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The Matilda Effect in STEM Disciplines in Argentina

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Inter-American Development Bank
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Abstract*

This study explores the presence of gender bias in public grants for science and technology (S&T) activities—known as the Matilda effect—in STEM disciplines (science, technology, engineering, and mathematics) in Argentina. The empirical analysis is based on the Scientific and Technological Research Projects program (PICT in Spanish) for the period 2003–2015 and found that female researchers are less likely to be awarded the first time they apply for a research grant than their male counterparts (-6.2 percentage points, or p.p.). Even for follow-on applications after the first one, without having been awarded before, female researchers remain less likely to be awarded (-3.8 p.p.). However, the probability of being recurrently awarded—known as the Matthew effect—is the same for both male and female researchers. This paper concludes that female researchers in STEM suffer disadvantages in the allocation of public funds to finance their research projects. Only those female researchers that overcome the initial barriers and obtain their first grant can take advantage, as their male counterparts do, of the Matthew effect that makes them more likely to obtain further awards. These results suggest the need for policies aiming at reducing the initial gender gap in accessing public grants for female researchers in STEM.

JEL Codes: N46, 031
Keywords: Matthew effect, Matilda effect, gender bias, STEM, S&T grants

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1. Introduction

This paper focuses on a subject that has progressively gained worldwide attention: the gender gap in science and technology (S&T). Just 28 percent of researchers are female, measured as average values for the world (UNESCO, 2017). Among Latin American countries, this value ranges from 50–60 percent in the case of Uruguay, Argentina, Guatemala, and Venezuela, and drops to 30–35 percent in the case of Peru, Mexico, and Chile (Albornoz et al., 2018). Besides this aggregated gap, there is the “horizontal” segregation. As regards the disciplines, women tend to specialize in Humanities and Social Sciences disciplines and men in Science, Technology, Engineering, and Mathematics (STEM) (López-Bassols et al., 2018). At the international level, women represent less than 30 percent of STEM positions on S&T even when they compose 35 percent of undergraduate students enrolled in STEM degrees (UNESCO, 2017). Women’s lower participation in STEM fields is a problem for development in the sense that it reduces the diversity and breadth of the themes approached by S&T.

Argentina is among the countries with the highest levels of female participation in S&T with 53 percent (Albornoz et al., 2018). However, while 17 percent of all male researchers reach the highest level in their academic career, this value drops to 11 percent for women (D’Onofrio and Tignino, 2018; Albornoz et al., 2018), suggesting the existence of a glass ceiling or vertical segregation (D’Onofrio and Tignino, 2018). Additionally, women are less likely to be awarded research grants to fund S&T activities (Fiorentin et al., 2018) and also receive lower levels of recognition by peers (Fiorentin, Pereira, and Suarez, 2020). Only 38 percent of women researchers are working in STEM fields, while among men the participation is close to 50 percent (SiCyTAR, 2020).

In this context, the objective of this study is to provide evidence about the presence and extension of the gender bias in being awarded a public grant for S&T activity in STEM fields[1] in Argentina. To analyze the presence of different manifestations of the Matilda effect, the focus is on the process of allocation of grants,. The Matilda effect refers to the lower probability of women to be awarded than men (Rossiter, 1993). The Matilda effect is, to some extent, the application of the gender perspective to the Matthew effect (Merton, 1968), which refers to the positive impact of reputation on the probability of being awarded public funds for S&T. This study analyzes different patterns of persistence by gender, assuming the Matthew effect as a possible source of the Matilda effect.

[1] This paper follows the definition of STEM fields provided by Statistics Canada (https://www.statcan.gc.ca/). This definition includes Mathematics, Sciences, Engineering, and Computer and Information Sciences (CIS).

The contribution of this study is threefold. First, it questions gender equality at the aggregate level by closely analyzing the allocation of Argentine S&T funds in STEM fields considering gender. Second, it analyzes the existence of gender gaps in developing economies—where empirical evidence tends to be scarcer—and, finally, it explores three sources of the Matilda effect, provides evidence, and solves that contradiction. The study examines whether there are different patterns of accessing S&T funds by gender, distinguishing in terms of the first application, first award, and—once awarded—recurrence.

The S&T policy under study is the Scientific and Technological Research Projects (PICT in Spanish) program in Argentina, a line of funding of the Argentine National Fund for Scientific and Technological Research (FONCyT). PICT is the main public source of funding for S&T projects in Argentina. The period under analysis is 2003–2015, which coincides with an increase in the level of financial resources (Suarez and Fiorentin, 2018). PICT's information was expanded by adding bibliometric information retrieved from the Scopus repository. The integration of the information resulted in an unbalanced panel database. Each data point represents a researcher-year of application observation—6,429 researchers and 11,291 observations—containing information related to their academic productivity and achievements, and bibliographical characteristics.

Results confirm the gender gap in Argentine S&T funding in the case of STEM projects. We find that female researchers are less likely to be awarded the first time they apply to PICT than their male counterparts (-6.2 percentage points, or p.p.), and especially in the case of senior researchers compared to young ones (-8 p.p. vs. -5.1 respectively). Even for follow-on applications after the first one, female researchers that had not been previously awarded remain less likely to be awarded (-3.8 p.p.). However, the probability of being recurrently awarded—the Matthew effect—is the same for both male and female researchers. These results show that the Matilda effect is verified in the first award, whether it is the first time women apply or not. Once female researchers in STEM are part of the "awarded group" they can take advantage of the Matthew effect—that is, they become as likely as men to be awarded again. However, appropriate caution is necessary to interpret our empirical findings due to the limited number of observations.

The rest of the paper is organized as follows. The theoretical framework and research questions are presented in Section 2. The PICT program is described in Section 3. Data, methodology, and some PICT descriptive statistics with a gender perspective are presented in Section 4. The presentation and discussion of results are in Section 5. Finally, some conclusions are provided in Section 6.

2. Theoretical Framework and Research Questions

2.1. The Gender Gap in S&T and the Case of STEM Fields

Women's underrepresentation in S&T activities is heterogeneous among Latin American and Caribbean countries: some countries reach gender parity while others show increasing gaps (Albornoz et al., 2018). However, women have lower participation in the private sector and STEM disciplines in every country of the region (López-Aguirre, 2019; Arredondo Trapero, Vázquez Parra, and Velázquez Sánchez, 2019; López-Bassols et al., 2018).

Literature sustains that women face several barriers as they progress in their personal life and career. In terms of S&T, several interrelated concepts that describe gender bias have emerged, which can be grouped into two explanations: those related to difference and those associated with deficit. (Kubota, 2003; León, Mairesse, and Cowan, 2017; Sonnert and Holton, 1995). The difference explanation refers to a set of observable characteristics that have been systematically identified and that account for the quantitative bias, such as gender-based differences in tenure, seniority, productivity, and citations (Ranga, Gupta, and Etzkowitz, 2012; Huang et al., 2020). This explanation also includes other observable factors beyond the academy and linked to the generic division of labor, such as maternity, emotional plus-value (mental load), and childcare (Sotudeh and Khoshian, 2014; Canetto et al., 2017). The problem of these elements, even when they are observable, is that they can hardly be controlled in any empirical approximation, mainly due to scarce information.

The deficit explanation refers to discrimination as an unobservable factor suffered by women in academia. As a result, there is a biased self-perception among women that leads to the selection of particular professions, research themes, and even the use of particular language, which is generally assumed as deficient compared to male research's practices (Zare-ee and Kuar, 2012; Sunderland, 2006; Piña-Watson et al., 2016). These problems are induced by a set of macro-social beliefs that create a collective imagination that claims that women lack the appropriate characteristics to exercise particular positions, such as project and team management (Linková, 2017; León, Mairesse, and Cowan, 2017), and that they also lack the intelligence needed to specialize in particular disciplines, mainly STEM ones (Cidlinská, 2019; Dasgupta and Stout, 2014; López-Bassols et al., 2018).

Within these explanations, several concepts define observable differences between genders in S&T (Bautista-Puig, García-Zorita, and Mauleón, 2019). The "leaky pipeline" effect suggests that the "flow" of women's participation decreases from grade school to post-secondary school (Xu, 2008; López-Aguirre, 2019), particularly in the case of STEM disciplines (Morcelle, Freitas, and Ludwig, 2019; Xu, 2008). The flow of women that is not lost along the way and attains graduate studies is then affected by vertical segregation or the glass ceiling. These concepts imply that even when distribution among gender is harmonic at the base of the pyramid, women are less represented in more hierarchical positions (Park, 2020; Mauleón and Bordons, 2006; León, Mairesse, and Cowan, 2017). This is also manifested by the “scissors diagram”: at the beginning, there are more women than men in absolute terms, but as they progress in academic positions, men outnumber women (Bautista-Puig, García-Zorita, and Mauleón, 2019). Problems are even worse in the presence of horizontal segregation, related to the fact that women and men are centered in different disciplines, suggesting some type of gender-based division of labor in S&T (López-Bassols et al., 2018; Park, 2020). The “sticky floor” effect refers to some extent to all these problems and shows that women face additional obstacles, especially in STEM fields, all along their career that prevent them from moving upward (Carrillo, Gandelman, and Robano, 2014; Bukstein and Gandelman, 2017). All of this results in occupational segregation.

In this line, and in terms of performance, a complex phenomenon in the academy is the difference in productivity by gender, called the “productivity puzzle” (Cole and Zuckerman, 1984). Evidence largely proves that women publish fewer papers than men. In fact, in the last sixteen years, even when the gender gap has been reduced, the productivity gap did increase (Huang et al., 2020). The lower productivity leads women to receive fewer citations and recognition, thus making them less likely to be awarded, known in the literature as the Matilda effect (Rossiter, 1993).

As in any complex system, all these factors of discrimination reinforce each other. Women act differently than men because they are (self)assumed as different (the difference explanation), and that impacts cultural stereotypes. Conversely, cultural barriers prevent them from having the same trajectories as men (the deficit explanation), and that impacts women’s and men’s perception about the generic division of labor (Miller, Eagly, and Linn, 2015; León, Mairesse, and Cowan, 2017). Horizontal segregation triggers the glass ceiling; that is, women occupy fewer managerial positions in the private sector than men (Bastarrica et al., 2018) and are less likely to be promoted in academia (Mauleón and Bordons, 2006; León, Mairesse, and Cowan, 2017). The glass ceiling negatively impacts the probability of being recognized and published, and the lower recognition and publishing rates affect women’s applications to public funds. In addition, the leaky pipeline effect makes women desist from studying a university degree, particularly in a STEM discipline, due to culturally imposed barriers (Dasgupta and Stout, 2014; Morcelle, Freitas, and Ludwig, 2019). Of course, given that women occupy less-hierarchical positions and manage fewer teams and projects in the S&T sector, they are less productive than men (Prpić, 2002; Mauleón and Bordons, 2006).

All these facts have been largely proven at the international level (Frietsch et al., 2009; Boustan and Langan, 2019; Jiménez-Rodrigo et al., 2008; Huang et al., 2020), including in

Latin American countries (López-Bassols et al., 2018; López-Aguirre, 2019). However, how the different explanations affect women's performance (and if they do) is still an enigma. Results are not conclusive in terms of how family structure and academic career impact researchers' performance by gender (Mairesse, Pezzoni, and Visentin, 2019; Kyvik, 1990). For instance, León, Mairesse, and Cowan (2017) studied women's productivity in Mexico and found that once all factors related to the career are controlled (meaning, if women have equal opportunities of promotion and tenure), women tend to be more productive than men. In this regard, several studies suggest that family condition generates the productivity puzzle. In this sense, married women and/or mothers are less productive than married men and/or fathers, particularly when their children are young (Kyvik and Teigen, 1996; Mairesse, Pezzoni, and Visentin, 2019; Kyvik, 1990). However, these family characteristics have also been demonstrated to make women more productive (Frandsen et al., 2015; Aiston and Jung, 2015; Fox, 2005; Padilla-Gonzalez et al., 2011). In addition, some studies do not verify the productivity gap (Aboal and Vairo, 2018; Padilla-Gonzalez et al., 2011; León, Mairesse, and Cowan, 2017).

One possible explanation of the inconclusive evidence is that several observable factors are not adequately taken into account in the econometric models (Mairesse, Pezzoni, and Visentin, 2019; Kyvik, 1990). Of course, part of the lack of consensus might also lie in the fact that unobservable dimensions cannot be totally controlled, as is the case with the deficit explanation (Miller, Eagly, and Linn, 2015; Morcelle, Freitas, and Ludwig, 2019).

However, literature about STEM disciplines specifically is far more conclusive and provides overwhelming evidence. STEM disciplines are generalized to be male-dominated disciplines (Cidlinská, 2019; Dasgupta and Stout, 2014) in the sense that the "proper scientists" in these fields are assumed to be linked to masculine features (Cidlinská, 2019; Miller, Eagly, and Linn, 2015). For instance, Miller, Eagly, and Linn (2015) analyzed 66 countries and concluded that women are less represented in STEM due to national stereotypes that discourage them from studying these fields. Morcelle, Freitas, and Ludwig (2019) demonstrated that Brazilian women, especially black women, suffer cultural barriers not only in research and universities but also in primary and secondary schools, thus confirming the leaky pipeline. The leaky pipeline effect has also been demonstrated in Colombia (López-Aguirre, 2019) and the United States (Xu, 2008). The productivity gap (Mairesse, Pezzoni, and Visentin, 2019; Huang et al., 2020) and occupational segregation (Conti and Visentin, 2015; Bastarrica et al., 2018) have also been proven for researchers worldwide.

In short, the literature concludes that the gender bias in STEM is more related to cultural stereotypes (deficit explanation) rather than observable factors, such as generic division of labor or opportunities to access university education (difference explanation) (Ong et al., 2011;

Arredondo Trapero, Vázquez Parra, and Velázquez Sánchez, 2019; Xu, 2008; Morcelle, Freitas, and Ludwig, 2019; Cidlinská, 2019; Dasgupta and Stout, 2014). Hence, neutral policy to foster S&T activity shall not be expected to lead to equality in generic terms since STEM fields are a priori male-biased. In this regard, this study aims to explore whether a horizontal public program to foster S&T activity in Argentina reinforces the initial bias suffered by female researchers in STEM.

2.2. Matthew and Matilda Effects on S&T Public Grants and Research Questions

Literature about S&T policy is mostly focused on impact evaluations of grants, with special attention to the effects on awarded researchers' performance. Based on bibliometric analyses, the majority of these works confirm positive impacts on quantity and quality of publications, for both developed and developing countries (Arora, David, and Gambardella, 2000; Inglesi-Lotz and Pouris, 2011; Godin, 2003; Jacob and Lefgren, 2011; Arza and Vazquez, 2015). Another important body of literature—although less developed—analyzes the process of allocation of grants, based on the traditional Matthew effect from Merton (1968).

The origin of the Matthew effect is placed in the field of Sociology of Science and refers to the higher levels of recognition some researchers receive due to their reputation instead of their current performance. In the matter of S&T public grants, the Matthew effect is defined as the recurrent awarding of researchers due to reasons not exclusively based on the submitted research project (David 1994). Researchers who have been previously awarded are then more likely to be selected in the next calls, either because of the learning processes they went through when formulating and implementing an awarded research project, or due to the accumulation of recognition because of the previous award(s) (Merton, 1988, 1968). Evidence confirms the Matthew effect both for developed countries (Bol, de Vaan, and van de Rijt, 2018; Cremonini, Horlings, and Hessels, 2018; Langfeldt et al., 2015) and, although the evidence is scarcer, developing countries (Vera-Cruz et al., 2008; Suarez and Fiorentin, 2018).

Related to the Matthew effect, gender studies alert about the Matilda effect (Rossiter, 1993), which refers to women's lower probabilities of being awarded. Of course, most of the explanations about the Matilda effect are based on the concepts defined in Section 2.1. Lower positions, levels of publication, and citation rates negatively impact the evaluation of a researcher's profile, which is usually a key dimension of the evaluation process. The Matilda effect also results from biased peer-review evaluations: both male and female reviewers are less likely to select projects directed by women (Witteman et al., 2019; Mutz, Bornmann, and Daniel, 2012; Bornmann, Mutz, and Daniel, 2007). It is also the result of the Matthew effect, given that the latter leads to the selection of the same prominent male researchers at the expense of women. All of this results in a perverse dynamic of systematic underrepresentation by women in S&T in general, and in public grants allocation in particular.

The gender gap in public grants for S&T has been verified, particularly in STEM fields (Ranga, Gupta, and Etzkowitz, 2012; Mutz, Bornmann, and Daniel, 2012; Cruz-Castro and Sanz-Menéndez, 2019). For instance, a study based on STEM fields in Canada between 2011 and 2016 found that women's probability of being awarded was -0.9 p.p. (Witteman et al., 2019). The study concludes that the gender bias probably emerges from subjective bias among reviewers (both female and male), systematic bias within the program, and the fact that women's submissions are less robust than men's (because they do not know how to prepare them or are discouraged by so many rejections). Among medical school faculty in the United States, a study shows that women are less likely to be awarded in biomedical themes (Waisbren et al., 2008). This study confirms that men are more likely to be awarded in first submissions and resubmissions than women. In addition, women receive less administrative, professional, and technical support, fewer years of granting, and a lower median amount of money than men. In the case of STEM fields in the United States, women are less represented in submissions (26 percent), grants (22 percent), and reviews (26–28 percent) (Bautista-Puig, García-Zorita, and Mauleón, 2019). In the United Kingdom, women have been less likely to be granted for the past 20 years (Head et al., 2013). In Italy (Jappelli, Nappi, and Torrini, 2017) and Austria (Mutz, Bornmann, and Daniel, 2012), women are discriminated against by evaluation processes based on peer review. In Iceland, women are less awarded than men, especially in male-dominated disciplines (Steinþórsdóttir et al., 2020).

Among developing countries, the evidence is scarce and contradictory. Bukstein and Gandelman (2017) show that female researchers have 7.1 p.p. lower probabilities than male researchers of being accepted into the largest national research support program in Uruguay. The gender gap is wider at the higher ranks of the program, consistent with the existence of a glass ceiling. Aboal and Vairo (2018) evaluated the impact of Paraguay's National Researcher Incentive Program on the gender production gap in academic science. Their results indicate that there is a preexistent gender gap in productivity among researchers. There is no evidence, however, of intended gender discrimination in favor of male researchers at the allocation stage of the program. The outcome also demonstrates that the impact of the program is heterogeneous across genders.

Regarding the impact of Argentina's PICT program, studies conclude that researchers awarded by PICT are more productive, their production is of higher quality, and they strengthen their research groups through hiring and retention and greater visibility on social media, as a result of being awarded (Chudnovsky et al., 2008; Codner et al., 2006; Codner, 2011, 2013; Ghezan and Pereira, 2014; MINCyT, 2011; Arza and Vazquez, 2015). However, none of these works included a gender perspective. Part of the same project as this paper, Fiorentin et al. (2018) analyzed the probability of access and persistence for women's submissions to PICT and found robust evidence about the Matilda effect whether it was the first submission or they had been awarded before. Their results show that female researchers are 3.3 p.p. less likely to be awarded for the first time than men, and 6 p.p. less likely if they were awarded before. One of the elements not explored in Fiorentin et al. (2018) was the impact on STEM in particular. Going forward in that vein, we derive from this evidence our research questions:

- *RQ1: Are women in STEM less likely than men to be awarded a research grant the first time they submit a project?*
- *RQ2: Are women in STEM less likely than men to be awarded a research grant for the first time, regardless of how many projects they have submitted?*
- *RQ3: Are women in STEM less likely than men to be awarded a research grant when they have been awarded before?*

The research questions highlight the novelty of the paper—that is, they are focused on the different instances in which a female researcher may suffer the Matilda effect. RQ1 wonders about the existence of the Matilda effect only in the case of the first submission (that is, gender discrimination in entering PICT). Regarding RQ2, a female researcher can suffer gender discrimination linked to lower probabilities of being awarded for the first time, regardless of how many previous submissions she has done (that is, gender discrimination in accessing PICT). Finally, regarding RQ3, once a female researcher obtains her first grant, she may suffer gender discrimination in her following submissions (i.e., gender discrimination in receiving recurrent awards with PICT—the Matthew effect as the source of the Matilda effect). She could also be recognized the same as a man, since she has already overcome several barriers that the S&T system imposed on her. To the best of our knowledge, however, there are no previous studies centered on this issue, so we cannot present a hypothesis about this.

The underlying hypothesis of this research is that the PICT program might be a good instrument to reduce gender bias given its scope and recognition. However, it could be working as a non-neutral program by reinforcing the ex ante discrimination against female researchers, since it does not consider the existence of the gap (see Annex 1 for more detail about the gender gap in STEM in the Argentine S&T system). The results of this paper may offer a more complex view of the phenomenon and provide some evidence and reflections to contribute to the process of policy design to eliminate existing gender bias and to avoid the creation of new gaps.

3. The Scientific and Technological Research Projects (PICT) Program in Argentina

3.1. PICT Aims and Calls

PICT is based on matching grants and is the most important line of funding of the Fund for Research in Science, Technology, and Innovation (FONCyT in Spanish). FONCyT is one of the three funds that compose the National Agency for the Promotion of Research, Technological Development, and Innovation (Agencia I+D+i in Spanish). Agencia I+D+i is a decentralized institution that depends on the Ministry of Science, Technology, and Innovation (MINCyT). It was created in 1996 to separate the functions of promotion and financing from those activities related to the design and execution of Science, Technology, and Innovation (STI) policy. The PICT program began its activities in 1997 and it has remained almost unaltered since then.

The PICT program is intended to support participation in scientific conferences, specialized technical services, and equipment expenses. Unlike typical subsidy programs in developed countries, PICT's funds cannot be used to pay researchers' salaries, which are assumed to be paid by the institutions where they work. Most of the applications to the PICT program come from public universities or research centers where salaries are guaranteed from the public budget. Therefore, researchers' wages are accepted as the counterpart required of the beneficiary institution (to which the responsible researcher belongs, and where the project is executed).

PICT's lines of funding are organized around three types of calls. One call is for young researchers. It requires the principal investigator of the project to be less than 38 years old and not in charge of a research team. The second type of call is for recently formed teams,[2] in which all team members are required to be less than 48 years old. Finally, there is a call for consolidated teams that requires at least one team member to be more than 48 years old. Each of the three call types is further divided into subject areas. Four subject areas are defined: (i) open themes: all fields of science, (ii) Argentina 2020: themes defined as strategic for development in the national plan, (iii) international cooperation: projects that include research teams from abroad, and (iv) start-up: projects that include technological development and transfer. Table 1 presents the types of calls and subject areas allowed.

[2] Since there is no unified registry of research groups in Argentina, to define if a research group is recently formed (or consolidated) PICT uses the age of the responsible researcher and its members as indirect proxies.

Table 1. PICT: Types of Calls and Subject Areas

Type of call	Subject areas
Consolidated teams	All
Young researcher	I and II
Recently formed teams	I and II

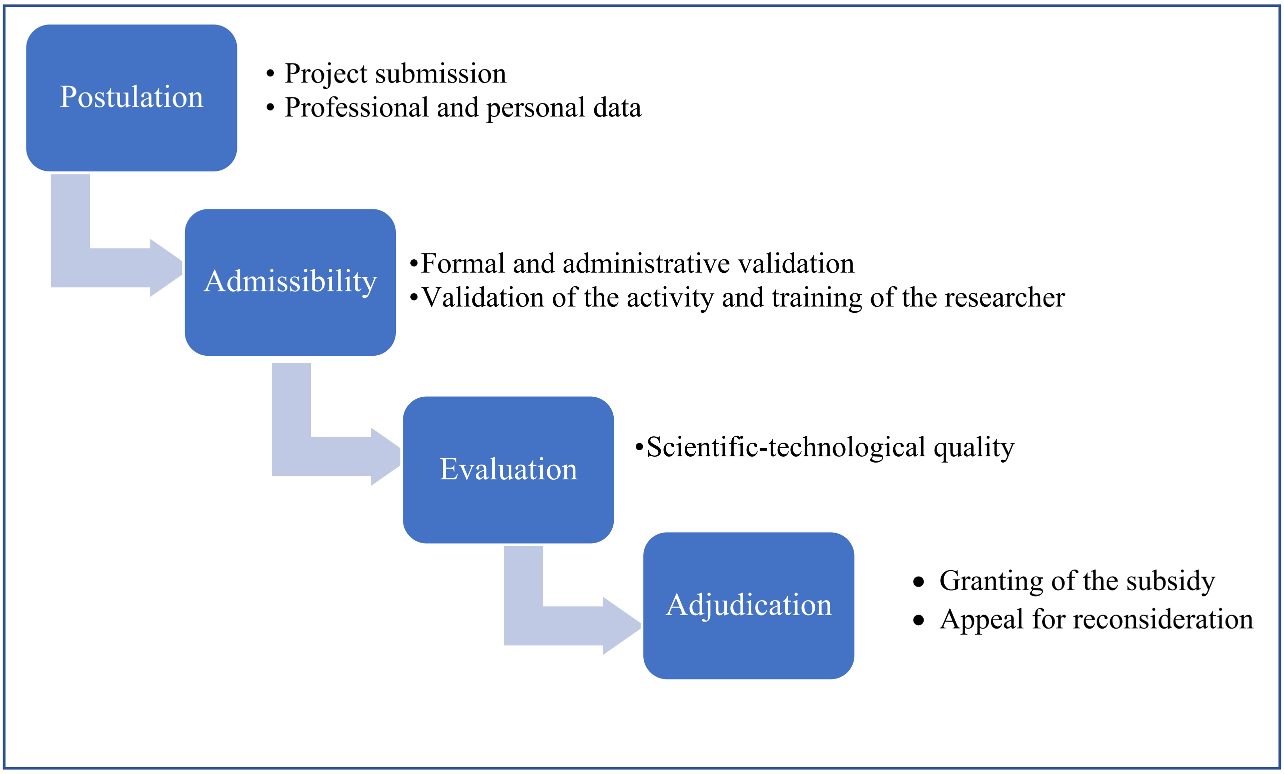
Source: Authors' elaboration based on PICT calls for submissions.

Researchers from public or private nonprofit organizations can apply to the fund by submitting a detailed project proposal. Each project has a maximum duration of three years—two for young researchers—and does not impede researchers who were awarded in the past to reapply for another grant, except for young researchers, who are not able to reapply to the same type of call. The only constraint is the maximum of two granted projects at the same time.

3.2. The Submission and Selection Processes

Regarding the submission and selection processes, four steps can be identified: submission, admissibility, evaluation, and adjudication. Figure 1 summarizes these steps.

Figure 1. PICT: The Roadmap from Submission to Adjudication



Source: Authors' elaboration based on terms and conditions of PICT calls for submissions.

3.2.1. Submission

The PICT annual calls are published and shared by different means (FONCyT's official page and social media, among others), and establish the deadlines for submissions. To apply for funds, researchers must submit a research project. The structure of the project is based on general guidelines of a research project that lasts between two and three years, depending on the type of call the researcher and their team are submitting. Guidelines for the elaboration of the technical description are provided to responsible researchers, who must detail the budget assignation based on the type of call and subject area. They also must include counterpart details. The technical description includes seven sections: (i) general objectives, (ii) specific objectives and working hypotheses, (iii) relevance of the problem, (iv) preliminary results and contributions of the working group, (v) construction of the hypothesis and justification of the methodology, (vi) type of research and research methods, and (vii) schedule.

In addition to the research project, the responsible researcher must submit their professional and personal information, as well as that of the rest of the team. Both research projects and researchers' information must be uploaded through official online applications: a submission system managed by FONCyT for the project details and the CVar platform for the professional information, which must include details of the capabilities of the economically benefited institution and the team's knowledge of the disciplinary field that corresponds to the project impacts. Finally, space allows for the optional inclusion of ethical and environmental safeguards, as well as the challenge of peer evaluators.

3.2.2. Admissibility

The admission stage consists of an administrative and procedural analysis of the applications received. PICT's disciplinary area coordinators verify that each project fulfills the administrative requirements that constitute the admission criteria related to the dates of the calls, the characteristics of the research project, and budget distribution allowed. Then, the required characteristics of researchers are also verified. The most important criteria are that the applicants must have a formal labor relationship with an Argentinian institution, dedicate at minimum 50 percent of their time to the project, have a PhD degree or equivalent merit, have participated on research projects, and have a high enough publication score in the last five years. Those projects that overcome the admissibility stage are deemed "accredited" and sent to evaluation. The rest of the projects are "nonaccredited" and rejected by the administrative process.

3.2.3. Evaluation

Once the project passes the first screening, an evaluation of the scientific-technological quality of the submitted project is executed by the disciplinary and ad hoc commissions. This stage is based on a single-blind peer-review process. Commissions assign each project to two specialized evaluators whose identity remains anonymous. However, the evaluators are provided with the personal data of the researcher (including name), in order to evaluate their career in addition to the project. The evaluation must follow an evaluation grid and good practice guidelines. To evaluate the project, each evaluator assesses three criteria: the scientific and technological content of the project; the consistency between objectives, methodology, and work plan; and the scientific and technological capacity of the research group or young researcher. The final grade is the weighted average of the score assigned to each criterion.

Then, an ad hoc commission[3] assesses the merit of the proposed projects. To this purpose, a project's quality and pertinence in terms of the expected impact are considered,[4] depending on the type and subject area of the project. The weighting of the quality and pertinence attributes does not follow a pre-established formula and is defined by each commission according to its criteria. Then, the disciplinary commission's coordinators carry out a general review that considers the scientific-technological capacity of the responsible researcher and the team, the presence of dispersions in the evaluations, and possible observations made by peers, including the need for a new evaluation.

Projects are scored from 1 to 10. Once the project ranking has been determined, the ad hoc commission proposes a list of projects to be awarded, depending on the funds available and seeking to maintain a regional balance in the distribution of funds. In any case, projects scored less than 6 are not selected.

3.2.4. Adjudication

Finally, Agencia I+D+i's executive board approves the list drawn up by the disciplinary commission and publishes the results. This step includes the official communication of the ranking and notification to responsible researchers. Also, the board resolves requests for

[3] Each ad hoc commission is designated by Agencia I+D+i's executive board and is composed of eight well-known members of the scientific and technological community and/or foreign experts with the necessary expertise to analyze the projects.
[4] According to PICT's calls, the criteria to analyze the pertinence of a project are (i) the impact on the institutional capacities for research and development, (ii) the impact on the disciplinary areas, and (iii) the impact on the productive and social sector. Also, each ad hoc commission may define and apply other criteria as deemed appropriate as long as they are consistent with the general criteria.

reconsideration submitted by non-awarded researchers. Reconsiderations are revised by disciplinary or ad hoc commissions, and finally resolved by Agencia I+D+i's executive board.

4. Methodology

4.1. Data

To address our three research questions, we merge two sources of information: (i) PICT's administrative registers of the population of responsible researchers that applied to the PICT funding program, whether they were granted or not, and (ii) applicants' bibliometric information retrieved from the Scopus database. Since we could not access the information about the members of the research team, the unit of analysis is the responsible researcher who applies. This category includes both the young researcher who applies without a team as well as the research team leader.

We restricted the sample to responsible researchers working in STEM fields. Departing from the All Science Journal Classification used in Scopus,[5] we identified the most frequent subject area for each responsible researcher. If this subject area belonged to Science, Engineering, Mathematics, or Computer and Information Sciences (CIS), we determined that this researcher belonged to a STEM field.

The resulting dataset is an unbalanced panel at the level of responsible researcher and year of application: 6,429 responsible researchers and 11,291 observations. The database covers the period from 2003 to 2015, but the PICT started its activities in 1997. In order to study RQ1—barriers to entry during the observational period—we analyze the historical record of applicants. In this way, we identify 3,153 researchers that applied for a research grant for the first time. The database includes information on researchers' participation in the program together with their scientific productivity, academic achievements, and bibliographic information. Table 2 presents a detailed description of the explanatory variables used in the model.

[5]Available at https://service.elsevier.com/app/answers/detail/a_id/15181/supporthub/scopus/.

Table 2. Variable List

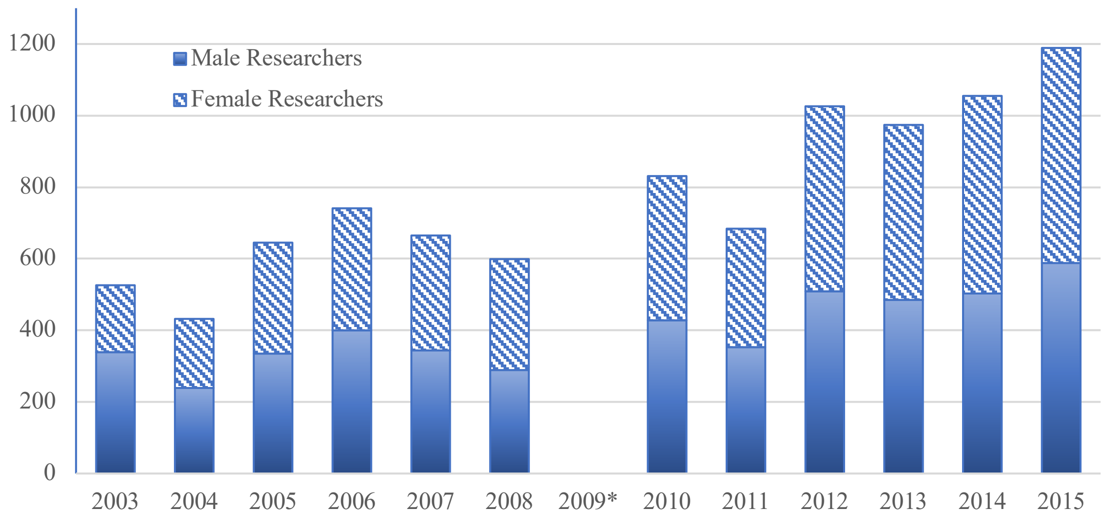
Variable	Description	Values
Responsible Researcher Characteristics		
$PICT_{it}$	Research grant awarded in year t	1 if yes; 0 otherwise
$Past_{i,t}$	At least one grant awarded in the past	1 if the researcher was previously awarded; 0 otherwise
Number of $submissions_{it}$	Total number of submissions to PICT	0 to 8
Published $papers_{it}$	Total number of papers indexed in Scopus	0 to ∞
Citations received	The average number of citations per year	0 to ∞
$Experience_{it}$	Years since the researcher's first publication indexed in Scopus*	0 to ∞
Project $category_{it}$	Set of 3 binary variables that indicate the category of the submitted project	1 if open theme; 0 otherwise 1 if Argentina 2020; 0 otherwise 1 if Rest of categories; 0 otherwise
Project $type_{it}$	Set of 3 binary variables that indicate the type of research team of the project	1 if Young Researcher; 0 otherwise 1 if New Research Group; 0 otherwise 1 if Consolidated Research Group; 0 otherwise
$STEM_{it}$	Set of 3 binary variables that indicate the major field of study within STEM following the definition of Statistics Canada (2016): Science, Engineering, Mathematics, and Computer and Information Sciences	1 if Science and Science Technology; 0 otherwise 1 if Engineering and Engineering Technology; 0 otherwise 1 if Mathematics and CIS; 0 otherwise
$Female_i$	The binary variable indicates if the researcher is a woman	1 if woman; 0 otherwise
Time, Institutional, and Regional Fixed Effects		
$Region_{it}$	Set of 5 binary variables that indicate the geographical location of researchers	1 if Northwest; 0 otherwise 1 if Northeast; 0 otherwise 1 if South; 0 otherwise 1 if West; 0 otherwise 1 if Central; 0 otherwise
$Institution_{it}$	Set of 3 binary variables that indicate the institution type of researchers	1 if University; 0 otherwise 1 if National Scientific and Technical Research Council (CONICET); 0 otherwise 1 if Research Center; 0 otherwise
$Year_t$	Set of binary variables that account for time-fixed effects	2003–2015

Source: Authors' elaboration based on the PICT database.
* PICT's administrative registers do not include information about researchers' birth or graduation year. Hence, their experience was measured from the time their first paper was published.

4.2. A First Glance at the Gender Gaps in PICT

During the period under analysis in this study (2003–2015), the number of projects awarded by PICT grew noticeably (see Figure 2). Between 2003 and 2008 an average number of 601 projects were granted per year, while between 2010 and 2015 the average number of projects granted grew to 960 per year. In this context, the number of female researchers awarded remained stable at around 45 percent throughout the entire period. These results suggest to some extent the existence of a gender gap in PICT, given that women's participation in this program (45 percent) is lower than women's participation in the whole scientific system (53 percent).

Figure 2. Awarded Projects: Gender of Responsible Researchers (2003–2015)



Source: Authors' elaboration based on the PICT database.
* During 2009 PICT did not launch calls for proposals due to the international financial crisis that affected public budgets.

In terms of STEM projects, they represent most of the submitted projects (70 percent) as well as projects awarded (69.8 percent) during the period under analysis. In respect to the gender bias, 53.4 percent of STEM projects were awarded to male researchers. This proportion drops to 50.1 percent for the other disciplines. As shown in Table 3, female researchers from the whole sample reach a ratio of awarded to submitted projects of 46.9 percent, while this increases to 57 percent for men. When it comes to the STEM award ratio, differences are similar: the award ratio is 55 percent for male researchers and 46 percent for their female counterparts. This means that while the total adjudication rate within STEM projects is 50.6 percent, it is only 46 percent for women. Similarly, the award ratio is also higher for men than women in the rest of the fields (61 percent vs. 48.9 percent).

Table 3. PICT's Grant Distribution by Gender and Disciplines (total number of projects, 2003–2015)

Women			Men			Whole Sample		
Submitted	Awarded	Ratio	Submitted	Awarded	Ratio	Submitted	Awarded	Ratio
STEM Researchers								
6,601	3,037	46.0%	6,286	3,481	55.4%***	12,887	6,518	50.6%
Non-STEM Researchers								
3,084	1,507	48.9%	2,475	1,516	61.3%***	5,559	3,023	54.4%
Whole Sample								
9,685	4,544	46.9%	8,761	4,997	57.0%***	18,446	9,541	51.7%

Source: Authors' elaboration based on the PICT database.
Note: *** statistically significant at 1 percent, ** statistically significant at 5 percent, * statistically significant at 10 percent.

Considering the distribution by gender and type of call in STEM fields, Table 4 shows award ratios. In the case of young researchers, the ratio is higher than for research teams (recently formed and consolidated teams), but the difference is lower by gender. In the case of team leaders, men's average probability of being awarded is 8 p.p. higher than for women responsible researchers. For young researchers, the gap is 6 p.p., suggesting that the gender gap is manifested in both cases and is larger for senior researchers. Hence, as female researchers progress in their profession, they are less likely to be awarded than male researchers, suggesting the existence of a glass ceiling as well as the leaky pipeline effect.

Table 4. PICT's STEM Grant Distribution by Gender and Type of Call (total number of projects, 2003–2015)

Women			Men			Whole Sample		
Submitted	Awarded	Ratio	Submitted	Awarded	Ratio	Submitted	Awarded	Ratio
Young Researchers								
2,099	1,126	53.6%	1,551	924	59.6%	3,650	2,050	56.2%
Research Teams								
4,502	1,911	42.4%	4,735	2,557	54.0%***	9,237	4,468	48.4%
STEM Researchers								
6,601	3,037	46.0%	6,286	3,481	55.4%***	12,887	6,518	50.6%

Source: Authors' elaboration based on the PICT database.
Note: *** statistically significant at 1 percent, ** statistically significant at 5 percent, * statistically significant at 10 percent.

Regarding performance (see Table 5), male researchers publish more papers than female researchers and receive more citations. Even though this paper is not focused on determinants of obtaining grants, this performance bias between genders may affect the process of allocation of PICT, disadvantaging women.

Table 5. PICT's STEM Researchers' Performance by Gender and Type of Call (total number of projects, 2003–2015)

	Whole Sample			Research Teams			Young Researchers		
	Rejected	Awarded	Total	Rejected	Awarded	Total	Rejected	Awarded	Total
Papers									
Male	2.4	3.0	2.7***	2.6	3.4	3.0***	1.6	2.0	1.9**
Female	1.9	2.2	2.0	2.1	2.6	2.3	1.3	1.4	1.4
Total	2.1	2.6	2.4	2.3	3.0	2.7	1.4	1.7	1.6
Citations									
Male	6.0	10.0	8.2**	6.8	11.3	9.2***	3.4	6.6	5.3***
Female	5.2	6.9	6.0	6.0	8.2	7.0	3.1	4.6	3.9
Total	5.6	8.6	7.1	6.4	10.0	8.1	3.2	5.5	4.5

Source: Authors' elaboration based on the PICT database.
Notes: Mean test is performed to study differences between male and female researchers despite their awarded status. *** statistically significant at 1 percent, ** statistically significant at 5 percent, * statistically significant at 10 percent.

All in all, PICT's distribution of awards suggests the existence of a gender gap, related to the Matilda effect. According to the adjudication rate, women are less likely to be awarded than men, both for STEM and non-STEM disciplines. For both groups of disciplines, women's awarded projects are less than half of the total awarded projects. However, when it comes to young researchers who submitted projects based on STEM disciplines, the participation of female researchers increases, not only because they apply more but also because they are more often awarded. Evidence is in line with the productivity bias in the case of STEM in Argentina, given that female researchers publish less, in journals with lower impact factors, and receive fewer citations than their male counterparts (see Annex 1).

4.3. Identification Strategy

We will aim to capture the existence of gender gaps in the allocation of funding for science-based projects. To do that, we estimate two sets of regression. First, a regression on first-time applicants. Second, a discrete choice participation model for applications done at any point in time.

For the first set of regressions, the observed discrete variable $PICT_i$ is associated with an underlying $PICT_i^*$ latent variable. The probability of obtaining funding is assumed to be a function of a set of lagged observable covariates $x_{i,t-1}$; $female_i$ which is a dummy that indicates if the researcher who submitted a project is a woman; an unobservable time-invariant individual's effect; and a time-varying idiosyncratic random error component ($u_{i,t}$). The proposed baseline estimation is in Equation [1].

$$PICT_i^* = \alpha_i + \gamma female_i + x'_{i,t-1}\beta_k + u_{i,t} \qquad [1]$$

The probability of receiving funding will be estimated given the characteristics of the researcher before the awarding status (gender, age, level of education, scientific production). We would find evidence of gender bias in the selection process if, after controlling for all relevant covariates, female researchers have a lower probability of being awarded than men.

For the second set of regressions, we model the probability of obtaining funding on a panel data setting (Equation [2]). Given the possibility that researchers will apply multiple times in consecutive years we employ a PROBIT model for panel data.

$$PICT_{it}^* = \alpha_i + \gamma female_i + \lambda Past_{i,t} + \eta\ (female_i\ x\ Past_{i,t}) + x'_{i,t-1}\beta_k + u_{i,t} \qquad [2]$$

The model in [2] controls for previous funding status ($Past_{i,t}$), which captures whether the applicant was awarded in any previous call and interact it with female participation ($female_i\ x\ Past_{i,t}$). The interaction term allows the effect of gender ($female_i$) on the probability of receiving funding to depend on the history of participation ($Past_{i,t}$). The conditional expectation of $PICT_{it}^{*} = 1$ for $past_i = 1$ given different values ($female_i$) is then computed as follows:

$$E\left(PICT_{it}^{*} = 1 \middle| female_i = 1, Past_{i,t} = 1\right) = \alpha_i + \gamma + \lambda + \eta \quad [3]$$

$$E\left(PICT_{it}^{*} = 1 \middle| female_i = 0, Past_{i,t} = 1\right) = \alpha_i + \lambda \quad [4]$$

$$E\left(PICT_{it}^{*} = 1 \middle| female_i = 1, Past_{i,t} = 1\right) - E\left(PICT_{it}^{*} = 1 \middle| female_i = 0, Past_{i,t} = 1\right) = \gamma + \eta \quad [5]$$

Then $\gamma + \eta$ in Equation [5] is the difference in the effect of being a recurrent participant for women versus men. The latter would allow us to test for gender discrimination in recurrent access to funding. If $\gamma + \eta < 0$ this could suggest that there is gender discrimination against women in recurrent access to the funding (i.e., a Matilda effect potentially sourced from a Merton's Matthew effect). In addition, λ represents the conditional expectation of the probability of funding given that the researcher is male and obtained a research grant in the past. If $\lambda > 0$, this provides evidence of a Matthew effect in access to public funding for scientific research.

To allow for correlation between α_i and $x'_{i,t-1}$ we follow the proposition of Mundlak (1978) and Chamberlain (1984): $\alpha_i = \xi' \overline{X_\iota} + \varepsilon_i$ where ε_i is assumed independent from $x'_{i,t-1}$ and $u_{i,t}$ for all the researchers and time periods. We define $\overline{X_\iota}$ as the longitudinal average of researcher structural characteristics. The assumption is that differences in average longitudinal characteristics are informative about the underlying researcher-specific characteristics so that the individual differences that are left (ε_i) may be more plausibly supposed to be independent of observed characteristics.

5. Results and Discussion

In order to answer RQ1, we estimated the presence of gender bias in the probability of being awarded the first time a researcher applies. Table 6 is based on Equation [1] and reports the average marginal effect estimated using a PROBIT model. Three groups of estimates are presented. The first group includes the whole sample of STEM researchers, the second one the subsample of applications made by young researchers, and the last one the subsample of applications made by research teams. In each group, we split the sample considering the different STEM disciplines.[6] All the regressions include the same set of covariates: academic recognition; productivity and experience of the responsible researcher; and fixed effects that indicate the type and category of the submitted project, the region and institution of the responsible researcher, and the year of presentation. Explanatory variables are defined so that the base category is a male researcher who submitted a research project.

Considering all disciplines within STEM, results show that compared to male researchers, once all other relevant covariates have been controlled, the average woman researcher's access to public S&T support the first time she submits a project is negative and statistically significant. Considering the sample of STEM researchers, on average, a female researcher has 6.2 p.p. lower probabilities of being awarded during her first application than her male counterpart. Breaking down the sample by a team and by young researchers, results show that gender discrimination is stronger for the former (-8.0 p.p. vs. -5.1 p.p. respectively).

It is worth noting that these results are mainly explained by the Science discipline (which represents at least 80 percent of the STEM researchers who applied for a PICT grant). Gender discrimination in Engineering, Math, and CIS are lower in comparison (and similar to the entire population of STEM researchers in Argentina; see Annex 1). However, since the number of observations in this group is reduced, these findings should be taken with caution.

Hence, regarding our first research question, results so far confirm this manifestation of the Matilda effect. These results also confirm one of our initial hypotheses, regarding the fact that a horizontal program could reproduce the gender bias manifested at the aggregate level in STEM fields. In this line, evidence coincides with previous studies which have highlighted the existence of the Matilda effect in being awarded (Cruz-Castro and Sanz-Menéndez, 2019; Witteman et al., 2019; Mutz, Bornmann, and Daniel, 2012; Waisbren et al., 2008).

[6] Since the number of observations within the disciplines of Engineering, Mathematics, and Computer and Information Science (CIS) is limited, we considered them a single group. Therefore, appropriate caution is necessary to interpret our empirical findings from this group.

Table 6. Gender Bias in PICT Participation: The Probability of Being Awarded the First Time a Researcher Submits a Project

	Whole Sample			Research Teams			Young Researchers		
	STEM	**Science**	**Engineering, Math & CIS**	**STEM**	**Science**	**Engineering, Math & CIS**	**STEM**	**Science**	**Engineering, Math & CIS**
Female Researcher	-0.062**	-0.056**	-0.099*	-0.080*	-0.092*	0.031	-0.051*	-0.039+	-0.165**
	(0.017)	(0.018)	(0.048)	(0.033)	(0.036)	(0.099)	(0.020)	(0.021)	(0.059)
Cited per Year	0.003	0.002	0.018**	0.001	0.001	0.009	0.002	0.002	0.024**
	(0.002)	(0.002)	(0.005)	(0.002)	(0.002)	(0.008)	(0.002)	(0.002)	(0.008)
Published Papers	0.004**	0.004**	0.002	0.003**	0.003**	0.005	0.005+	0.005+	0.004
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.004)	(0.003)	(0.003)	(0.007)
Experience (years)	0.008*	0.007+	0.012	0.007	0.005	0.005	0.007	0.007	0.001
	(0.003)	(0.004)	(0.010)	(0.006)	(0.007)	(0.019)	(0.005)	(0.005)	(0.015)
Observations	3,153	2,795	358	779	676	103	2,374	2,119	255
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
STEM FE	YES	NO	NO	YES	NO	NO	YES	NO	NO
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Call FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Institution FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: Authors' elaboration based on the PICT database.
Notes: "FE" refers to fixed effects; Marginal effects. The binary dependent variable takes value 1 if the researcher was awarded. Base category corresponds to a male researcher who applied for a public subsidy for his scientific project. Standard errors in parentheses. ** statistically significant at 1 percent, * statistically significant at 5 percent, + statistically significant at 10 percent.

RQ2 and RQ3 are focused on the other two possible manifestations of the gender gap in the process of allocation of grants. On the one hand, a female researcher may suffer gender discrimination the first time she is awarded a research grant, regardless of how many times she has previously applied for it (RQ2: barriers to participation). On the other hand, a female researcher may suffer gender discrimination when, if awarded before, she submits a project again (RQ3: barriers to recurrent access). Equation [2] allows us to study both manifestations of the gender gap at the same time. To estimate them we employed a Mundlak-Chamberlain approach for the random-effects model. We extended the previous list of covariates with a variable that indicates the number of previous submissions to PICT to control the learning-by-applying process. Once again, estimated results are presented according to the type of call and STEM disciplinary area. The base category characterizes the situation of a male researcher requesting a grant (Table 7).

The first row of Table 7 shows the gap in the probability of being awarded for the first time. According to estimates for the whole sample, after controlling for all other relevant covariates, a female researcher has 3.8 p.p. lower probabilities of being awarded for the first time. The comparison between teams and young researchers shows that gender discrimination is stronger among young female researchers than among research teams: -3.8 p.p. versus -3.0 p.p. respectively. These results are surprising because descriptive statistics indicated the opposite. Regardless, they reinforce the results estimated by Equation [1], to the extent that the Matilda effect is manifested not only the first time a female researcher submits a project but any time, particularly in the case of young female researchers. In fact, the confirmation of RQ2 could suggest the existence of the leaky pipeline effect in the first stages of women's careers, to the extent that lower probabilities might discourage them from participating in STEM research activities (Morcelle, Freitas, and Ludwig, 2019; López-Aguirre, 2019; Xu, 2008).

The analysis of estimated marginal effects within each STEM discipline shows that women researchers in Engineering, Mathematics, and CIS face the same probabilities as male colleagues. On the opposite side, women researchers that belong to Science disciplines suffer a barrier to their participation. The probability of being awarded a research grant for the first time is -4.2 p.p. than that estimated for male researchers.

Finally, the second and third rows of Table 7 show the probability of being a recurrent beneficiary for teams with a female and male responsible researcher, respectively.[7] Considering all STEM disciplines, estimated marginal effects indicate that once the researcher

[7] As was mentioned in Section 2, the basis and conditions of PICT's young researcher calls do not allow researchers to be awarded more than once.

has been awarded for the first time, the probability of receiving a new grant increases significantly (+56 p.p. both for female and male researchers), which is in line with previous evidence about the Matthew effect in the case of PICT (Suarez and Fiorentin, 2018; Fiorentin et al., 2018). In this line, evidence denies RQ3 and suggests the absence of gender discrimination in recurrent awarding. In addition, this time we didn't find heterogeneities in terms of STEM disciplines. Therefore, beyond the STEM discipline considered and the gender of the researcher, being awarded in the past triggers a learning and recognition process that positively affects the probability of being awarded again. Despite the fact that previous studies and the evidence presented in this paper show the existence of discrimination against women, those female researchers who have overcome the initial barriers have achieved as much reputation as men.

Summing up, these results may indicate that women who have smashed the glass ceiling at least to some extent and accessed public S&T policy are in the same conditions as men in terms of PICT recurrent access. Then, they are not affected by any gender bias once they have overcome all the barriers which appeared along their path. However, since recurrence similarly impacts the probabilities of being awarded and since women face gender discrimination at the stage of submission, the gender bias persists even among senior female researchers. In addition, the manifestation of just two out of three sources of the Matilda effect may also respond to inconclusive evidence in the literature. The corollary is that most of the dimensions of the Matilda effect must be taken into account when studying gender bias in science.

Table 7. Gender Bias in PICT Participation: Probability of Being Awarded

	Whole Sample			Research Teams			Young Researchers		
	STEM	Science	Engineering, Math & CIS	STEM	Science	Engineering, Math & CIS	STEM	Science	Engineering, Math & CIS
Female Researcher	-0.038**	-0.042**	0.003	-0.030**	-0.034**	0.013	-0.037*	-0.035*	-0.057
	(0.009)	(0.010)	(0.029)	(0.011)	(0.011)	(0.038)	(0.017)	(0.018)	(0.053)
Prev. PICT—Team Led by Female	0.563**	0.560**	0.602**	0.537**	0.535**	0.555**			
	(0.013)	(0.013)	(0.060)	(0.015)	(0.016)	(0.069)			
Prev. PICT—Team Led by Male	0.560**	0.558**	0.553**	0.537**	0.541**	0.465**			
	(0.013)	(0.013)	(0.044)	(0.014)	(0.015)	(0.050)			
Published Papers	0.000	0.000	-0.001	0.001	0.000	0.003	0.012**	0.014**	-0.008
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.009)
Citations Received	0.001**	0.001**	0.009**	0.001**	0.001*	0.007*	0.003**	0.003**	0.030**
	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.003)	(0.001)	(0.001)	(0.007)
Experience (years)	0.014**	0.012*	0.028+	-0.002	-0.009	0.020	0.062**	0.060**	0.098**
	(0.005)	(0.005)	(0.016)	(0.009)	(0.010)	(0.026)	(0.009)	(0.009)	(0.029)
Observations	11,291	10,216	1,075	8,037	7,306	731	3,254	2,910	344
No. of Researchers	6,429	5,751	678	3,800	3,400	400	2,629	2,351	278
Time-Averaged Characteristics	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
STEM FE	YES	NO	NO	YES	NO	NO	YES	NO	NO
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Call FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Institution FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Sigma-u	0.0008	0.0008	0.0004	0.0009	0.0005	0.0007	0.0007	0.0007	0.0017
Rho	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Source: Authors' elaboration based on the PICT database.
Notes: "FE" refers to fixed effects; Marginal effects. The binary dependent variable takes value 1 if the researcher was awarded. Standard errors in parentheses. ***statistically significant at 1 percent, **statistically significant at 5 percent, *statistically significant at 10 percent.

6. Conclusions and Policy Implications

The objective of this study was to analyze the presence of gender bias in the process of allocation of grants for S&T activity in STEM. The question that guided our research was about the presence of the Matilda effect in STEM fields in the case of public S&T policy in Argentina. The empirical approach was based on information provided by the Scientific and Technological Research Projects program (PICT in Spanish) for the period 2003–2015, and the Scopus repository. The methodological approach was based on the application of different identification strategies to identify the existence of gender gaps when women researchers apply for a research grant.

Estimated results confirmed the presence of two out of the three proposed sources of the Matilda effect. First, the probability of being awarded the first time a female researcher applies is 6.2 p.p. lower than for male researchers. Second, the probability of being awarded the first time regardless of the number of submissions in the past is 3.8 p.p. lower among female than male researchers. These results highlight the presence of the Matilda effect in the case of STEM in PICT: women are less likely to be first-time awarded than men. In this vein, since the Matthew effect has been proven in previous studies in general and in the case of PICT in particular, we wondered whether it takes different values for female and male researchers to approximate a third manifestation of the Matilda effect that has not been studied in the literature before. Results do not provide evidence of gender bias in this regard. Past awards impact the probability of persisting within the grant for women as much as for men. This suggests that once women overcome all the obstacles imposed by the S&T system, including first awards, they are in similar conditions to men in terms of being awarded again.

Despite the novelty and robustness of results, this research had some limitations that call for future research on the subject. The most important ones are derived from the nature of the database. We cannot know the different paths of both female and male researchers before applying to PICT. The database is isolated to those outstanding researchers who have at least submitted a project to PICT. Therefore, we do not know how many barriers women had to face to even apply for the first time to this grant. Another limitation is the lack of information about changes in research teams, to the extent that we just count on information about responsible researchers. Sometimes researchers decide to rotate the person in charge of the project to maximize the accumulation of academic background. Therefore, our results may underestimate the Matthew effect because there is no way to know when research teams may rotate responsible researchers in the different submissions. Additionally, we cannot know if this rotation takes place between men and women members of the teams. Finally, we do not know to what extent gender bias is a result of family composition, division of labor, or mental load, among others, either.

Finally, it is worth stressing some policy implications. Our results show that simple—and traditional—indicators such as the number of female researchers or awarded projects are not enough to analyze the existence of gender parity in S&T. In Argentina, equally distributed charges between women and men hide the fact that women are underrepresented in STEM fields and, therefore, they must submit a higher number of projects to reach the same number of awards as their male counterparts. Our results also show that to some extent a horizontal program to foster S&T activity can be a source of discrimination against women in STEM, increasing the initial gender gaps. All in all, this research shows that two types of policies are required. On the one hand, we need policies to close the present gender gap and eliminate both the observable and unobservable bias. On the other, we need policies that avoid the creation of gender biases at all. In both cases, policymakers will have to create mechanisms to generate consensus regarding the need to modify this situation and to collectively consider complex strategies to eliminate the gender gap and any other form of discrimination.

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Annex 1. The STEM Gap in Argentina

This Annex describes the current situation of women STEM researchers in Argentina at the aggregate level. The tables were elaborated using the information from the Argentine Science and Technology Information Portal (SiCyTAR, 2020) and refer to the total number of active researchers in 2018 (last available data). Table 8 shows the distribution of researchers according to their gender and main field of study. The participation of female researchers in STEM disciplines is 38 percent, while among men it almost reaches 50 percent.

Table 8. Argentine Scientific System: Researcher Distribution by Gender and Discipline (2018)

	Female		Male		Total	
Science	5,006	27%	3,759	28%	8,765	27%
Engineering	1,560	8%	1,903	14%	3,463	11%
Math and CIS	578	3%	650	5%	1,228	4%
STEM	**7,144**	**38%**	**6,312**	**47%**	**13,456**	**42%**
Non-STEM	**11,578**	**62%**	**7,137**	**53%**	**18,715**	**58%**
Active Researchers	**18,722**	**100%**	**13,449**	**100%**	**32,171**	**100%**

Source: Authors' elaboration based on SiCyTAR (2020).

Table 9 shows that male researchers publish more papers than their female colleagues. This general pattern is only altered within Engineering, where men and women show similar academic productivity. This result can be explained by the fact that most women have a PhD degree. The rest of the indicators show that the best male performance is concentrated in Science. In this case, academic productivity in higher-quality journals is double than that registered among female researchers. In addition, the rate of application and granting of patents is higher among men. In the rest of the STEM fields, no significant differences by gender were found.

Table 9. Characteristics of STEM Researchers by Gender

	Science			Engineering			Math and CIS		
	Female	Male	p-value	Female	Male	p-value	Female	Male	p-value
Age	42	44	0.000	43	45	0.000	46	42	0.000
PhD	66%	73%	0.000	56%	49%	0.000	39%	55%	0.000
Papers (All journals)	5	8	0.000	5	4	0.200	3	4	0.000
Papers (SJR > 1)	2	4	0.000	2	2	0.110	1	1	0.090
Probability of patent application	3%	5%	0.000	8%	10%	0.130	1%	2%	0.120
Probability of being granted a patent	1%	2%	0.000	2%	3%	0.040	1%	2%	0.160

Source: Authors' elaboration based on SiCyTAR (2020).

Finally, Table 10 shows that vertical segregation is mainly documented in the Science discipline. Women's participation tends to decrease when higher positions are analyzed (from 28 percent in the lowest up to 11 percent in the highest). However, the distribution tends to be more equitable within the rest of the STEM disciplines.

Table 10. Hierarchical Distribution in STEM Disciplines by Gender

Seniority Level	Science			Engineering			Math and CIS		
	Female	Male	p-value	Female	Male	p-value	Female	Male	p-value
A	11%	21%	0.000	14%	15%	0.500	11%	13%	0.270
B	17%	18%	0.510	14%	19%	0.000	21%	17%	0.120
C	44%	39%	0.000	46%	45%	0.460	51%	47%	0.150
D	28%	22%	0.000	25%	21%	0.010	16%	23%	0.010
	100%	**100%**		**100%**	**100%**		**100%**	**100%**	

Source: Authors' elaboration based on SiCyTAR (2020).
Note: D is the lowest level of the hierarchy and A is the highest level.