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# Lifetime Survivor Pensions of Daughters of Military Personnel and Educational Choices in Brazil

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**Abstract**

This paper investigates whether the expectation of a future lifetime survivor pension affects the educational choices of individuals and their families, focusing on the case of military daughters in Brazil. To assess this effect, we exploit a policy reform in the early 2000s that eliminated permanent pensions. The empirical analysis is based on microdata on daughters of different cohorts, and the impact of the permanent pensions is estimated using the average treatment effect (ATE) and the inverse-probability-weighted regression-adjusted estimator (IPWRA). The findings indicate that eligibility for lifetime pensions induced a 12.4-percent reduction in the average number of years of education, thus supporting the argument that generous social security benefits can act as a disincentive to education. The findings have relevant implications for the design of survivor pensions and other social security benefits, while also highlighting an inefficiency stemming from the Brazilian pension system.

**Keywords**: survivor pensions, social security, education, impact assessment

**JEL**: H55, I20, J24

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## 1. Introduction

In recent decades, there has been ongoing debate and reform in pension and social security systems across different countries, triggered by societal changes such as increased life expectancy, population ageing and increased labor supply of women and old-age individuals (Börsch-Supan & Coile, 2021; Hinrichs, 2021). Some of the main concerns addressed by these reforms are financial sustainability, high deficits affecting the public budget and economic inefficiencies (Feldstein, 2005; Huggett & Ventura, 1999; OECD, 2018). However, one point that has received less attention is the effects of pensions on the educational choices of individuals and families. This is an important aspect to be taken into consideration, given its implications for human capital accumulation, which constitutes one of the channels through which social security can either boost or hinder economic growth (Paiva & Varella, 2019; Zhang & Zhang, 2004).

Survivor pensions are a part of such a reform agenda, given their high costs, the behavioral responses of beneficiaries and the potentially regressive effects. This type of benefit makes up one recipient for every five old-age pensioners in OECD countries, while in Brazil, for each survivor pensioner, there are 2.7 old-age retirees (Ministry of Social Security, 2023; OECD, 2018).[3] The structure and funding allocated to survivor pensions exhibit considerable variation across countries, but in most cases, they are at least partially funded through taxes and contributions (OECD, 2018), which justifies the debate on their relevance and impacts on the economy. Past research suggests that generous survivor schemes can harm labor market participation (especially for females) and family savings (Groneck & Wallenius, 2021; James,

[3] Data for Brazil refers to the RGPS (General Regime of Social Security).

2009). In addition, cross-subsidies between families may cause wealth redistribution from low to higher-income households (Kaygusuz, 2015; Nishiyama, 2019).

While such shortcomings are commonly acknowledged, the debate on the potential impact of survivor pensions on the educational choices of beneficiaries is limited and still lacks consensus. Two opposing theories can explain this relation by focusing either on the increase in family wealth in the present (in which case the impact would be positive—Lambrecht et al. (2005)) or on the expectation of a future income (with a resulting disincentive to education—Caliendo and Findley (2020)). The empirical evidence on this point is scarce and conflicting (Cockx et al., 2023; Reis & Camargo, 2007), thus, the subject is still open to debate. Thus far, few studies have assessed how the generosity of pension schemes changed or predicted educational choices before benefits are due (Cockx et al., 2023; Hernæs et al., 2017).

In light of this debate, this paper aims to investigate whether the expectation of a lifetime survivor pension in the future can affect the educational choices of individuals and their families, considering the case of military daughters in Brazil. The country has a large and complex social security system that encompasses different schemes with varying rules and levels of generosity, which have undergone reforms over the recent years (Lanzara & Silva, 2023). The permanent pensions for military daughters were a case of a favorable entitlement that was eliminated in the early 2000s to enhance the system's financial sustainability. This change in regime constitutes an appropriate setting for investigating the impact of survivor pensions on educational choices.

To estimate the effect of the permanent pensions, we exploit a policy reform in the early 2000s that abolished permanent pensions for military daughters, while preserving the rights of those whose parents had already joined the forces. The empirical analysis is based on microdata on daughters of different cohorts who reside with their military parents, and information on such

parents' age is used to distinguish between daughters entitled to permanent pensions and those who are subject to the new rules (and, therefore, only eligible for an age-limited benefit). The effect of the pension is estimated using the average treatment effect and the inverse-probability-weighted regression-adjusted estimator, supplemented by additional approaches to test the robustness and sensitivity of the results. The findings indicate that, after controlling for confounding factors, lifetime pensions reduced the number of years of education of eligible military daughters chosen by their families, thus providing support for the argument that generous social security benefits can act as a disincentive to education.

The analysis contributes to the literature mainly by adding to the scarce empirical evidence on the relation between, on the one hand, social security policies and, on the other hand, individuals' educational and human capital levels. Moreover, this is the first investigation on this topic with a specific focus on survivor pensions, a benefit found in most countries and systems, despite the controversy over their role and suitability in current society (OECD, 2018). The findings have relevant implications for the design of survivor pensions and other benefits, and they also highlight an inefficiency stemming from the Brazilian social security system to be considered in future policy reforms.

The remainder of this paper is structured as follows. The second section provides a review of the existing literature and evidence concerning survivor pensions and the interplay between such benefits and education. The third section offers a summary of the Brazilian social security system and outlines the relevant regulations pertaining to survivor pensions and the case of military daughters. The fourth part details the data and empirical approach employed to assess the effects of permanent pensions, and the fifth section presents and discusses the findings of the analysis. Finally, the sixth section concludes and suggests future research directions.

## 2. Survivor Pensions and Educational Choices: Review of the Literature

Survivor pensions are a form of co-family life insurance for the dependents or beneficiaries of the pension provider, with payouts comprising periodic installments instead of a fixed one-time payment. It was originally envisioned as an insurance to wives and families in a time where the male-breadwinner model prevailed, divorces were rare, and women were excluded from the labor market (Groneck & Wallenius, 2021; Hanemann & Rausch, 2020). The benefit has two main objectives: to protect widows and children from poverty and to smooth family consumption levels, avoiding a sharp decrease in disposable income after the death of a partner or parent (James, 2009).

The number of these pensions increased substantially worldwide as of the second half of the 20th century, along with general social security coverage. Expenditures on survivor pensions in OECD countries are currently estimated to be approximately 1 percent of gross domestic product (GDP), although this proportion varies considerably across countries (Ansiliero et al., 2014; OECD, 2018). In light of such costs and the increased participation of women in the labor force, the relevance and desirability of survivor benefits has been challenged (Hanemann & Rausch, 2020), and different countries have reformed the applicable rules over recent decades, mostly to tighten eligibility requirements (Rabaté & Tréguier, 2022; Shelton & Nuschler, 2010).

As the original societal features that provided grounds for survivor pensions became outdated, the justification for these benefits changed to efficiency grounds, pointing to failures in voluntary insurance markets responsible for nonoptimal low levels of purchases. First, workers tend to save less than necessary for themselves and their families and to purchase low levels of insurance due to myopia (Pinheiro, 2005; Rabaté & Tréguier, 2022). Second, couples and families benefit from household economies of scale not accounted for by individuals, which means that, in the case of

death of an income earner, household consumption falls less than proportionately; therefore, revenue decline is greater than household spending reduction (Groneck & Wallenius, 2021; OECD, 2018). Finally, there are also adverse selection problems in insurance markets, as companies facing asymmetric information are likely to charge a high premium, as they cannot differentiate low-risk and high-risk individuals, causing families to purchase less insurance (James, 2009).

Notwithstanding such arguments, survivor pensions may present inequity and inefficiency shortcomings, which have sparked controversy over whether they still play a meaningful role in present-day policies and what the potential gains of their elimination may be (Kitao & Mikoshiba, 2022; Sánchez-Marcos & Bethencourt, 2018). The main inefficiency discussed in the literature is the disincentive for beneficiaries to work both before and after the death of the pension provider. The rationale is that individuals in a noninsured household who experienced such an event respond to the loss of income by increasing the labor supply of widows or working-age family members (Böheim & Topf, 2021; Borella et al., 2023; Fadlon & Nielsen, 2019). As receiving a survivor pension increases household wealth, the need for such compensation decreases (or is completely offset), thus reducing the labor supply response (Fadlon et al., 2019; Sánchez-Marcos & Bethencourt, 2018). Moreover, these individuals can anticipate such benefits and smooth their labor supply (Rabaté & Tréguier, 2022), so that the expectation of future income would reduce work incentives even before the death of the pension provider (Groneck & Wallenius, 2021; James, 2009; Kaygusuz, 2015).

These negative effects of survivor benefits on employment (especially for females) were found in different countries (Böheim & Topf, 2021; Fadlon et al., 2019; Giupponi, 2019; Rabaté & Tréguier, 2022) despite the large disparities in the design and rules of the benefits. In Brazil,

where survivor benefits are among the most generous (Ansiliero et al., 2014), two studies concluded that they negatively impact women's participation in the labor market (Costanzi et al., 2017; Rocha, 2021).

The magnitude of such labor supply distortion depends on the pension design, including whether pensions are permanent and the respective eligibility age. Existing evidence suggests that a lower eligibility age for permanent pensions negatively impacts female employment (Atalay & Barrett, 2015). Many OECD countries have limited entitlement to permanent survivor pensions by establishing minimum age limits, both to reduce the cost of public systems and because it might not be necessary for working-age survivors who can join or reenter the labor market (James, 2009; OECD, 2018). Those under the minimum age may either be entitled to a temporary benefit for an adjustment period or have the permanent pension delayed until the needed age. The eligibility age for permanent survivors is usually lower than that for old-age pensions, and spouses who cannot work or who care for children may be entitled to such permanent or longer benefits even if they are younger (Hanemann & Rausch, 2020).

Just as these benefits can affect employment choices, they can also change the incentives for investing in education. This type of effect on human capital accumulation has been much less investigated for survivor pensions, but a limited literature on the general subject has been developed for other types of insurance and pension benefits (Caliendo & Findley, 2020; Cockx et al., 2023; Weiss et al., 1980).

There are two main economic approaches that suggest an association between social security transfers and educational attainment, yielding opposite results (Butler, 1990). The first considers the income increase caused by welfare benefits received at the time when education investment takes place. The main assumption is the presence of liquidity and credit constraints. In this

scenario, low and middle-income families would underinvest in human capital, despite its high rate of return. Therefore, by increasing family wealth, social security benefits would lift such financial constraints and have a positive effect on educational investment (Ku, 2001; Lambrecht et al., 2005). According to this argument, as high-income families are not so much constrained, pensions would not considerably affect the education of their offspring.

The other approach considers that entitlement or even the expectation of future benefits creates a disincentive for education. Assuming a human capital framework, studying is costly, but it increases work productivity and the prospects of future compensation. Rational individuals invest in education up to the point where the marginal costs and returns of education are equal (Becker, 2009). In this setup, individuals entitled to or expecting to receive future pensions should have lower marginal utility returns of education. Therefore, by increasing expected nonwork income in the future, such benefits would reduce the relative utility value of a life-cycle salary increase due to an additional unit of education (Butler, 1990; Gensler, 1996). As the relative rewards of education decline (Caliendo & Findley, 2020), more families would choose to reduce investment in human capital for their children, leading to lower educational attainment levels.

Empirical evidence on such effects of contributory pensions on education is sparse (Paiva & Varella, 2019). Support for the increase in education argument was found in an early literature in the U.S. (McDonald & Stephenson, 1979; Venti, 1984) and in a recent analysis in Brazil (Reis & Camargo, 2007).[4] However, different empirical studies also found support for the disincentive argument. Stricter eligibility conditions for unemployment benefits were found to improve high

[4] However, there is substantial evidence of such positive 'increased income' effect in the case of noncontributory cash-transfer program targeting poor families (Bastagli et al., 2016; Paiva & Varella, 2019).

school graduation rates (Cockx et al., 2023; Hernæs et al., 2017). On similar grounds, research on family aid programs found that, controlling for family income, welfare transfers are negatively associated with or have a negative effect on the educational attainment of children (Butler, 1990; Gensler, 1996; Ku, 2001).

The literature on survivor pensions has not yet considered this debate, and only a few papers have addressed the potential association of such benefits with educational attainment. These studies investigated students who experienced the death of a parent and found that pensions reduce the odds of college dropout and increase the likelihood of obtaining a higher education degree, in line with the 'increased education' argument (Dynarski, 2003; Groves & Lopoo, 2015). A study using Brazilian household data found that young people living with a survivor or old-age pensioner are more likely to be enrolled in school or college (Reis & Camargo, 2007). However, these analyses focused on responses and outcomes after individuals obtained the benefits.

Therefore, the potential presence of the disincentive argument has not been yet addressed, and it remains unknown whether educational choices are affected or associated with the expectation of future survivor pensions before the death of the pension provider. In addition, it is not clear whether the permanence of the benefits plays a role. That is, whether those entitled to permanent survivor pensions present educational outcomes distinct from those with temporary benefits is unclear. The empirical analysis presented in the next sections of this paper contributes to filling these gaps in the literature.

**Survivor Pension Systems in Brazil and the Case of Military Daughters**

Brazil has a large public retirement and pension system, with high benefits and low retirement ages (OECD, 2017). The public '*pay-as-you-go*' system was not privatized, which makes it an

outlier in Latin America (Arza, 2017; Matijascic & Kay, 2014). This framework was initially designed in the 1988 Federal Constitution, which grouped different insurance and social policies (including health, social assistance and pensions) under the broad concept of 'social security' (Matijascic & Kay, 2008). Considering all public schemes and benefits, social security coverage reaches nearly 70 percent of the active working population and 85 percent of the elderly population (Silva Filho et al., 2023).

Along with other parts of this system, the rules on survivor pensions are considered more generous and advantageous than those in other countries (Ansiliero et al., 2014). Before the 2019 reform,[5] spending on such benefits reached approximately 2.6 percent of the country's gross domestic product (GDP), while in other countries, such expenditures usually do not exceed 1 percent (Costanzi et al., 2017; Rocha & Caetano, 2008). The main differences in relation to other countries include the minimum number of contributions required from the pension provider, the minimum duration of marriage for the entitlement of widows, the high replacement rate and the accumulation of survivor pensions with other social security benefits (Ansiliero et al., 2014).

The country's social security system is a complex array of several schemes, with different rules on entitlement, contributions and benefits. The main subsystems are the 'General Regime of Social Security' (RGPS)[6]—applicable mostly to private sector workers—and the 'Special Regime of Social Security' (RPPS)[7], which is a collection of more than two thousand schemes applicable to public employees at different levels (World Bank, 2022). In both subsystems, survivor pensions are due to the widow or widower and any children of the deceased younger than 21 years old, although in some RPPS schemes, such limit is extended if the descendant is in

[5] Constitutional Amendment 103/2019.
[6] *Regime Geral de Previdência Social.*
[7] *Regime Próprio de Previdência Social.*

college (usually up to 24 years of age).[8] The law does not require a minimum time of contribution, sufficing that the pension provider is affiliated with the respective scheme at the time of death (as either an active worker or retiree). The main difference between the two subsystems is that pensions in RGPS are limited to the maximum 'contribution salary',[9] which is not applicable to the RGPS.

Along with these subsystems, the 'Military Social Protection System' (*SPSM*)[10] is a set of rules exclusively applicable to federal-level military forces and to military police and fire departments at the state level. For most intents and purposes, it is more advantageous than both the RGPS and RPPS schemes, offering average benefits more than seven times the mean value granted by the RGPS (Silva Filho et al., 2023). The main features distinguishing the SPSM of the other schemes are the low retirement age, the integrality and parity principles,[11] and the noncontributory nature of retirement benefits (Schettini & Vizioli, 2022).

Survivor pensions under the military scheme are equivalent to the salary of the active military servant of the same rank, and they are shared equally by all first-order beneficiaries of the deceased. As with the RGPS and the RPPS, the first-order beneficiaries are the spouse and children.[12] However, until the 2000s, there was an important distinction between beneficiary children covered by the SPSM: while sons were entitled to the survivor pension up to 21 years old (or 24 if in college), daughters would receive the pension for life, with no age limit.[13] This

[8] E.g., art. 14 of Rio de Janeiro State Law 5,260/2008.
[9] The RGPS contribution salary cap is approved annually by the federal government.
[10] *Sistema de Proteção Social dos Militares.*
[11] Such principles mean that a military servant is entitled to the totality of his or her last salary as retirement benefits, as well as to any compensation increases associated with his or her last occupation.
[12] Art. 7 of Law 3,765/1960, as amended by Law 8,216/1991.
[13] Art. 7 of Law 3,765/1960, as amended by Law 8,216/1991. Originally, Law 8,216/1991 only granted lifetime pension to single daughters, i.e., up to their marriage. However, such rule was deemed unconstitutional by the Supreme Court in 1993 (Direct Action of Unconstitutionality 574-0).

provision dates back to early XIX century legislation,[14] and it constituted the only case of children's lifetime survivor pension still valid under the 1988 Federal Constitution.[15]

In 2000 and 2001, a series of provisional measures (the latest of which was Provisional Measure 2,215-10/01, still in force) changed this rule, establishing age limits for daughters similar to that for military sons (and children under the RGPS and RPPS schemes). Therefore, according to the new rules, daughters of military personnel who joined the forces after the reform (dated as of November 29th, 2000) were only entitled to a temporary pension up to the age of 21 (or 24 if in college).[16]

Importantly, the rights and benefits of those who were already in service by the time of the reform were partially preserved. Their daughters remained entitled to a lifetime survivor pension if the military parent agreed to pay an additional contribution of one and a half percent. For this reason, although this benefit has been extinguished for more than twenty years, it is still paid to a large group of military daughters. Data on these lifetime pensions are limited, but an indication of the great number of beneficiaries is that in December 2020, there were approximately 40 military daughters receiving a survivor pension from the federal government for each military son with such benefits (CGU, 2023).

A last distinctive feature of military employment in Brazil worth mentioning is that there are minimum and maximum age limits for someone to join the forces. The limits depend on the career and the force,[17] but in most cases, the minimum limit is 16 or 17 years old,[18] and the

[14] Art. 3 of Law of November 6th, 1827.
[15] Not considering incapacitated children and specific individual cases approved by law.
[16] Art. 27 of Provisional Measure 2,215-10/01.
[17] Army personnel – Law 12,705/2012 and Law 4,375/1964, as amended; Navy forces– Law 12,704/2012; Air force – Law 12,464/2011.
[18] Law 12,705/2012, art. 3, III.

maximum is below 30 years old if it is not for a specialty career (such as health care or engineering). In the case of temporary army personnel, the maximum age limit is 40 years.[19] However, military servants usually join the forces at a much younger age: the average age of admission of all active personnel in 2018 (including federal forces, state police and state fire departments) was 22 years old. In that year, around 98 percent of all active military personnel had enlisted before reaching the age of 40 (Ministry of Labor and Employment, 2023).

## 4. Research Hypothesis

In this paper we use the case of military daughters in Brazil to investigate how lifetime pensions affect the educational choices of individuals. As military daughters subject to the former scheme (before the 2000–2001 reform) are entitled to a lifetime pension (subject to the requirements established by the law), we can compare their families' choices with those of a different cohort of daughters who are only eligible for an age-limited benefit. This allows us to assess whether the expectation of a permanent pension changes family's choices before the death of the pension provider.

The studies that explicitly considered entitlement to future benefits argued that it may act as a disincentive to educational investment (Butler, 1990; Gensler, 1996). According to the human capital framework, education is costly, and rational individuals study up to the point where marginal benefits are equivalent to marginal costs (Becker, 2009). In this framework, the expectation of a lifetime survivor pension would reduce the marginal utility of a salary increase caused by additional years of schooling (Caliendo & Findley, 2020). As military daughters entitled to such benefits already expect to receive nonlabor income at a certain point in the

[19] Art. 27 of Law 4,375/1964.

future, their families would value the marginal returns of human capital accumulation less than those whose daughters must rely on their own (or their families') labor and resources. In a cost-benefit analysis, such lower utility returns would lead these families to reduce their investment in the education of their daughters.

Thus, all else being equal, military daughters entitled to a lifetime survivor pension should study less (i.e., have fewer years of education) than those who are not eligible for the same permanent benefit. This is the research hypothesis to be tested empirically below.

## 5. Empirical Analysis

### *5.1 Data and sample*

The empirical analysis is based on data from the 'National Household Sample Survey' (PNAD)[20] and its successor, the 'Continuous National Household Sample Survey' (PNADC)[21], both of which were gathered by the Brazilian Institute of Geography and Statistics (IBGE). PNAD was an annual survey[22] carried out up to 2015 that used a sample representative of the Brazilian population (Guerra, 2001). It was succeeded by PNADC, which started in 2012 and presents a broader range of indicators and a more sophisticated sampling strategy, with more households visited on a rotating basis (Jannuzzi, 2017). These data sources have been used before in different analyses of survivor pensions and other social security issues in Brazil (Ansiliero et al., 2014; Costanzi et al., 2017; Matijascic & Kay, 2014), as they include variables on the labor market, salary, contributions and pensions at the individual and family levels.

[20] *Pesquisa Nacional por Amostra de Domicílios.*
[21] *Pesquisa Nacional por Amostra de Domicílios Contínua.*
[22] Except for the years of the national population census (once each decade).

We use data from daughters of military personnel from the 2008 to 2015[23] waves of PNAD and from the 2012 to 2022 waves of PNADC.[24] Both surveys present similar structures and variables, so they were merged into a single dataset for the purposes of this analysis. The microdata are at the individual level, but they present variables identifying each residence and family surveyed; thus, it is possible to link people from the same family and identify their kinship. Using such information, we identified military daughters five or more years of age who resided with their parents. As military parents were still alive, their daughters did not receive the respective survivor pension at the time of the survey, and they only had an expectation to receive it in the future, depending on and according to the applicable eligibility rules.

Unfortunately, PNAD and PNADC do not explicitly inform the pension scheme to which daughters in the dataset were subject to. For this reason, it was necessary to reduce the sample to distinguish those eligible for a lifetime survivor's pension (considered the 'treated group') from daughters who were entitled only to pensions up to 21 or 24 years old (the 'control group'). As there are age limits to joining the forces in Brazil, the age of the military parent can be used for this purpose. According to Provisional Measure 2,215-10/01, military personnel must have enlisted up to December 29, 2000 — the 'threshold date' — to secure their daughter's entitlement to a lifetime pension. This condition implies that any military parent exceeding the maximum age limit on the threshold date must have joined the forces prior to the reform. Assuming that such parents agreed to pay the additional contribution fee,[25] their daughters qualify for a lifetime pension; therefore, they are part of the treated group. Conversely, if the

[23] Data prior to the 2008 wave were not used because the number of individuals in the control group was null or too small, thus risking violation of the common support or overlap assumption necessary for estimation (Abadie & Cattaneo, 2018; Wooldridge, 2010).
[24] We used the microdata of the 1st visit of each year, which present variables on labor market and education of individuals. For the 2020 and 2021 waves, such information was available in the 2nd visit, which was used herein.
[25] This assumption is discussed in the results section as a potential limitation of the findings.

military parent fell below the minimum age required to join the forces on the threshold date, their enlistment would have occurred post-reform, thus designating their daughters to the control group.

In this analysis, the age of 40 years, as established by Law 4.375/64 for temporary personnel, was used as the maximum age for enlisting. This age limit consequently serves as the lower limit for the age of the military parent on the threshold date within the treated group. Similarly, the age of 16 years provided by Law 12,705/2012[26] was used as the upper limit for the military parent's age within the control group. The final sample used in the analysis comprises 372 daughters who were at least 5 years of age and who resided in the same domicile as a living military parent. These parents were either (i) 40 years or older on the threshold date (the treated group) or (ii) 16 years or younger on the threshold date (the control group).

The chosen age limits ensure that the sample comprises only individuals with a high probability of being correctly classified in the treated or control groups. However, these limits may be considered too strict, as different military careers establish more flexible age limits for new personnel. To minimize this problem, we run a sensitivity analysis as part of the overall empirical strategy, reducing the age gap between parents in the treated and control groups.

*5.2 Variables and Descriptive Statistics*

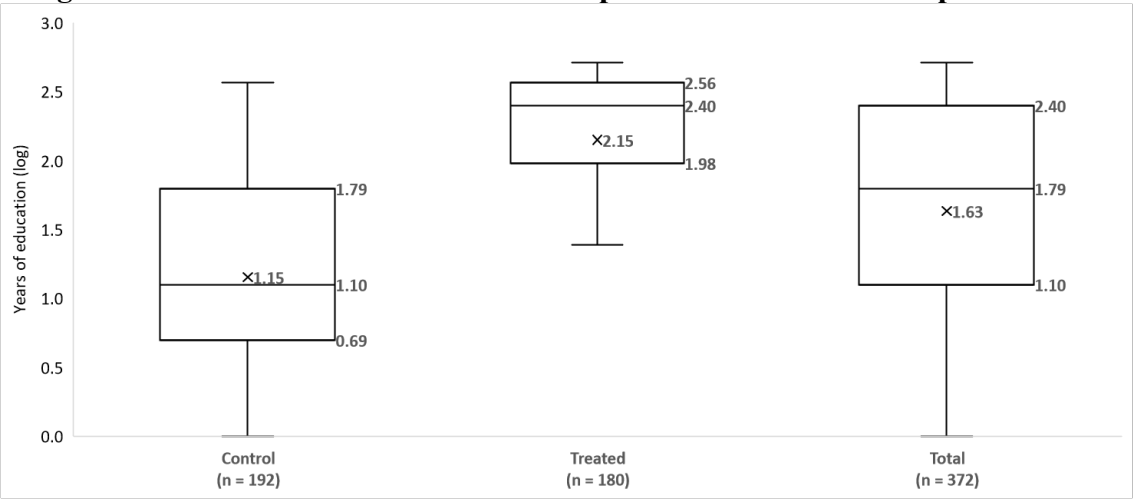
The outcome considered in the empirical analysis is the number of years of education (log-transformed), which ranges from one to 15 years, following the PNAD scale.[27] Figure 1 presents the distribution of the variable for the treated and control groups, as well as for the total sample.

[26] Lower age limit established in the law, applicable for joining the preparatory cadet course (Art. 3, III, a).
[27] The data is right-censored at this point. In PNADC, the upper limit is 16 years. For consistency of the analysis, individuals in PNADC with 16 years of education were considered as having only 15 years.

In general, daughters entitled to lifetime pensions (treated) had more years of education than did those in the control group, both on average and considering the main quantiles (25, 50 and 75). Therefore, such a 'naïve estimator' (Duguet, 2012) does not support our research hypothesis, as individuals in the treated group seem to be generally more educated than those in the control group are.

However, the two groups present substantial differences in factors that are correlated with the educational level, which suggests that the naïve estimator should be biased. These dissimilarities are shown in Table 1, which displays the descriptive statistics of the variables used in the empirical analysis for both groups. The most important distinction is that those in the treated group are on average older,[28] so it is expected that, *ceteris paribus*, they would be more educated, thus partially explaining the higher average of this group in Figure 1. In addition, those in the treated group also present a higher average per capita household income, which is another variable positively correlated with education attainment (Ku, 2001; Lambrecht et al., 2005).

**Figure 1. Distribution of the Number of Years of Education (log-transformed) for Military Daughters in the Control and Treated Groups and for the Total Sample**




Notes: Parameters of the boxplot according to Tukey (1977). Outliers excluded. *'X'* indicates the average of the

[28] This is explained by the fact that military parents of daughters in the treated group are generally older, for they joined military forces years before the parents of those in the control group.

distribution. Source: prepared by the authors, based on IBGE (2016, 2023b).

**Table 1. Descriptive Statistics of the Variables Used in the Empirical Analysis**

| Variable | | Military daughters not entitled to lifetime pension (control group) | Military daughters entitled to lifetime pension (treated group) | Total |
|---|---|---|---|---|
| No. of years of education (log) | Mean<br>s.d.[a] | 1.151<br>(0.802) | 2.148<br>(0.647) | 1.633<br>(0.884) |
| Age (log) | Mean<br>s.d.[a] | 2.309<br>(0.314) | 2.832<br>(0.335) | 2.562<br>(0.416) |
| Household per capita income (log)[b] | Mean<br>s.d.[a] | 7.325<br>(0.688) | 8.025<br>(0.697) | 7.664<br>(0.775) |
| Mother: no. of years of education (log) | Mean<br>s.d.[a] | 2.487<br>(0.237) | 2.424<br>(0.358) | 2.457<br>(0.303) |
| Race: Black | % | 5.2% | 6.7% | 5.9% |
| Race: Brown | % | 52.1% | 43.9% | 48.1% |
| Rural household | % | 1.6% | 1.7% | 1.6% |
| Country region: North | % | 19.8% | 17.2% | 18.6% |
| Country region: Northeast | % | 19.3% | 23.3% | 21.2% |
| Country region: Southeast | % | 28.7% | 32.8% | 30.7% |
| Country region: South | % | 11.5% | 7.8% | 9.7% |
| Country region: Central-west | % | 13.5% | 15.6% | 14.5% |
| *N*<br>% | | 192<br>51.6% | 180<br>48.4% | 372<br>100.0% |

Notes: [a] Standard deviation. [b] Constant values (December, 2022), readjusted using the National Consumer Price Index (INPC) published by IBGE (2023a). Source: prepared by the authors, based on IBGE (2016, 2023b).

Additionally, the treated and control groups are distributed unevenly across the period of analysis. The treated group presents a greater density in the first years of observation (approximately 75 percent in the first six years), whereas the opposite trend is observed for the control group (approximately 74 percent in the last six years). This observation is important because the educational system in Brazil underwent substantial changes during this period. Notably, there was a marked increase in the educational level of the population over the years (Todos Pela Educação, 2021). Consequently, individuals observed in the latter years are expected to have higher levels of education than those in earlier years.

These features suggest that the naïve estimator should not be relied upon, and that a more nuanced estimation model is required to partial out these factors and accurately assess the impact of lifetime pensions on the educational attainment of military daughters.

### *5.3 Estimation Strategy: The Inverse-Probability-Weighted Regression-Adjusted Estimator*

The effect of lifetime pensions is estimated herein using the 'potential outcomes' or 'Rubin causal' framework, which has been extensively discussed and applied in the economic evaluation literature (Abadie & Cattaneo, 2018; Athey & Imbens, 2017; Imbens & Wooldridge, 2009). It mainly addresses impact assessment as a missing data problem, as only one of the potential outcomes is observed, so it is necessary to find a suitable counterfactual for the other (Wooldridge, 2010). The basic assumption of the model is that the treatment of one unit does not affect the others (the 'stable unit treatment value assumption'), which is arguably acceptable in the case of military daughters, as the pension of one should not have any impact on the behavior or educational choices of others, assuming that they are not related.

The parameter of interest is the average treatment effect (ATE), which estimates the expected impact of a policy on an individual randomly chosen from either the treated or control group (Varaku & Sickles, 2023). Following the usual notation, $W$ is a binary indicator of treatment (where $W_i = 1$ means entitlement to lifetime pension, and $W_i = 0$ otherwise), $Y_i$ is a random variable that represents the realized outcome (number of years of education) for individual $i$, $Y_{1i}$ is the potential outcome of such unit had it been treated, and $Y_{0i}$ is the potential outcome in the absence of treatment. In this setup, the ATE informs the average difference in potential outcomes (with and without treatment) for the population, or the expected effect induced by the pension (Abadie & Cattaneo, 2018), as presented in equation 1.

$$ATE = E(Y_1 - Y_O) = E(Y_1) - E(Y_O) \quad (1)$$

However, as each potential outcome is only observed for one group ($Y_1$ for treated individuals and $Y_0$ for the control units), the expected values for the entire population on the right-hand side of the equation must be estimated. In the case under analysis, military daughters in the treated and control groups present important differences, so treatment and potential outcomes cannot be deemed independent (i.e., they are confounded). For this reason, the expected value of the potential outcomes of each group should not be the same (i.e., '$E(Y_1) \neq E(Y_1|W = 0) \neq E(Y_1|W = 1)$' and '$E(Y_0) \neq E(Y_0|W = 0) \neq E(Y_0|W = 1)$'), and therefore, neither can be used directly as a counterfactual for the whole sample or the entire population (Athey & Imbens, 2017).

We estimate the ATE using primarily the inverse-probability-weighted regression-adjusted estimator (IPWRA), which combines regression adjustment (RA) and inverse-probability weighting (IPW) techniques in a single approach. IPWRA is considered one of the best practices in the program evaluation literature (Imbens & Wooldridge, 2009), and its main appeal is its double-robust nature, i.e., consistent estimation of the ATE requires that only one of the main models (IPW treatment probability or the RA potential outcome equation) be correctly specified, not both (Cattaneo, 2010; Wooldridge, 2010).

Two additional assumptions are necessary for consistency of the IPWRA. The first is the conditional independence or ignorability of treatment, an untestable assumption that means that, conditional on a set of covariates *X*, treatment and potential outcomes (*W,* $Y_0$ and $Y_1$) can be deemed independent.[29] And the second is the overlap or common support assumption, which

[29] As suggested by Wooldridge (2010), this assumption loosely means that while ($y_0$, $y_1$) and *w* might be correlated, they should not be correlated as we control for '*X*'.

requires that, given the covariates, all individuals in the sample must have a positive but lower than one probability of being in the treated group, i.e., $0 < Pr(W_i = 1|X) < 1$ (Abadie & Cattaneo, 2018).

Using the IPWRA framework, the ATE is estimated through three steps (Lu et al., 2021; Wooldridge, 2010; Zheng & Ma, 2023): (i) estimation of the treatment probability equation parameters to obtain the inverse-probability weights, as presented in equation 2.1; (ii) estimation of the outcome regression coefficients $\hat{\alpha}$ and $\hat{\beta}$ for the treated and control groups (separately) using the weights calculated in the first step (equations 2.2 and 2.3); and (iii) prediction of the potential outcomes (with treatment and not) using the coefficients obtained in the previous step, and estimation of the ATE by averaging the difference between such outcomes for all units in both groups (equation 2.4).

$$p(X_i) = \Pr(W_i = 1|X_i) = E(W_i|X_i) \quad (2.1)$$

(2.1)

$$\min_{\alpha_1,\beta_1} \sum_{i=1}^{N} W_i\left(Y_{1,i} - \alpha_1 - X_i\beta_1\right)^2 / p(X_i) \quad (2.2)$$

(2.2)

$$\min_{\alpha_0,\beta_0} \sum_{i=1}^{N} (1 - W_i)\left(Y_{0,i} - \alpha_0 - X_i\beta_0\right)^2 / (1 - p(X_i)) \quad (2.3)$$

$$\widehat{ATE_{IPWRA}} = N^{-1} \sum_{i=1}^{N} \left(\left(\widehat{\alpha_1} + X_i\widehat{\beta_1}\right) - \left(\widehat{\alpha_0} + X_i\widehat{\beta_0}\right)\right) \quad (2.4)$$

As suggested by Wooldridge (2010), the set of covariates *X* of the treatment and regression models should include available variables that both predict treatment (but are not affected by it) and might be correlated with the outcome. Controlling for such variables should reduce (or ideally avoid) the risk of dependence (conditional on *X*) between treatment and potential

outcomes, as required by the ignorability of treatment assumption. The literature suggests that maternal education and household income are crucial predictors of educational attainment (Delaney et al., 2011; Rumberger, 1983), so they are included in the model. The set of covariates also includes those listed in Table 1, along with state (province) dummies (instead of the country region reported in the table) to control for locational factors, and year dummies to account for the evolution of the Brazilian educational system over the period of analysis.

Alternative estimates are presented as robustness tests and compared with the results of the main model. First, the ATE is also estimated using the regression-adjusted estimator. We also estimate the impact of the permanent pension using the average treatment effect on the treated (ATT), which calculates the mean difference in potential outcomes, but considering only the treated group (i.e., military daughters subject to the former pension scheme). Additionally, we run a linear model, using a standard ordinary least squares (OLS) estimator with a robust variance-covariance matrix, and using $X$ along with a dummy for lifetime pensions (the parameter of interest) as independent variables.

Finally, we conduct a sensitivity analysis to assess whether the results of the main model are contingent upon our choice of age limits for the military parent on the threshold date. In this analysis, we gradually narrow the gap between the age limits of the military parents by raising the maximum age for the control group and lowering the minimum limit for the treated group (both by one year), and then recalculating the model parameters. As the gap between limits decreases, the sample size grows, as more military parents meet the age criteria for one of the groups. However, this adjustment also increases the risk of misclassifying a daughter as treated or control. Through this procedure, we explore the extent to which we can change the age limits without compromising the qualitative findings of the main model.

## 6. Results

This section presents and discusses the results of the empirical analysis on the effects of lifetime pensions on educational choices. We first present the ATE estimates derived from the main model. Subsequently, we examine the results of the robustness tests and sensitivity analysis. Finally, we discuss the findings and analyze their policy implications.

### *6.1 Results of the Main Model*

Table 2 presents the estimated effect of eligibility for a permanent survivor pension on the years of education of military daughters, considering the ATE parameter and the IWRA estimator. As the outcome is measured in logarithmic form, the result represents the average percentage change induced by the treatment on the education of daughters. The precise value of the estimated change is derived by computing '$(e^{ATE} - 1)$' (Wooldridge, 2018), which is also depicted in the table (column 4). A 95-percent confidence level is used to assess the statistical significance of the results.

**Table 2. Estimated Average Treatment Effect (ATE) of Entitlement to Lifetime Pension on Years of Education (IPWRA Estimator)**

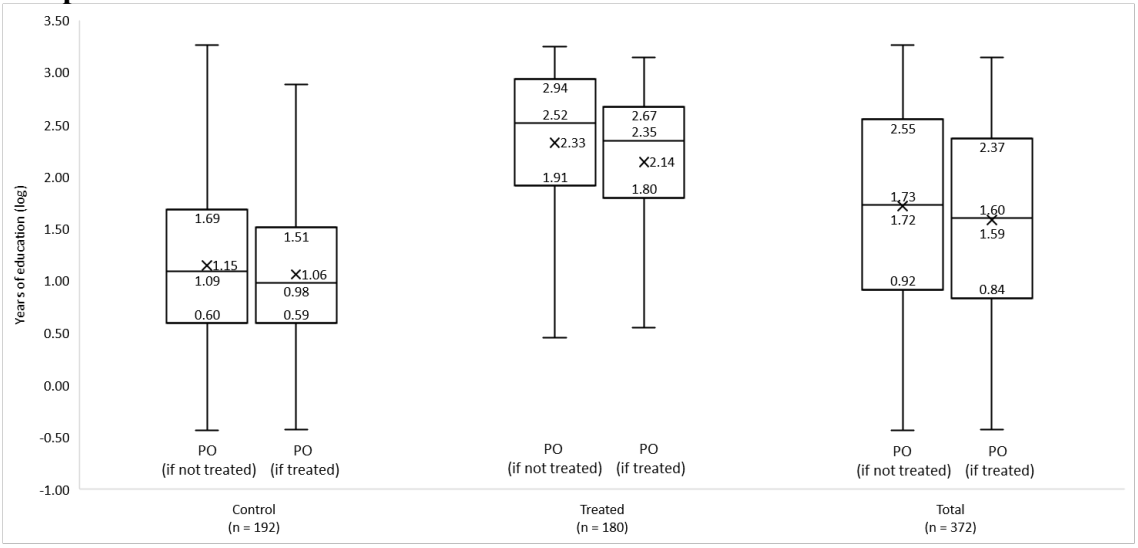
| Outcome variable | Mean potential outcomes (of all units) | | | |
|---|---|---|---|---|
| | With treatment (1) | Without treatment (2) | ATE (3) | $(e^{ATE} - 1)$ (4) |
| No. of years of education (log) | 1.587 | 1.719 | -0.133*** (0.043) | -12.37% |
| *N* | | | | 372 |

Notes: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: prepared by the authors, based on IBGE (2016, 2023b).

The estimated ATE suggests that eligibility for the lifetime benefit reduces the average number of years of education by 12.37 percent. This corresponds to approximately -0.7 year, considering the mean potential outcome for all individuals had they not been treated (as presented in logarithmic form in column 2). This information is also displayed in Figure 2 (third pair of box

plots), which illustrates that the estimated potential outcome with treatment (eligible for permanent pension) is lower than without treatment. Such finding is observed for both the control (first set of box plots) and treated (second set) groups, although the difference is greater in the latter case. Moreover, the figure reveals that not only the average but also the first three quartiles of the distribution are lower for the outcome with treatment, regardless of the group under consideration.

**Figure 2. Distribution of the Potential Outcomes (PO): Number of Years of Education (log-transformed) for Military Daughters in the Control and Treatment Groups and Total Sample**




Notes: Parameters of the boxplot according to Tukey (1977). Outliers excluded. 'X' indicates the average of the distribution. Source: prepared by the authors, based on IBGE (2016, 2023b).

These results support the research hypothesis and indicate that entitlement to a lifetime pension may have created a disincentive for investment in education (prior to the death of the pension provider). According to such reasoning, the families of military daughters who were eligible for such a benefit did not value the expected wage gains associated with additional years of education as much as those whose daughters only had the right to a limited pension, since the permanent benefit already provides them with a stipend unrelated to employment (Butler, 1990).

As a result, and considering that education is costly, these families tend to underinvest in education to match the marginal costs and benefits of schooling (Caliendo & Findley, 2020). The findings are in accordance with the empirical evidence for other pension and social security benefits, demonstrating how the expectation of a future income can adversely impact present educational choices (Cockx et al., 2023; Hernæs et al., 2017).

Tables A.1 and A.2 of the appendix present the results for the first (treatment model) and second (outcome models) stages of the empirical strategy, and Table A.3 displays the standardized differences in the average value of covariates between the treated and control groups. Although such estimates are not the main point of the analysis, they provide insights into the pension rights and education of military daughters. In both models, age is a significant predictor of (and is positively correlated with) both treatment and outcome, thus confirming the importance of controlling for this factor in the analysis. Table A.1 also indicates that household income has a positive association with the probability of treatment, which is consistent with the fact that the domiciles of militaries under the old pension scheme are generally wealthier than those subject to the new rules. The outcome model (Table A.2) suggests that more maternal education predicts a greater number of years of schooling for daughters, a result consistent with the previous literature on educational attainment (Delaney et al., 2011). Finally, the differences in age, household income and maternal education in Table A.3 considerably decreased after the weighting procedure (first stage), which indicates that the empirical strategy made units in the treated and control groups more comparable for the purpose of estimating causal impact.

*6.2 Robustness Tests and Sensitivity Analysis*

Tables 3 and 4 exhibit the alternative estimates used as robustness tests, which confirm the findings of the main model and the research hypothesis. The ATT (Table 3) indicates that the

effect of entitlement to lifetime pensions on eligible military daughters (the treated group) is -16.7 percent, which means approximately minus 1.7 years of education considering the mean potential outcome without treatment (column 2). This finding suggests that the negative impact for this group surpasses that found for nontreated units, an expected result in light of the higher average age and educational level of daughters in the treated group. Moreover, the treatment dummy variable in the OLS estimates (Table 4) also has a negative and significant coefficient, which suggests that eligibility for a permanent survivor pension is associated with an approximately 10-percent reduction in the number of years of education.

**Table 3. Robustness Test: Estimated Average Treatment Effect on the Treated (ATT) of Entitlement to Lifetime Pension (IPWRA Estimator)**

| Outcome variable | Mean potential outcomes (of treated units) | | | |
|---|---|---|---|---|
| | With treatment | Without treatment | ATT | $(e^{ATT} - 1)$ |
| | (1) | (2) | (3) | (4) |
| No. of years of education (log) | 2.1475 | 2.330 | -0.183** | -16.7% |
| | | | (0.072) | |
| *N* | | | | 180 |

Notes: Robust standard errors in parentheses (not reported for potential outcomes of treated firms). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: prepared by the authors, based on IBGE (2016, 2023b).

**Table 4. Results of the Ordinary Least Squares (OLS) Estimates**

| Dependent variable: No. of years of education (log)<br>Independent variables | Coef.<br>(std. er). |
|---|---|
| Entitlement to lifetime pension (treatment dummy) | -0.102** |
| | (0.0496) |
| Age (log) | 2.092*** |
| | (0.0555) |
| Household per capita income (log) | 0.0287 |
| | (0.0295) |
| Mother: no. of years of education (log) | -0.187 |
| | (0.118) |
| Race: Black | 0.0451 |
| | (0.0689) |
| Race: Brown | 0.00679 |

| | |
|---|---|
| | (0.0360) |
| Rural household | -0.187 |
| | (0.118) |
| Constant | -4.277*** |
| | (0.257) |
| State dummies | Yes |
| Year dummies | Yes |
| No. of observations | 372 |
| $R^2$ | 0.891 |
| F-stat | 79.96 |
| Prob>F | 0.00 |

Notes: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: prepared by the authors, based on IBGE (2016, 2023b).

Finally, the results of the sensitivity analysis are presented in Table 5, and they also align with the expectations and the design of the empirical strategy. As the gap between the age limits of military parents on the threshold date decreases, the sample size of each regression increases, while the absolute value (and significance) of the estimated negative effect decreases. Such result is expected because as the gap diminishes, we allow more individuals in the sample who have a decreasing probability of belonging to the correct group, so the treated and control groups become more similar, which reduces the average difference between them. However, a negative and statistically significant effect persists up to the fifth iteration, which is based on a greater sample of approximately 1,5 thousand individuals. This suggests that the findings of the main model persist with a larger group of daughters and a substantial change in the threshold of the military parent's age is employed. This indicates that such findings are relatively robust to variations in this choice.

**Table 5. Sensitivity Analysis: Estimated Average Treatment Effect (ATE) of Entitlement to Lifetime Pension (IPWRA Estimator), with a Gradual Reduction in the Gap between the Minimum and Maximum Age Limits of Military Parents on the Threshold Date**

| Age gap reduction<br>Age limits of military parents on the threshold date | Outcome: No. of years of education (log) | | Number of observations |
|---|---|---|---|
| | ATE | $(e^{ATE} - 1)$ | |
| **Gap reduction: 0 (main model)**<br>**Minimum parent's age for treated: 40**<br>**Maximum parent's age for control: 16** | **-0.133*****<br>**(0.0427)** | -12.5% | **372** |
| Gap reduction: 1 (for each limit)<br>Minimum parent's age for treated: 39<br>Maximum age for control: 17 | -0.190***<br>(0.0312) | -17.3% | 504 |
| Gap reduction: 2 (for each limit)<br>Minimum parent's age for treated: 38<br>Maximum parent's age for control: 18 | -0.169***<br>(0.0310) | -15.5% | 726 |
| Gap reduction: 3 (for each limit)<br>Minimum parent's age for treated: 37<br>Maximum parent's age for control: 19 | -0.0769**<br>(0.0306) | -7.4% | 1,007 |
| Gap reduction: 4 (for each limit)<br>Minimum parent's age for treated: 36<br>Maximum parent's age for control: 20 | -0.0655**<br>(0.0255) | -6.3% | 1,234 |
| Gap reduction: 5 (for each limit)<br>Minimum parent's age for treated: 35<br>Maximum parent's age for control: 21 | -0.0601***<br>(0.0223) | -5.8% | 1,549 |
| Gap reduction: 6 (for each limit)<br>Minimum parent's age for treated: 34<br>Maximum parent's age for control: 22 | -0.0397*<br>(0.0215) | -3.9% | 1,940 |
| Gap reduction: 7 (for each limit)<br>Minimum parent's age for treated: 33<br>Maximum parent's age for control: 23 | -0.0575***<br>(0.0178) | -5.6% | 2,344 |
| Gap reduction: 8 (for each limit)<br>Minimum parent's age for treated: 32<br>Maximum parent's age for control: 24 | 0.00353<br>(0.0179) | 0.4% | 2,931 |
| Gap reduction: 9 (for each limit)<br>Minimum parent's age for treated: 31<br>Maximum parent's age for control: 25 | 0.0104<br>(0.0174) | 1.0% | 3,468 |

Notes: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: prepared by the authors, based on IBGE (2016, 2023b).

*6.3 Discussion of the Findings*

This study adds to the scarce literature on pension rights and education (Caliendo & Findley, 2020), presenting new evidence on the potential effects of contributory benefits on educational choices. To date, few analyses have focused on this relation before the benefits are due (Cockx et al., 2023; Hernæs et al., 2017), and this is the first investigation on this topic considering the case of survivor pensions. These findings support the disincentive argument (Butler, 1990; Gensler, 1996), suggesting that a generous pension scheme can inadvertently harm human capital accumulation, as families anticipate the expected income of their offspring and respond by reducing educational investment that could potentially enhance their future wage earnings. This is an indirect yet important side effect that should be considered in the design of pension policies, in light of the importance of human and intellectual capital for productivity and economic growth (Hanushek & Woessmann, 2020).

While the evidence presented herein is based on the exceptional case of a pension being phased out of the Brazilian legal system, its implications are relevant to the discussion and design of different pension and retirement schemes. Low eligibility ages for the permanent benefits of widows and widowers may yield similar effects to those found for military daughters, providing further justification for stricter rules or their substitution with a temporary pension (OECD, 2018). Additionally, the disincentive argument may also apply to benefits based on marital status such as spousal benefits (Borella et al., 2023) and to rules that increase the financial cost of working at older ages (Börsch-Supan & Coile, 2023), so that they may not only reduce the labor supply but also affect individuals' educational choices. Finally, the results also point to economic distortions of more advantageous retirement and pension schemes for favored groups such as

civil and military servants in Latin America (Mesa-Lago, 2009, 2021), which can negatively affect both individual and overall human capital levels.

The results also underscore an important shortcoming of the Brazilian pension system that requires attention due to its adverse effects. Brazil has a large public social security system that has succeeded in providing coverage to a substantial share of its population (Silva Filho et al., 2023), but at the same time, it has established advantageous rules for specific groups and individuals. Such schemes not only are costly but can also negatively influence the economy and the labor market. The high public spending on survivor pensions in the country (proportionally larger than in developed countries – Costanzi et al., 2017) indicates that this benefit should be a key topic for consideration in any future reform. The lifetime survivor pension for military daughters serves as a case in point, embodying a vestige of a benefit hardly compatible with the current societal and legal framework, but that still benefits a large number of women, with adverse effects on their employment (Rocha, 2021) and educational choices.

The main limitations of this analysis are related to the data used to estimate the causal effect of permanent pensions. As information on the type of pension of military daughters was not available, it was necessary to exclude several individuals from the main sample and to assume that all military parents subject to the scheme prior to the 2000 reform had chosen to pay the additional contribution fee to ensure their daughters' right to a permanent pension. These shortcomings were partially addressed by the sensitivity analysis, which gradually included additional units in the sample. Moreover, the lack of information on the value of the expected pension for each daughter required the use of a binary indicator of treatment, so it was not possible to estimate the marginal effect of the permanent pension on the educational level. Finally, as estimates are based exclusively on military daughters, the generalizability of the

findings to other groups of individuals is limited and requires caution, although they still provide an initial basis for consideration in other analyses.

## 7. Concluding Remarks

Social security systems can affect the economic performance of nations through various channels, including consumption and savings, fertility, migration and the development of capital markets (Iparraguirre, 2019; Paiva & Varella, 2019). While education and human capital are important pathways mediating the effects of pensions on growth, they have not been thoroughly analyzed. To date, the literature has presented contrasting arguments and limited evidence on how the generosity, contributory nature and design of pension schemes can affect educational investment and attainment (Davis & Hu, 2006; Yang, 2020; Zhang & Zhang, 2004). Similarly, scant attention has been given to the potential repercussions of survivor pensions on individuals' educational choices, despite the enduring importance of such benefits in current pension systems. This point deserves further investigation, considering the crucial role of education in fostering socioeconomic development and the substantial resources and efforts invested globally to enhance educational attainment levels (May Bend et al., 2023).

This paper contributes to this debate by presenting and discussing the case of military daughters in Brazil, where a generous pension policy has had an adverse impact on the education of beneficiaries. We demonstrate this effect by analyzing a policy reform using microdata of individuals entitled to different pension rights. The estimates confirm the theoretical expectation that eligibility for a future permanent pension served as a disincentive for families to invest in the education of their daughters prior to the accrual of such benefits. These negative results were found using different empirical strategies and samples, strengthening the presented evidence. This study constitutes a novel investigation that adds to the limited research on the topic, and its

implications extend to the design of different social security benefits and highlight an important distortion introduced by Brazilian pension regulations.

The research agenda on the relationship between social security and educational policies offers numerous pathways for future investigation, given its current status as an underexplored subject. Analyses using more detailed data on the pension entitlements of military daughters in Brazil can improve the empirical approach outlined in this study and yield further insights into the effects of this specific benefit. Moreover, similar investigations in other countries on low eligibility ages for permanent survivor benefits are important for assessing the generalizability of the findings across different contexts. Finally, new research on the potential effects of other social security rules and benefits on educational decisions and human capital levels is necessary to underscore the importance of this agenda and to propose reforms and solutions aimed at alleviating these associated problems.

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## Appendix

### Table A.1. Treatment Probability Model (Logit Estimates)

| Dependent variable: entitlement to lifetime pension.<br><br>Independent variables | Coef.<br>(std. er.) |
|---|---|
| Age (log) | 4.845*** |
| | (0.689) |
| Household per capita income (log) | 2.038*** |
| | (0.386) |
| Mother: no. of years of education (log) | -2.094*** |
| | (0.747) |
| Race: Black | 0.897 |
| | (0.858) |
| Race: Brown | -0.739 |
| | (0.501) |
| Rural household | 1.188 |
| | (1.685) |
| Constant | -21.53*** |
| | (3.449) |
| State dummies | Yes |
| Year dummies | Yes |
| No. of observations | 372 |
| Pseudo-$R^2$ | 0.5886 |
| $Chi^2$ | 118.92 |
| $Pr>Chi^2$ | 0.000 |

Notes: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: prepared by the authors, based on IBGE (2016, 2023b).

**Table A.2. Potential Outcome Weighted Regression Models for the Treated and Control Groups**

| Dependent variable: No. of years of education (log) | Treated | Control |
|---|---|---|
| Independent variables | Coef. (std. er) | Coef. (std. er) |
| Age (log) | 2.002*** (0.0840) | 2.247*** (0.0875) |
| Household per capita income (log) | 0.0278 (0.0459) | 0.0414 (0.0376) |
| Mother: no. of years of education (log) | 0.174** (0.0837) | 0.212* (0.110) |
| Race: Black | -0.150* (0.0828) | 0.126 (0.0984) |
| Race: Brown | -0.147** (0.0605) | -0.0150 (0.0487) |
| Rural household | 0.0927 (0.183) | -0.0901 (0.130) |
| Constant | -4.144*** (0.410) | -4.705*** (0.442) |
| State dummies | Yes | Yes |
| Year dummies | Yes | Yes |
| No. of observations | 180 | 192 |
| $R^2$ | 0.975 | 0.892 |

Notes: Robust standard errors in parentheses. $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$. Source: prepared by the authors, based on IBGE (2016, 2023b).

**Table A.3. Standardized Differences in the Main Covariates between the Treated and Control Groups before and after Weighting**

| Covariates | Standardized differences | |
|---|---|---|
| | Raw | Weighted |
| Age (log) | 1.61 | -0.33 |
| Household per capita income (log) | 1.01 | 0.47 |
| Mother: no. of years of education (log) | -0.21 | -0.09 |
| Race: Black | 0.06 | -0.05 |
| Race: Brown | -0.16 | 0.52 |
| Rural household | 0.01 | -0.08 |
| No. of observations – treated | 180 | 258.1 |
| No. of observations – control | 192 | 113.9 |
| No. of observations – total | 372 | 372 |

Source: prepared by the authors, based on IBGE (2016, 2023b).