

Survivor's pension: a NDC model applied to survivor's pension of the Brazilian Armed Forces

Pensão por Morte: um Modelo de Contas Nacionais Aplicado às Pensões Militares das Forças Armadas

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Abstract:

This paper aims to investigate the impact on the actuarial result of the survivor's pension system in the Brazilian Armed Forces, as well as on the benefit itself, resulting from the modification of its costing plan with the use of the NDC system. To achieve this, a simulation was conducted using the R software, based on a model of notional accounts, and utilizing data from 3,942 military personnel who joined the Armed Forces in 2020. From both the perspective of public spending and the amount received by the beneficiary, the results indicate a significant reduction, mitigating the deficit in the Social Protection System of the Armed Forces at the expense of the degradation of the survivor's pensions to be granted. In addition to the uncertainty about the replacement rate, depending on the variation in the parameters adopted for calculating the benefit, the pure NDC system would create differences that currently do not exist, such as the existence of distinct and greater benefits for men, and pensions of different values left by military personnel with identical careers. The originality of the article encompasses the theme "notional accounts" applied to the Brazilian Armed Forces, the perspective to be developed, with application to the survivor's pension benefit, since, as a rule, the focus is on the old-age pension, and empirical research on a social protection system little explored in the literature.

Keywords: NDC System; Survivor's Pension; Armed Forces; Social Protection; Military Survivor's Pension.

Resumo:

Este artigo pretende investigar o impacto no resultado atuarial do sistema de pensões por morte das Forças Armadas brasileiras, bem como no benefício propriamente dito, decorrente da

modificação do seu plano de custeio com o emprego do sistema de contas nocionais. Para alcançar esse objetivo, uma simulação foi conduzida, utilizando o software R, baseado no modelo de contas nocionais e empregando dados 3.942 militares que ingressaram nas Forças Armadas em 2020. Tanto do ponto de vista do gasto público quanto do ponto de vista do valor recebido pelo beneficiário, os resultados indicam uma redução considerável, mitigando o *déficit* no Sistema de Proteção Social dos Militares das Forças Armadas ao custo da degradação das pensões a serem concedidas. Em adição à incerteza quanto ao valor da taxa de reposição, haja vista a possível variação nos parâmetros adotados para definição do benefício, o sistema de contas nocionais puro criaria diferenças, que atualmente não existem, como a existência de benefícios distintos e maiores para homens, e pensões de valores diferentes deixadas por militares com carreiras idênticas. A originalidade do artigo englobe o tema “contas nocionais” aplicado às Forças Armadas brasileiras, a perspectiva a ser desenvolvida, com aplicação ao benefício da pensão por morte, visto que, em regra, o foco está na aposentadoria por idade, e uma pesquisa empírica sobre um sistema de proteção social pouco explorado na literatura.

Palavras-chave: Sistema NDC; Pensão por Morte; Forças Armadas; Proteção Social; Pensão por Morte dos Militares.

1 Introduction

In Brazil, in line with the trend highlighted by the European Commission (2018) and the OECD (2019), the sustainability of social protection systems is also threatened by demographic transition (Giambiagi and Zeidan, 2018). Projections for the ratio of public social security expenditures to GDP indicate an increase from 8.3% in 2020 to 19.3% in 2060 (Costanzi and Ansiliero, 2017).

The deficit of Brazilian social protection systems amounted to BRL326.2 billion in 2020, with BRL260.9 billion attributed to the General Social Security System (RGPS) for employees, BRL48.5 billion to the Own Social Security System (RPPS) for public servants, and BRL16.8 billion to Brazilian Armed Forces Survivor’s Pension (STN, 2020). It’s worth noting that the earnings of inactive military personnel, which resulted in a deficit of BRL 27.40 billion, are not included in the calculation. This is because they represent financial charges from the National Treasury without a specific contribution (Brazil, 1980).

It is important to note that, in Brazil, particularly within the Armed Forces, the survivor’s pension holds significant importance for its members. This contrasts with OECD countries where the benefit has either been eliminated or is of the “means-tested” type. In such countries, there is no justification for widows to receive a higher amount than other individuals facing similarly low-income situations. This is due to the presence of poverty-fighting mechanisms available in these countries (OECD, 2018).

Since the promulgation of the Brazilian Federal Constitution of 1988 (CF/88), the reforms implemented have primarily concentrated on parametric changes. These changes have involved aspects such as raising the minimum age for retirement and decreasing the value of benefits. However, these reforms have been deemed insufficient and incomplete, as they have not addressed other equally relevant issues, such as survivor’s pensions (Costanzi and Ansiliero, 2017).

Simultaneously, Swedish Social Security experts devised a system wherein records of individual retirement contributions would be converted into a notional savings amount. From this amount, the defined contribution approach would be utilized to calculate the benefit to be granted (Cichon, 1999; Palmer, 2006; Könberg, 2008).

Known as the Notional (or Non-financial) Defined Contribution, the NDC system establishes an analogy between the pay-as-you-go (PAYG) and capitalization regimes. This is achieved by incorporating financial and actuarial instruments used in the capitalization system

into the PAYG system. At the time of retirement, these instruments are employed to convert the balance of the notional account into an annuity based on the life expectancy of the beneficiaries, financed by the PAYG system (Vidal-Meliá, Domínguez-Fabián, and Devesa-Carpio, 2006; Costanzi and Sidone, 2019).

In 1994, the NDC system was initiated in Sweden, Italy, and Latvia. A couple of years later, Poland became the fourth country to adopt it, followed by Norway in 2009 (Holzmann and Palmer, 2020).

Considering the challenging scenario of social protection systems in Brazil (STN, 2020), the inadequacy of measures implemented in the reforms since CF/88 to address this situation (Costanzi and Ansiliero, 2017), the positive outcomes from the adoption of the NDC system (Aspegren, Durán, and Masselink, 2019; Boado-Penas, Naka, and Settergren, 2020), and the necessity to delve into reforms for benefits where the NDC system could be applied, such as the survivor's pension (Holzmann and Palmer, 2020), the objective of this paper is to investigate how the use of the NDC system impacts the actuarial result and the survivor's pension.

To achieve this, the next section provides a brief review of the literature on social protection, the NDC System, and the Survivor's Pension in the Brazilian Armed Forces. The third section outlines the components of the case study, details tests conducted to ensure the quality of the research method and presents the case study protocols. The fourth section presents the findings, revealing a substantial reduction in the implicit social security debt, accompanied by a significant decrease in the average replacement rate of the survivor's pension. Moreover, it is observed that military women are less likely to forego the survivor's pension due to their longer life expectancy compared to men. This leads to variations in benefits between male and female pensioners, and military personnel with identical careers may leave their spouses with different benefits. The fifth and final section concludes by discussing these results and advocates for further studies employing the NDC system.

In theoretical terms, the notable contribution of this paper is that it represents the first documented study in Brazil that applies the NDC system to the survivor's pension, focusing on the benefit within the Armed Forces. Through this approach, it became apparent that, if the aim is to decrease public debt, it will be imperative to reduce the benefit replacement rate, thereby generating negative effects that are presently not evident.

2 Theoretical Foundation

Social protection: the challenge of ensuring a sustainable benefit

The social protection system, or welfare state, is one of the most critical functions of a government. It can be comprehended as a collection of policies constituting a "social contract" - an implicit agreement between the government and the citizens of a country. In this agreement, the basic social and economic protections that the government will provide, along with the corresponding responsibilities of the citizens expecting to receive them, are defined (Brearley, 2016).

These social protection policies are categorized into two types: social assistance, which aims to alleviate poverty and address equity issues, with its benefits funded by taxes in non-contributory systems, and social insurance, intended to ensure the smoothing of consumption through contributory systems (Brearley, 2016).

Until the end of the 19th century, security systems were, in most cases, of a private nature. The predominant models were those of "montepio"¹ (or monte pio), characterized by

¹ The origin of the word dates to the 15th century, when the Italian friar Bernardino Feltre created a charitable institution that he called "Monte de Pietá", which, through subscriptions, alms, and donations, gathered a fund where money was accumulated and later lent to the poorest with limited interest to cover administrative expenses. Thus, the "montepios" or "heaps of piety" were born (Neves, 2001).

voluntary entry and organization carried out by private individuals, without any guarantees from the State for the future preservation of benefits (Ibrahim, 2011). The emergence of public welfare resulted from struggles for better working conditions, giving rise to different protection systems depending on the momentary circumstances of each country involved. This helps to explain why some countries limited social protection to what is necessary for survival, while others aimed to program the replacement of remuneration arising from work activity (Ibrahim, 2011).

Two models have guided the development of public pension systems worldwide: the Bismarckian and the Beveridgean. The Beveridgean models are typically designed to prevent poverty and offer flat-rate universal or welfare benefits. In contrast, the Bismarckian models are based on the principle of social insurance, providing benefits related to earnings aimed at maintaining one's status in old age (Schludi, 2005).

The Social Security model instituted by the CF/88 represents a combination of the Bismarckian and Beveridgean models. The social insurance model is present in Pensions and Health Assistance, while the universalization model is evident in Social Assistance (Wünsch, Mendes, and Martins, 2017).

However, the expansion of state social security entailed the need for additional funding, which proved to be higher than the social security revenues collected. As a means of attempting to control the deficit in social protection, the principle of financial and actuarial balance was introduced by Constitution Amendment No. 20, 1998 (Vaz, 2009). This change in logic underlying retirements shifted the focus from length of service to the contribution to the social protection system (Porto and Caetano, 2015).

It is important to highlight that difficulties in maintaining the financial and actuarial balance of the Social Security system can arise from factors that are both endogenous (eligibility, granting and significance of benefits, compulsory nature) and exogenous to the system (level of employment, degree of formality, salary, productivity, interest, and demographic dynamics) (Izerrougene, 2009).

Most of these factors pertain to eligibility and demographic dynamics. Generally, the benefits outweigh the average contributions, resulting in an intergenerational transfer and, in the long term, financial requirements due to an unfavorable demographic evolution (Izerrougene, 2009).

In this context, interest in the NDC system arises, which consists of an arrangement whereby the resources allocated to the benefit plan are of the defined contribution type. This system demonstrates a direct connection with the quantity and value of contributions made by the individual throughout their working life. However, the financing logic through the distribution regime is maintained, thus operating with the mimicry of individual accounts accompanied by the accounting (book-entry) record of the contributions (Costanzi and Sidone, 2019).

Notional accounts: is the nordic solution suitable for the tropic?

Contributions are made based on a rate defined by the government on earnings from work (salary), with the goal of forming individually accounted assets (Chłoń-Domińczak, Franco, and Palmer, 2012). These contributions are not perceived as a tax but rather as a contribution to one's own future retirement (Palmer and Könberg, 2020).

Additionally, a notional rate of return, based on economic indicators that are relevant from the perspective of financing a social protection system, such as growth in wages and Gross Domestic Product (GDP), is applied to the contributions made to form the amount that will support future benefits (Costanzi and Sidone, 2019).

This rate directs the system towards long-term financial equilibrium while ensuring the maintenance of the fixed contribution rate, in principle, for a lifetime (Chłoń-Domińczak, Franco, and Palmer, 2012).

Equation 1 represents the benchmark adopted in countries that used the NDC system to calculate the notional individual reserve.

$$F_k = \sum_{t=x}^{d-1} C_{t,k} (1 + r_a)^{d-t} {}_{d-t}P_t \quad (\text{Equation 1})$$

$C_{t,k}$ = the contribution referring to individual “k” at time “t”.

d = death age.

${}_sP_t$ = probability that an individual of age “t” survives for “s” years (s = d – t).

r_a = notional contribution revaluation index.

The initial value of the survivor’s pension from individual “k” to his spouse (b_k) is calculated dividing F_k by the notional conversion factor (f_{c_k}), which is directly related to the life expectancy of b_k (ω_{b_k}). According to the international benchmark, assuming that the survivor’s pension increases in a geometric progression with rate β , and that the interest rate applied to update the pension value is r_p , f_{c_k} will be calculated according to Equation 2:

$$f_{c_k} = \sum_{s=0}^{\omega_{b_k}-d} (1 + \beta)^s (1 + r_p)^{-s} {}_sP_d \quad (\text{Equation 2})$$

Military survivor’s pension: the cost of a treatment specific

It can be asserted that the theoretical foundation of the survivor’s pension system of the Armed Forces is supported by Samuelson’s model of overlapping generations (OLG) (1958), more specifically, in Martins’ model (1995). Following the work of Gale (1973) and Barro (1974), Martins included the possibility of an individual leaving an inheritance to their dependents in that OLG model.

After a series of regulations, in 1941, Ordinance No. 3,084 created the Military Statute, establishing military heritage. This heritage included "montepio" and the half "soldo" to officers, "montepio" to enlisted personnel, and a special pension for the heirs of military personnel who died because of an accident at work or illness arising from the defense of order, institutions, on campaign, or because of enemy aggression (Brazil, 1941).

The simplification of these benefits occurred with Law No. 3,765, 1960, in which the three types of pensions were consolidated into a single benefit called the "military survivor’s pension," corresponding to the full value of the income of the deceased military. Some updates to this law were carried out in 2019, through Law No. 13,954, highlighting the following:

- i. The contribution to the military survivor’s pension became universal, including the current beneficiaries.
- ii. The contribution rate is now 10.5%, increased from 7.5%.
- iii. A contribution of 3% was instituted for current non-disabled daughters who are lifelong pensioners, and 1.5% for pensioners.

With these measures, the collection of revenues destined to support the payment of military survivor’s pensions was increased, aiming to contribute to the reduction of the deficit in the short and long term, as has been recorded over the last few years.

However, the balance between revenues and expenses has not yet been achieved, as evident in the Summary Report on Budget Execution for the period from January to December 2020, which shows a deficit of BRL 16.5 billion (STN, 2020). Furthermore, there is a long-

term provision in the Union's Balance Sheet of BRL 298.1 billion referring to military survivor's pensions granted and to be granted (STN, 2021).

3 Methodology

Following Creswell's (2010) classification, this paper was developed using a mixed methods approach, based on a pragmatic conception. It employs a sequential investigation strategy, beginning with a literature review and concluding with the conduct of a single integrated case study. The findings result from a microsimulation conducted in the R programming language, utilizing elements from the Armed Forces survivor's pension system database.

According to Stake (1994), a case study is both a process of learning about the case and the product of our learning. This statement aligns with the researcher's intentions, as there is an interest in shedding light on an alternative procedure in Brazilian literature that seeks to improve the results of public accounts.

Preliminarily, it is important to clarify that the case study method is not merely a form of qualitative research. The case study is a research method that has its own logical sequence, albeit not entirely systematized, connecting empirical data to initial research questions and conclusions (Yin, 2010).

Components of the Case Study

There are five especially important components for case studies (Yin, 2010). In this paper, they are treated as follows:

a) The research question – how does the use of the notional account system affect the actuarial result and the survivor's pension?

b) Propositions – concern something that must be examined within the scope of the paper. Preliminarily, the theoretical foundation provided the necessary and sufficient framework to support the premises on which this paper was developed, namely:

i. The Brazilian social protection system is financially and actuarially unbalanced.

ii. The NDC system can be an alternative for reducing the deficit shown by social protection systems.

iii. The NDC system seems to be applicable to the costing plan of Armed Forces survivor's pension.

From this logical chain, considering that the theme explored here gives rise to the examination of at least two topics rarely addressed in the Brazilian literature, the NDC system and the Armed Forces' social protection, the following propositions were formulated:

P1: The adoption of the NDC system positively impacts the actuarial result of the survivor's pension system; and

P2: The adoption of the NDC system generates negative externalities for beneficiaries of the survivor's pension system.

c) The unit(s) of analysis – what is being analyzed is the actuarial result of the Armed Forces survivor's pension system, as well as the benefit itself, under the protection of the rules and procedures of the NDC system.

d) The logic that links the data to the propositions – the explanation construction technique, which is a special kind of pattern matching (comparing an empirically based pattern with one or more predicted patterns), was chosen to link the data to the propositions. The objective of this paper is achieved through the analysis of the case study data, building an explanation about the case.

e) The criteria for interpreting the findings – the analytical strategy of using qualitative and quantitative data characterize the mixed approach chosen for the present study. While the

quantitative data contribute to covering the behavior of one of the units of analysis in this study, the qualitative analysis allows explaining the event itself.

Tests to ensure the quality of the research method

a) Construct validity – concerns the identification of the correct operational measures for the concepts being studied. Yin (2010) suggests that two steps should be observed: defining the change in terms of specific concepts (relating them to the research objectives) and identifying the operational measures that combine the concepts (preferably, citing published studies that make the same combinations).

This paper investigates the impact on the actuarial result of the survivor's pension system, as well as on the benefit itself, for the military personnel of the Armed Forces. This investigation results from the modification of their costing plan with the use of the pension system notional accounts.

The researcher made use of multiple sources of evidence to establish a chain of evidence. This chain encompasses the deficient result of the Brazilian social protection systems, the imposition of the constitutional principle of balance on social security systems' financial and actuarial aspects, and its driving role in the reforms promoted since the CF/88. Additionally, it includes the characteristics of the NDC system and the experiences of pioneering countries in its use, along with the legal nature of the benefits granted under the Armed Forces' social protection system.

b) External validity – deals with defining the domain to which research findings can be generalized, that is, whether such findings are generalizable beyond the immediate case study (Yin, 2010). The present paper is not a sample survey with a view to generalizing to a larger universe. Thus, employing the sample-universe analogy for the case study is not an adequate procedure (Yin, 2010). The possible generalization here is analytical, not statistical. Since the research method adopted in this article is an exploratory and descriptive case study, the internal validity will not be applied.

c) Reliability – demonstrates that the operations of a research, such as the procedures for data collection, can be repeated, with the same results. In other words, if another researcher subsequently follows the same procedures adopted in the original research, the same findings and conclusions will be obtained. The goal of reliability is to minimize errors and biases in the study (Yin, 2010). To ensure the reliability of this paper, all procedures to be adopted will be documented with the aid of a case study protocol.

Case Study Protocol

The protocol is considered an instrument of such importance for the researcher because it helps to keep the focus on the topic of the study itself and leads to the anticipation of possible problems arising from its performance, such as the public of the case study report (Yin, 2010). This protocol has the following sections:

a) An Overview of the Case Study Design

This paper was conceived in the context of the “social security reform” enacted by Constitution Amendment No. 103, of 2019, and by Law No. 13,954, of 2019.

In the original text of this Amendment, seven guidelines were defined for a new social security regime, among which the institution of a defined contribution capitalization system, admitting the NDC system (Poder Executivo, 2019).

During its processing, the Special Commission of the Chamber of Deputies, created to preliminarily analyze it, decided to remove this guideline, claiming, among other factors, that such capitalization would not be adequate for a country like Brazil, whose workers have low incomes, in addition to presenting a high transition cost (Câmara dos Deputados, 2019).

The mention of the NDC system led to the emergence of interest in studying it, not only with the aim of expanding theoretical knowledge on the subject but also of properly knowing the strategy formulated by the Federal Government to modify the current systems of social protection.

b) Field procedures

Data on military pension contributors were obtained together with the Navy Finance Board, as the author of this paper had access to the data while serving as Head of the Department of Remuneration Studies of that board. Additionally, official documents available on the internet were consulted.

It is important to point out that the data treated in this paper comprise a population subset, the result of an intentional non-probabilistic sampling (Martins and Theóphilo, 2009), being strictly sufficient for the intended simulation. This ensures the anonymity of members belonging to the studied population and avoids any affront to the protection guaranteed by the General Law for the Protection of Personal Data.

c) Case Study Questions

The study questions indicated in the case protocol are questions that serve as guidelines for the researcher. They act as reminders related to the data that need to be obtained for the development of the study. Thus, these issues aim to ensure that the researcher remains on track with his research (Yin, 2010).

To ensure the effectiveness and efficiency of the data collection procedure, the following questions were used as a reference:

Question 1) what are the data from the study population needed for the simulation intended in the thesis?

Answer 1) Identification of the military; Strength; Actuarial age; Gender; Rank; Commitment; Contribution salary; Pension discount; Service time; and Interstice.

Question 2) what are the legal bases that guide the professional behavior of the population?

Answer 2) Law No. 3,765, of 1960, which provides for military survivor's pensions; Law No. 6,880, of 1980, which provides for the Military Statute; Provisional Measure No. 2,215-10, of 2000, which provides for the restructuring of the remuneration of Armed Forces personnel; and Law No. 13,954, of 2019, which amends, among others, the aforementioned laws and provisional measure, with a view to restructuring the military career, and provides for the Military Social Protection System.

Question 3) what are the initial assumptions of a notional defined contribution military survivor's pension system?

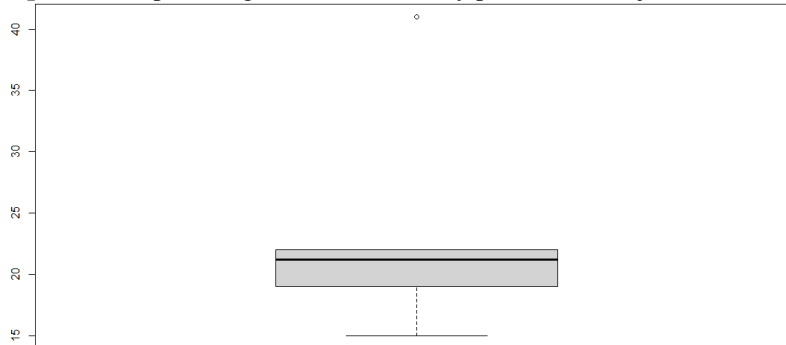
Answer 3) P1 - Only trunk pensions will be considered; P2 - Lifetime pensions for daughters will not be considered; P3 - Application of the notional defined contribution only for military personnel who joined the Armed Forces as of 2020, considering the changes implemented in the legislation resulting from Law No. 13,954, of 2019, and the contribution rate of 10.5%; P4 - Adoption of the actuarial assumptions of the Actuarial and Accounting Evaluation Report of Military Survivor's Pensions of the Armed Forces prepared annually by the Ministry of Defense.

4 Results

Of the 3,942 career military personnel who joined the Forces in 2020, 3,347 (85%) are male and 595 (15%) are female. It must be considered that there are different ways of joining

the Armed Forces that encompass different ages, levels of education and training schools. The boxplot, present in Graphic 1, shows the distribution of these military personnel by age.

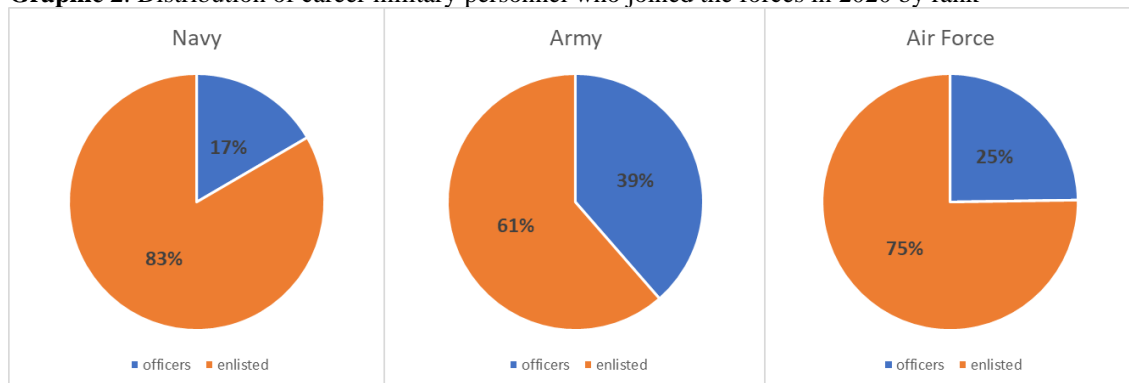
Graphic 1. Boxplot of ages of career military personnel who joined the Forces in 2020



Observing the boxplot, it is possible to notice that the lowest age is 15 years old (20 military), the limits between the first and third quartiles are defined by the ages of 19 and 22 years old, respectively, representing about 69% of the total (2,707 military), the median is 21 years old (737 military) and the outlier is a 41-year-old military man.

When we analyze the distribution of these military personnel in the Forces by rank or graduation, that is, by the training choices of Officers or Enlisted, respectively, Graphic 2 show us that, of the 3,942 military personnel, about 66% (2,608) joined as enlisted and 34% (1,334) as officers.

Graphic 2. Distribution of career military personnel who joined the forces in 2020 by rank



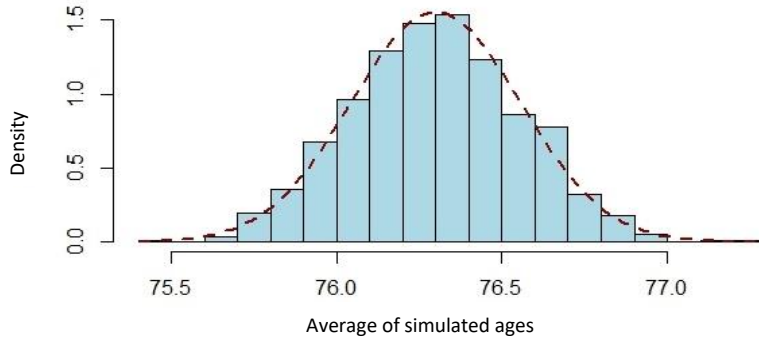
From the information summarized in Graphics 1 and 2, it is possible to simulate the careers of each of these military personnel over 35 years of service and the value of the earnings they will receive when they reach the required age for the transfer to inactivity. This simulation aims to identify the number of contributions that will be added to the formation of the notional individual fund to support the military survivor's pension to be left to the spouse.

For the simulation of careers, it was assumed that all military personnel, regardless of gender, will achieve the functional progression foreseen for their career. The only limitation to the functional progression is the age of death of the military, identified by the average age of death estimated after applying 1,000 Monte Carlo simulations. If this variable, added to the age of the military, is lower than the functional career progression plan, the military will not have achieved full progression.

Following the statement by the Central Limit Theorem, the sampling distribution of the average estimated ages of death of the population is close to a normal distribution. It was found that the average of each of the 1,000 estimates of the ages of death of the elements of the 3,942

military populations has a sampling distribution close to normal, as seen in Graphic 3, giving statistical validity to the Monte Carlo Simulation used.

Graphic 3. Sampling distribution of the average estimates of the age of death of the military



For the present case, taking the contribution rate referring to the individual (T) as fixed throughout the entire period of formation of F_k , it is possible to adjust Equation 1, replacing $C_{t,k}$ by $T.E_k$ (individual contribution annual remuneration). Finally, it is possible to apply the Monte Carlo Simulation to define the age of death of everyone. In this sense, considering that the behavior of the curve of possible ages of death obtained from 1,000 simulations is a normal one, the average of these values is used as the reference age of death for each soldier (d_m). Thus, once d_m is known, the calculation of F_k would represent the calculation of the accumulated average notional fund (F_{m_k}) and would be carried out according to Equation 3:

$$F_{m_k} = T \sum_{t=x}^{d_m-1} E_{t,k} (1 + r_a)^{d_m-t} \quad (\text{Equation 3})$$

For the application of Equation 3, two other variables were established. First, the rate applied to the remuneration of the military for the formation of the notional fund. Assuming that this rate is fixed and continuous throughout the period in which the military personnel join the Force until his death, the variable T, adopted for this simulation, may correspond to 10.5%. It is important to point out, however, that the international benchmark for the use of the notional accounts model, about the formation of the notional fund, highlights the existence of an individual contribution and another employer contribution, which at least corresponds to the same percentage that, as discussed by Palmer (2000). Thus, following the best international practice, and considering the current contribution rate of the military for the survivor's pension, we will define that T is equal to 21%, representing the sum of two contributions, the military and employer contributions, each being, respectively, 10.5%.

The second variable is the notional contribution revaluation index (r_a), that is, the rate that corrects the number of contributions accumulated over the years. For this simulation, the average value of the GDP projection carried out by the Central Bank of Brazil and published in the Focus Bulletin was used, since it is an indicator that manages to maintain a direct relationship with the workforce and the increase in productivity in certain period.

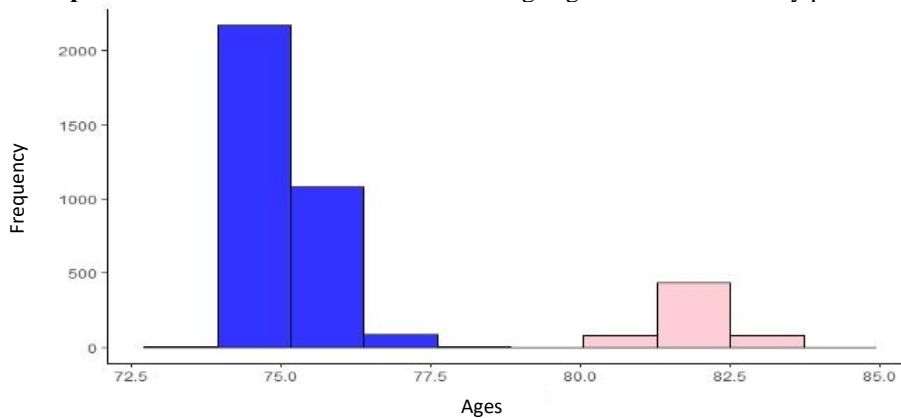
Once these two variables have been established, the application of Equation 3 to calculate the notional fund accumulated by the military would be as follows:

$$F_k = 0,21 \sum_{t=x}^{d-1} E_{t,k} (1 + 0,02)^{d-t}$$

Like the procedure performed to calculate the average age of death of the military, the Monte Carlo Simulation was used to calculate the age of death of each military spouse (ω_{b_k}). Thus, considering that the behavior of the curve of possible ages of death obtained from 1,000 simulations is a normal one, the average of these values is again used as the reference age of death for each spouse ($\omega_{m_{b_k}}$).

Turning to the analysis of the values referring to the average estimated age of death for each military, that is, the average of the 1,000 simulations carried out, the behavior of the distribution of these averages, illustrated in Graphic 4, seems to show the presence of two populations. However, there is an explanation: the gender variable.

Graphic 4. Distribution of the estimated average age of death of military personnel



The first part of Graphic 4, which delimits the curve of the estimated average ages of death that vary between 73 and 78 years, was represented in blue, characterizing the male military, while the second part of the Graphic in question, which delimits the curve between the ages of 80 and 84 years, was represented in pink, in order to characterize the female military.

Considering these ages, it is possible to state that the application of the notional accounts model would begin to generate impacts, both for the State and for the beneficiary of the survivor's pension, in 36 years (2056), which corresponds to the time between the actuarial age of the military who joined the Armed Forces at age 41 and their estimated mean age at death (77 years).

About the amounts of average notional funds accumulated by the military of each Force, calculated according to Equation 3, the smallest value would be around BRL1.210 million, while the highest, BRL6.286 million. The median of average funds is BRL1.929 million and the average, BRL2.670 million.

The total amount accumulated by the 3,942 military personnel would be around BRL10.53 billion. This amount would represent the total debt with survivor's pensions that the State would have to bear for the group of military personnel who joined the Armed Forces in 2020.

Table 1 presents the respective descriptive statistics of accumulated average notional funds according to the sex of the military. It is possible to notice that the median of funds accumulated by male military corresponds to about 76% of the median of funds accumulated by female military.

Gender	Minimum	Median	Average	Maximum
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Male	1,209,780	1,865,314	2,552,627	5,335,318
Female	1,845,592	2,451,294	3,329,362	6,286,078

Table 1. Descriptive statistics of notional average funds by gender

In the overall comparison, average notional funds accumulated by female service members would be higher; the minimum fund would be 52.56% higher; the medium, 30.43% higher and the maximum, 17.82% higher.

It should be noted that, in accordance with current legislation, and considering that there are no differences between the remuneration and earnings of men and women who occupy the same officer rank or enlisted rank in any of the Armed Forces, the amount of legacy survivor's pension benefits also shows no differences.

In the model proposed here, since the survivor's pension benefit is calculated from the accumulated notional fund, it is possible to state that there will be differences between the values of the pensions left to men and women, benefiting men more to the detriment of women, and consequently creating an unwanted and inappropriate situation that does not currently exist.

In order to understand the impact on the implicit social security debt, it is necessary to calculate the actuarial present value of the sum of accumulated average notional individual funds. Therefore, it is essential to define a proxy for the interest rate to be applied.

In order to enable the comparison between the amount calculated here (BRL10.53 billion) and the amount in the methodology currently in force in the Armed Forces, the same interest rate present in the Actuarial Valuation of Social Protection System of Armed Forces Militaries, which acronym in Brazilian Portuguese is SPSMFA, that accompanies the Bill will be used of Budget Guidelines for 2022: 5.40%.

This rate was defined based on the calculation of the duration of liabilities for military pensions, as stated in Art. 2 of Normative Instruction SPREV No. 2, of 2018, which provides for the calculation of the duration of liabilities and the parameter interest rate to be used in actuarial valuations of RPPS, combined with Annex I of Ordinance No. 12,223, of 2020, which discloses the parameter interest rate to be used in the actuarial valuations of the RPPS for the year 2021, positioned on December 31, 2020.

Thus, applying the interest rate of 5.40% to the amount of BRL10.53 billion, the actuarial present value of BRL584.81 million is reached. This value would correspond to the implicit social security debt referring to the military pensions to be granted to 3,942 military personnel, calculated using the notional accounts model.

According to the result of the simulation, 595 of these 3,942 military personnel, that is, 15.09% of the population, which corresponds to 100% of the women who joined the Armed Forces in 2020, despite having accumulated a notional individual fund, would not leave survivor's pension due to their respective spouses dying at a time prior to their deaths. In financial terms, it is BRL1.98 billion, equivalent to BRL98.55 million, in present value, to be redistributed to the beneficiaries of the 3,347 military personnel who would leave a survivor's pension.

Considering only those military personnel who would leave the survivor's benefit, it can be observed, as depicted in Table 2, that the implementation of the NDC model leads to a significant decrease in the values related to the descriptive statistics of the amount to be paid as a survivor's pension. This reduction is in comparison to the present value of the weighted average base salary contributions over the notional capitalization period. It's important to note that this value needs to be calculated, as the contribution base salary varies due to their career progression, even though a specific percentage of salary readjustment throughout the military career was not considered.

Methodology	Minimum	1st Quartile	Median	Average	3rd Quartile	Maximum
NDC (1)	792.10	1,157.20	1,325.60	1,757.10	2,397.70	8,658.60

PVWA(2) ^a	1,668.00	1,883.00	1,950.00	2,704.00	4,064.00	7,286.00
(1) / (2)	47.49%	61.46%	67.98%	64.98%	58.99%	118.84%

^a PVWA = Present Value of Weighted Average.

Table 2. Descriptive statistics of the present value of survivor’s pension

In this context, it appears more reasonable to compare the benefit generated by the NDC model with the present value of the weighted average of contribution base salaries rather than with the present value of the last salary of the military career.

It should also be noted that the descriptive statistics indicate the presence of survivor’s pension values lower than the minimum wage paid in 2020, which was BRL1,045.00. This is contrary to premise No. 4 of the proposed model. According to the simulation data, these values pertain to 208 beneficiaries, accounting for 6.22% of those who effectively received a pension. These individuals would require an additional contribution from the Federal Government to ensure that the pension amount is at least equal to BRL1,045.00.

The monthly expense calculated for these 208 beneficiaries would be BRL206,100.40, whereas it was expected to be BRL217,360.00, following premise No. 4 of the proposed models. This difference (BRL11,259.60 per month) could be covered by the accumulated notional amount that did not generate a death pension, totaling BRL98.55 million in present value. Assuming an annual contribution of BRL146,374.80 over an average period of 8 years, the total supplement to be covered would be approximately BRL1.18 million. In other words, the accumulated notional amount would be sufficient to support this additional expense and leave a surplus of BRL97.37 million that could be redistributed to all death pension beneficiaries.

We can observe that even if this notional amount is redistributed to the beneficiaries because it is an expense assumed by the Federal Government, due to the NDC system, the negative impact on the value of the individual benefit is significant. On one hand, while the implicit social security debt would decrease from BRL51.68 million to BRL5.88 million, a drop of 88.62%, the value of the pension for individual death would decrease, on average, by about 35%, causing a negative impact on the beneficiaries. Additionally, it would generate different benefits for dependents of military personnel who held the same rank, creating an undesirable situation that currently does not occur in the SPSMFA.

Still focusing on the data shown in Table 2, it is possible to verify that the maximum value of the notional benefit exceeded the maximum present value of the weighted average of the individual’s contribution base wages. This fact may occur due to the short duration of the benefit, defined by the beneficiary’s life expectancy. In this paper, the beneficiary’s age at death was estimated, with the application of the Monte Carlo Simulation from 1,000 repetitions of the calculation. Thus, this period would correspond to the difference between the beneficiary’s estimated age at death and the beneficiary’s age at the time of the military’s death.

The maximum survivor’s pension amount (BRL8,658.60) presented in Table 2 refers to a beneficiary of an official who would have contributed for 43 years and left a notional amount used to calculate the benefit whose duration would be only 3 years, depending on the estimated date of death of the beneficiary. In this case, we would have a replacement rate of 136.64%, ensuring, in fact, a benefit of 100% of the weighted average of contribution wages, given the provisions of premise No. 4 of the proposed model.

Regarding the uncertainty of the replacement rate, a target of criticism by many authors such as Cichon (1999), Table 3 demonstrates that the variation of one year in the life expectancy of the beneficiary directly impacts this percentage. The longer the beneficiary lives, the lower the amount of survivor’s pension received monthly. Furthermore, this impact is also susceptible to fluctuations in at least two variables: the notional rate and the discount rate.

3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
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136.64%	103.01%	83.07%	69.47%	59.43%	51.91%	45.95%	42.45%
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Table 3. Average replacement rate in relation to the beneficiary's life expectancy

Finally, when analyzing the results of this simulation from the point of view of the isomorphic approaches presented by DiMaggio and Powell (1983), it appears that the pure and simple application of an alternative model for defining the benefit in each protection system may, in fact, cause distortions that did not exist until then, as well as generate negative externalities for their respective beneficiaries. It is mandatory, therefore, that the specificities of both the social protection system itself and the policies and public services offered to the population be considered, prior to the effective adoption of a new methodology for calculating benefits in the country.

5 Conclusions

Encouraged, among other factors, by the challenge posed by Holzmann and Palmer (2020) to thoroughly examine the implementation of the NDC system in various social protection benefits, such as the survivor's pension, this paper has proposed a pure NDC system model for adoption in Brazil. Certainly, there is a necessity to adjust the current legislation for its practical implementation in the country. However, it is essential to clarify that this paper does not aim to formulate a new legal framework supporting the implementation of the NDC system but rather seeks to investigate its impact on this model. It should also be noted that the deliberate exclusion of a financial pillar in this model is intended to clearly demonstrate its effects on public accounts and the value of the benefit.

It was observed that, due to the longer life expectancy of women compared to men, despite receiving the inactive benefit for a more extended period, none of the 595 female military personnel would be eligible for a survivor's pension. This observation suggests that, from a purely financial standpoint related to social protection, an Armed Forces personnel policy aimed at increasing the number of women could contribute to reducing future expenses on survivor's pensions, thereby mitigating the actuarial deficit and implicit social security debt. Additionally, it must be acknowledged that the involvement of women in the Armed Forces is still relatively limited, although it has been steadily increasing since their initial entry into military ranks.

When analyzing the benefits provided through a survivor's pension, it was found that the impact is significant, both in terms of public spending and the amount received by the beneficiary. The results indicate an 88.62% decrease in the implicit social security debt and an average reduction of approximately 35% in the benefit amount. This means prosperity for the State but, unfortunately, misfortune for the beneficiary.

Based on the simulation results, the deficit linked to future spending on military pensions would decrease from BRL51.68 million to BRL5.88 million. This reduction would stem from the limitation set by the NDC system for calculating the benefit, which would, on average, have a replacement rate of 65%.

Specifically, regarding the SPSMFA, it's important to note that besides reducing the value of the survivor's pension, the adoption of the NDC system, from the beneficiary's standpoint, could lead to at least two negative externalities worth mentioning: firstly, the existence of differing pensions held by military personnel with identical careers, and secondly, the value of survivor's pensions being higher for men compared to women. Currently, the SPSMFA doesn't create any distinction between the values of lifelong survivor's pensions left by military personnel with the same career, whether for women - which are more common - or for men.

Consequently, it's evident that the goal of reducing the social security deficit and the implicit social security debt is attained through the implementation of the notional account system, without considering the impact on future beneficiaries. Concerning this impact, it's essential to consider that it may vary based on changes in the variables used. Furthermore, we aimed to introduce innovation by determining the life expectancy of military personnel and their spouses using Monte Carlo Simulation with 1,000 repetitions.

Drawing from the showcased results, it's also plausible to assert that employing the exclusive methodology of the NDC system to compute retirement benefits/earnings would potentially yield a more adverse impact. This is owing to the shorter time horizon, compared to the present simulation, which directly affects the notional amount. A comparable effect is anticipated in the valuation of benefits for individuals with irregular professional trajectories.

On this occasion, it wouldn't be inaccurate to suggest that the implementation of the NDC system indeed signifies a move towards incorporating the financial capitalization regime for determining benefits within social protection systems. Drawing from international benchmarks, it's evident that notional accounts form just one pillar of a social protection system, which typically relies on two additional pillars: a universal basic benefit and the financially capitalized one.

Applying this to the Brazilian context, alongside the notional pillar, we'd envisage a universal basic pillar generating a minimum benefit for the entire country's population, and a financial pillar where everyone manages a financial account exposed to market risks to pursue better interest rates. In this setup, while it's crucial to establish and extend the payment of a basic benefit universally, the impact arising from the NDC system, coupled with the transfer of risk to individuals through financial accounts, appears to present a favorable scenario for the State to promote its adoption. Otherwise, notional capitalization would merely scratch the surface. Future studies could explore this configuration to assess its impact on both the State and the beneficiaries.

In conclusion, the suitability of the Nordic solution for the tropics depends on the intended objectives. Its implementation aids in trimming public spending on social protection, but it generates adverse effects for the beneficiaries concerned. Consequently, a straightforward application without considering the characteristics of the existing social protection systems in the country, alongside the policies and public services provided to the population, would be unsuitable.

While controlling public spending remains crucial for enhancing and broadening public policies, introducing social protection benefits with a relatively low replacement rate in countries lacking essential services such as security, transportation, and robust healthcare systems appears to drive the elderly or pensioners toward poverty. Regrettably, this is the prevailing backdrop observable in Brazil, and it's a context that cannot be overlooked in this discussion.

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