Obs.: 2.418			
	Log likelihood = -2175.821				Log likelihood = -1250.926			
	Wald chi2(7) = 135.12				Wald chi2(7) = 108.08			
	Prob > chi2 = 0.0000				Prob > chi2 = 0.0000			
	Coef.	z	P>z		Coef.	z	P>z	
LOG_ASSIGNED RESOURCES								
ACADEMIC INSERTION TIME	.0370821	4.65	0.000	***	.0423091	4.64	0.000	***
DOCTORATE ATTAINMENT TIME	.0113812	0.89	0.375		-.0337314	-2.01	0.044	**
DISCIPLINE (NAT_SCI_ ENG=1|OTHERS=0)	.2527846	6.67	0.000	***	.2504156	5.01	0.000	***
ACADEMIC INST. ACCREDITATION	.0290127	2.67	0.008	**	.0108343	0.86	0.389	
ACADEMIC INST. LOCATION (MET.=1|REG.=0)	-.0581756	-1.88	0.060	*	.0093862	0.26	0.796	
SCHOLARSHIP TYPE (NAT.=1|INT.=0)	.0644064	1.97	0.049	**	.070652	1.93	0.054	*
RESEARCH MONTHS	.0425983	5.87	0.000	***	.0425764	5.81	0.000	***
_cons	8,645,168	31.61	0.000	***	8,781,062	30.34	0.000	***
INSERTION (YES=1|NO=0)								
DOCTORATE ATTAINMENT TIME	.0057949	0.36	0.719		-.0562972	-2.90	0.004	**
DOCTORATE GRADUATION YEAR	-.0954712	-9.53	0.000	***	-.0940181	-8.56	0.000	***
DISCIPLINE								
ENGINEERING	.4802656	5.39	0.000	***	.6484232	5.70	0.000	***
SOC. SCIENCES	.5532734	7.35	0.000	***	.6127043	8.06	0.000	***
NAT. SCIENCES	.2811032	3.58	0.000	***	.3641593	4.12	0.000	***
_cons	1,913,666	9.48	0.000	***	1884115	8.52	0.000	***
rho	.8541262				.9358534			
LR test of ind. eqns. (rho=0)	chi2(1)=49.76 Prob>chi2=0.0000				chi2(1)=81.79 Prob>chi2=0.0000			

***p<0,01;**p<0,05; *p<0,1

Source: Authors' own elaboration based on information obtained from ANID (2022a) and DIPRES (2022).

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