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Defined-benefit and variable-contribution plans: evidence of earnings management in Brazil

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Abstract

Objective: To verify whether the defined-benefit (DB) and variable-contribution (VC) plans of Complementary Pension Entities (*EFPC*) in Brazil tend to present a solvency volume equal to or above the established standard ratio when they are close to reaching it.

Method: Empirical histograms of coverage ratios (solvency), the τ test of Degeorge, Patel, and Zeckhauser (1999), and Mann-Whitney statistics were developed.

Results: Considerable discontinuity was found in the histogram distributions between the class, including the equilibrium coverage index and the class immediately below. A statistically positive solvency volume was also found for the private company plans, which are ruled by a governance structure concentrated around the sponsors, and for plans located in the Federal District and in the states of Rio de Janeiro and São Paulo, which have, on average, higher administrative expenses than those located in other states.

Contributions: Robust evidence shows that *EFPC* managers are possibly manipulating the coverage rates of the DB and VC plans to conceal insolvency problems from sponsors, participants, beneficiaries, and regulatory and inspection agencies, characterizing earnings management.

Keywords: earnings management; coverage ratio (solvency); DB plans; VC plans.

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1. Introduction

Entidades Fechadas de Previdência Complementar (EFPC) [Complementary Private Pension Funds] are non-profit organizations composed of a foundation or civil society, which administer pension plans accessible only to employees/servants of a sponsor or to people who are associated with a founder (Complementary Law no. 108, from May 29th, 2001).

As these entities care for the social security savings of millions of people, the sponsors, participants, beneficiaries, and regulatory and supervisory bodies (principals) must analyze these entities' financial statements and monitor their situation and benefit plans to be aware of decisions that are ultimately attributed to the funds' managers – agents (Chan, Silva & Martins, 2010). In this sense, because managers know the business, they can use their knowledge in the best possible way to help disseminate quality accounting information that portrays these entities' economic context, increasing accounting credibility (Reis, Lamounier & Bressan, 2015; Flores, Braunbeck & Carvalho, 2018). On the other hand, managers often take opportunities to make discretionary choices when preparing and disclosing accounting information to modify financial statements and change the stakeholders' perception regarding the activities and results of these entities, which characterizes the earnings management practice (Martinez, 2013).

As earnings management refers to the purposeful manipulation of accounts to serve particular interests, managers may manipulate some of these accounts to confirm market expectations regarding a company's performance; meet specific regulatory standards; seek government protection; or maximize their career possibilities, power, and remuneration within these companies (Sousa & Bressan, 2018).

It is essential to clarify the distinction between earnings management and fraudulent accounting. While there is manipulation within accepted accounting standards and practices in the first situation, the second violates accounting standards and principles and is illegal (Dechow & Skinner, 2000).

One of the techniques adopted in accounting for detecting earnings management practices is analyzing a variable's frequency distribution around its median (mean) via a histogram. A behavior similar to a symmetrical normal curve is expected during the validity under the null hypothesis of non-occurrence of earnings management. In turn, a substantial discontinuity between the first interval immediately below the median (mean) and the first interval immediately above it suggests the practice of earnings management.

In the case of accounting variables influenced by actuarial assumptions, such as in the case of complementary private pension plans, the technique of analyzing empirical histograms is valid to help identify potential earnings management, as there are observable parameters subject to verification for the main actuarial assumptions (actual interest rate and general mortality table), which restrict discretionary actions. Additionally, the other actuarial assumptions that have a lesser impact on accounting variables are not subject to objective rules and may be freely chosen by managers, which in this context, rules out, in principle, potential fraudulent behavior (Instrução da Superintendência Nacional de Previdência Complementar [PREVIC] No. 33, 2020).

A limitation found in studies analyzing discontinuities in empirical histograms as evidence for the practice of earnings management concerns the impossibility of discriminating between discontinuities naturally occurring in a business or market and discontinuities arising from occasional discretionary actions. That is, although the literature acknowledges that discontinuities in empirical histograms provide indications regarding the practice of earnings management, such a notion cannot be considered an absolute truth, especially if we consider issues such as samples' sensitivity and the impossibility of extrapolating data (Burgstahler & Dichev, 1997; Souza & Bressan, 2018).

The studies using empirical histograms to find evidence of earnings management include Burgstahler and Dichev (1997). In that study, the authors verified that companies have incentives to manage their results for two reasons: a) avoid disclosing small losses to the market when they are close to achieving positive results, and b) meet market benchmarks.

In addition to the motivations presented by Burgstahler and Dichev (1997), Degeorge, Patel, and Zeckhauser (1999) found that companies also manage their earnings in an attempt to confirm market analysts' predictions, as most investors ground their decisions on the information these professionals provide.

Burgstahler and Chuck (2017) conducted a literature review on studies analyzing frequency distributions to find the occurrence of discontinuities in corporate earnings as evidence of earnings management and found that evidence is consistent with the earnings management hypothesis.

In Brazil, Reis, Lamounier, and Bressan (2015) sought to confirm whether companies listed on BM&FBOVESPA from 2008 to 2013 used earnings management to avoid disclosing losses when they were close to achieving accounting profit. However, these authors focused on companies managing operational results, and the findings showed that companies avoided disclosing losses through operating expenses.

Sousa and Bressan (2018) investigated whether small and large Brazilian banks used earnings management to avoid disclosing losses from 2008 to 2015, according to Burgstahler and Dichev's (1997) methodology. Their results showed that the small banks managed their results, but the large ones did not.

Regarding complementary pension funds, the study by Westerduin, Wouterson, and Langendijk (2012) sought evidence of earnings management in 342 Dutch pension funds from 2008 to 2010. These authors verified whether part of the *EFPC* would be managing the index coverage (solvency), which is given by the quotient of the coverage equity by the mathematical provisions. The objective of the study above was to infer whether the coverage ratio was manipulated to meet, at least, the minimum regulatory standard of 1.05 (105%), avoiding the need for funds to prepare a short-term recovery plan under Dutch Central Bank oversight. Thus, the methodology adopted was to graphically analyze the distribution of coverage indices around their minimum rate, from which a behavior similar to that of a symmetrical normal curve is expected. In general, Westerduin, Wouterson, and Langendijk (2012) concluded that the Dutch *EFPC* tend to manage their coverage ratio when they are close to being under the regulatory standard. However, this behavior would not be verified in sectoral *EFPC*, which are overseen by many stakeholders and, in smaller *EFPC*, maintained by only one sponsor.

Therefore, based on Westerduin, Wouterson, and Langendijk (2012), this study's objective is to verify whether Brazilian defined-benefit (DB) and variable-contribution (VC) pension plans tend to present a solvency volume equal to or above the established standard ratio (100%), when they are close to reaching it, which would show the occasional practice of earnings management.

It is important, as the DB and VC plans are subject to discretionary choices of actuarial assumptions – such as the real interest rate, general mortality table, and salary growth rate, among others – which determine these plans' mathematical provisions, that is, their estimates of social security obligations with participants and beneficiaries. Thus, as mathematical provisions reflect changes in actuarial assumptions in accounting terms, this account adequately portrays changes in the plans' actuarial liabilities (Silva & Silva, 2021).

Thus, when these provisions increase above the coverage equity (guarantee assets), the plans start to incur deficits that usually need to be addressed by sponsors, participants, and beneficiaries via extraordinary contributions (Mello, Constantino, Macedo & Rodrigues, 2019).

However, to avoid potential problems with sponsors, participants, beneficiaries, and regulatory and supervisory bodies, *EFPC* managers may manipulate the mathematical provisions of the DB and VC plans to disclose a solvency situation when it is close to being achieved, even if temporarily, which characterizes earnings management.

In addition to this introduction, the next section presents this paper theoretical framework and the research hypotheses, followed by the methodological procedures and the results and respective analyses. Finally, the final considerations are addressed.

2. Theoretical Framework

According to Jensen and Meckling (1976), the Agency Theory deals with the relationships between managers (agents) and capital owners (principals) who do not share the same objectives. While the former is usually portrayed in the figures of presidents and directors of large publicly traded companies, the latter generally refers to shareholders but can also be creditors, suppliers, and all those who, in some way, finance the activities of these companies.

This theory is built upon the conflicting relationship between a principal, who hires someone else (agent) to perform, on his behalf, services that involve granting decision-making power. Thus, if the parties to this relationship maximize utility in an economic sense, the agent will not always act according to the principal's interests, which characterizes an agency conflict (Alchian & Demsetz, 1972; Jensen & Meckling, 1976).

This situation occurs because the managers' interests may differ from those of owners, with the first having the potential to favor strategies within the company that increase their career chances, power, and remuneration instead of being concerned with optimizing a firm's value (Alchian & Demsetz, 1972).

According to Teixeira, Santos, and Macedo (2020), this type of behavior may also be found among *EFPC* managers, who would have incentives to manage the results of post-employment benefit plans to conceal insolvency issues from sponsors, participants, beneficiaries, and regulatory and supervising bodies. Therefore, by manipulating the mathematical provisions of pension plans, managers would be able to demonstrate short-term business competence, transferring the costs of future deficits to their successors (Kisser, Kiff & Soto, 2017).

The specificities inherent to the market of complementary pension plans, mainly regarding DB and VC plans, have generated considerable information asymmetry between managers (agents), who are knowledgeable of actuarial assumptions that strongly impact mathematical provisions, and sponsors, participants, and beneficiaries (principals), who, in general, detain little understanding of the subject (Mello, 2020).

This information asymmetry provides managers with opportunities to make certain choices of actuarial assumptions in the DB and VC plans, which may be used to please sponsors, participants, beneficiaries, or regulatory and supervisory bodies in the present, thus reducing the mathematical provisions of the plans against their coverage equity and, therefore, maximizing their career opportunities, power, and remuneration. Figure 1 shows the relationship between coverage equity (guaranteeing assets) and mathematical provisions (actuarial liabilities) in surplus, deficit, and technical balance situations, respectively.

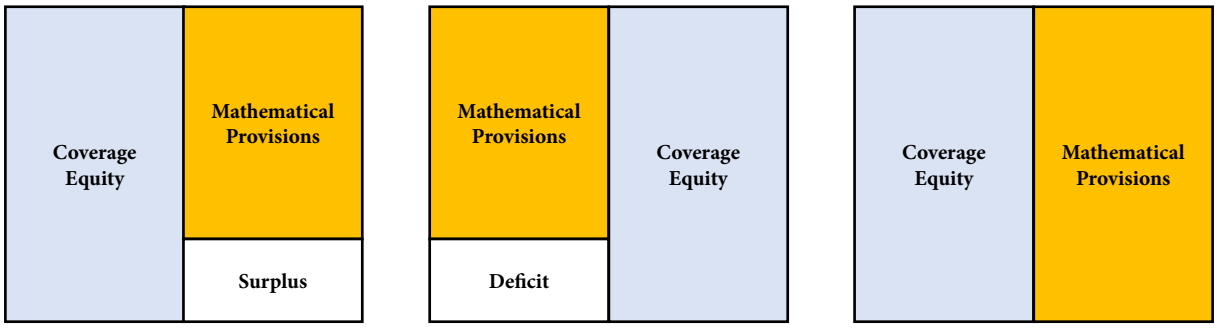

Figure 1. Mathematical Provisions *versus* Equity Coverage

Source: developed by the authors.

It is important to emphasize that the discretion of *EFPC* managers regarding the main actuarial assumptions impacting the mathematical provisions of DB and VC plans, that is, the real interest rate and the general mortality table, is restricted by the *Conselho Nacional de Previdência Complementar* (*CNPC*) [National Complementary Pension Council] (CNPC), former *Conselho de Gestão da Previdência Complementar* (*CGPC*) [Complementary Pension Management Board], and PREVIC, which are the regulatory and supervisory bodies, respectively, of complementary pension funds in Brazil. For example, since 2003, CNPC and PREVIC have determined that general mortality tables, with minimum limits for the expected survival of plan participants to be adopted (Resolution CGPC No. 11, 2002; Instruction PREVIC No. 10, 2018; and Instruction PREVIC No. 33, 2020). As for the real interest rate, its parameters have been regulated and revised since 2007 (Resolutions CGPC No. 18, 2006; CNPC No. 09, 2012; CNPC No. 15, 2014; and CNPC No. 30, 2018). On the other hand, regarding actuarial assumptions that have lesser impacts on mathematical provisions, such as the factor determining the real value of an entity's benefits (capacity factor) over time and the hypothesis on the composition of pensioners' families (family composition), the standard assigns responsibility to the actuaries and the *EFPC* Executive Board for proposing and approving, respectively, without specifying limits (PREVIC Instruction No. 33, 2020).

Glaum (2009) conducted a review of studies addressing the accounting of post-employment social security benefits and concluded that all empirical evidence indicates opportunistic behavior on the part of managers in determining the actuarial assumptions that influence determining mathematical provisions of the DB plans.

Pennacchi and Rastad (2011) showed the existence of agency conflict and opportunistic behavior on the part of managers of US state pension funds, who would act influenced, to a large extent, by their career possibilities in these entities, when determining actuarial goals of supplementary pension plans.

Sousa and Costa (2015) showed that the managers of Brazilian *EFPC*, with DB plans with a coverage ratio lower than 1.05, are encouraged to adopt more optimistic actuarial assumptions when determining the mortality table and the real interest rate of these plans, primarily as a result of information asymmetry that favors directors against the plans' participants and beneficiaries.

The World Bank view complements these studies by considering that *EFPC* managers are unlikely to be held responsible for the wrong choices of actuarial assumptions that do not take into account technically defined parameters and the independence of actuaries, causing a conflict of interest in the plans' management (BM, 2012).

As the actuarial assumptions of the DB and VC plans, which determine the mathematical provisions or social security obligations, are subject to the discretion of the *EFPC* managers, it is possible that these managers are using earnings management to conceal potential insolvency problems in Brazilian complementary pension plan, which requires investigation.

As the actuarial assumptions of the DB and VC plans, which determine the mathematical provisions or social security obligations, are subject to the discretion of the *EFPC* managers, these managers may be using earnings management to conceal potential insolvency problems in Brazilian complementary pension plans, which requires investigation.

Therefore, we intend to explore whether the DB and VC plans of Brazilian pension funds show signs that they manage their mathematical provisions, intending to remain balanced or in surplus, thus avoiding an eventual equation of deficit and/or a more detailed analysis by sponsors, participants, beneficiaries, and regulatory and supervisory bodies, similarly to the study carried out by Westerduin, Wouterson, and Langendijk (2012).

Therefore, the coverage ratio (solvency) will be used. It is given by the quotient of the coverage equity by the plans' mathematical provisions. Thus, if a substantial discontinuity is found in the histograms of the DB and VC plans between the interval that includes the coverage index balance parameter and the interval just below it, one may conclude that the managers of the DB and VC plans manipulate their mathematical provisions to meet a balance parameter, avoiding problems in the present with sponsors, participants, beneficiaries, and regulatory and supervisory bodies. Thus, the first research hypothesis (*H1*) is:

> **H1:** DB and VC plans with coverage ratios just below the minimum solvency standard (100%) adopt discretion so that these ratios reach the minimum or a level just above this minimum.

The method adopted by Westerduin, Wouterson, and Langendijk (2012) can still be helpful to assist in discriminating *EFPC* and plans according to the predominant type of sponsorship and to what is required by law. Complementary Law No. 109, of May 29th, 2001 (LC No. 109/2001), the general supplementary pension law in Brazil, encompasses all types of *EFPC* (with private and state sponsorship) and provides the general guidelines for the operation of these entities and their plans. Complementary Law No. 108, of May 29th, 2001 (LC No. 108/2001) brings specific requirements for *EFPC* and plans sponsored by state-owned entities.

One of the main differences between the two laws lies in the governance structure of the *EFPC* maintained by private and state-owned entities. For *EFPC* sponsored predominantly by private entities and companies, LC No. 109/2001 determines that at least 1/3 of the Deliberative and Fiscal Councils vacancies are destined to the participants and beneficiaries, while representatives' sponsors may occupy the remaining. In the case of *EFPC* maintained by public agencies and companies, LC No. 108/2001 requires parity in the composition of these Councils between participants and beneficiaries (half of the vacancies) and sponsors (half of the vacancies).

In this sense, because DB and VC plans sponsored by private companies are subject to a governance structure more concentrated around the sponsors, they make greater use of actuarial discretion to balance their coverage indices compared to their state-owned counterparts, which are more closely monitored by participants and beneficiaries, given the greater sharing of power provided by LC No. 108/2001. Therefore, the second research hypothesis (*H2*) is the following:

H2: Discretion when determining the coverage rates of DB and VC plans occurs to a greater extent in EFPC predominantly sponsored by private companies and entities, due to the stakeholders' limited involvement and a more concentrated governance structure, compared to plans DB and VC predominantly sponsored by state-owned companies and entities, which are watched over by many stakeholders.

As both the DB and VC plans sponsored by private companies and entities and the DB and VC plans sponsored by state-owned companies probably use actuarial discretion to manipulate coverage ratios, the difference between the influence exerted by these two types of sponsorship would be observed by the persistent disclosure of positive results for the solvency of plans maintained by private companies compared to plans maintained by state-owned entities. Otherwise, DB and VC plans from private sponsors are expected to reveal a greater concentration of positive results for the coverage index around the median (mean) than negative results. In contrast, a more symmetrical behavior is expected for the positive and negative values around the median (average) of state-owned companies' DB and DV plans.

The third research hypothesis (*H3*) departs from the idea that the geographic location of a pension fund influences the solvency disclosed by DB and VC plans. According to Cunha (2018) and Teixeira and Rodrigues (2021), an *EFPC* headquartered in the Federal District (DF) or the states of Rio de Janeiro (RJ) and São Paulo (SP) tends to have higher administrative expenses than an EFPC located in any other Brazilian state, because of the cost of living in these locations. Therefore, to justify the higher administrative expenses, the funds in DF, RJ, and SP would need to demonstrate that they manage the DB and VC plans better than their counterparts in other states.

H3: The discretion in determining the coverage rates of the DB and VC plans occurs to a greater extent in EFPC located in the DF, RJ, and SP than among those located in other Brazilian states.

As DB and VC plans are endowed with risks, these are expected to use actuarial discretion in determining the coverage ratio, regardless of an *EFPC's* geographic location. However, this characteristic would tend to be more frequent in the DB, and VC plans managed by pension funds in DF, RJ, and SP, due to a particular propensity to present a more significant number of solvent plans around the median/average (solvency persistence), than *EFPC* located in other states, which would have present a more symmetrical index in histograms.

3. Methodological Procedures

The data collected for this study concern the annual observations provided in balance sheets of the complementary pension plans from 2010 to 2020, available at PREVIC website: https://www.gov.br/economia/pt-br/orgaos/linked-entities/autarquias/previc/acesso-a-informacao/data-abertos/balancetes-accounting/balancetes-de-plans. Data treatment and analysis were performed using RStudio software.

A procedure similar to that of Westerduin, Wouterson, and Langendijk (2012) was adopted to assess research hypotheses 1 to 3, according to the methodology proposed by Burgstahler and Dichev (1997). However, unlike the above studies, the focus of analysis did not fall on the consolidated solvency of *EFPC* but on the DB and VC plans.

The following accounts were used to build the coverage ratio (solvency) of the plans: coverage equity (account: 2.3.1.0.00.00.00.00), divided by mathematical provisions (account: 2.3.1.1.00.00.00.00), all concerning the 4th quarter of each year under study.

In turn, data obtained from the plans' balance sheets, based on a registration database that defines the legal basis related to each of the plans (LC No. 109/2001 or LC No. 108/2001), were cross-checked to identify the plans covered only by Complementary Law No. 109/2001 (private) and the plans predominantly subject to Complementary Law No. 108/2001 (public). This verification was possible thanks to the key variable "*Número do Cadastro Nacional de Planos de Benefícios* (CNPB)" [Number of the National Registry of Benefit Plans (CNPB)] present in both databases, which is the individualized and a non-transferable record of each plan.

In order to identify the state of the federation where each plan is located, data from the individual balance sheets with an *EFPC* registration database, which contains information about the state and city where the pension funds' headquarters are located, were cross-referenced. Thus, the "*EFPC* Name," simultaneously present in both databases, was used as a key variable.

Initially, 3,628 observations were collected for DB plans. However, 492 observations with missing values concerning coverage equity or mathematical provisions were excluded. Another 39 observations that revealed values equal to zero for one of the two variables mentioned above and 27 observations that contained negative values were excluded. Hence, a sample with 3,070 feasible observations for the solvency calculation remained. Table 1 summarizes how the final sample was obtained.

Table 1
Sample selected for DB plans

Sample/Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
General sample	345	343	344	336	332	328	327	327	319	313	314	3.628
(-) Missing observations	(41)	(42)	(42)	(46)	(44)	(45)	(47)	(48)	(46)	(45)	(46)	(492)
(-) Observations with values equal to zero	(3)	(3)	(14)	(4)	(4)	(3)	(2)	(4)	(2)	–	–	(39)
(-) Observations with negative values	(1)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(3)	(3)	(3)	(27)
Final sample	**300**	**296**	**286**	**284**	**282**	**277**	**275**	**272**	**268**	**265**	**265**	**3.070**

Source: developed by the authors.

As for the VC plans, 4,714 observations were initially collected. However, in order to perform the solvency calculation, 14 observations were excluded as they revealed the absence of values for the coverage equity or mathematical provisions. Another 33 observations with values equal to zero for one of these two variables were also excluded, resulting in a final sample of 4,667 observations for this type of plan. Table 2 summarizes the final sample.

Table 2
Sample selected for VC plans

Sample/Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
General sample	441	446	449	447	446	433	414	425	410	402	401	4.714
(-) Missing observations	–	–	–	(1)	(2)	(2)	(2)	(2)	(2)	(1)	(2)	(14)
(-) Observations with values equal to zero	(4)	(3)	(8)	(2)	(4)	(1)	–	(1)	(4)	(2)	(4)	(33)
Final sample	**437**	**443**	**441**	**444**	**440**	**430**	**412**	**422**	**404**	**399**	**395**	**4.667**

Source: developed by the authors

With the samples defined, the natural logarithm of the coverage index was calculated for all plans. It makes this index equal to zero at equilibrium, as Degeorge, Patel, and Zeckhauser (1999) recommended. According to these authors, using variables in logarithms for studies of distributions improves the visualization of the central range of histograms in the presence of severe outliers.

Thus, after transforming the variable of interest, the study methodology consisted of three basic steps. First, the histograms for the DB planes were constructed, considering the entire sample; only DB plans sponsored by private companies and entities; only DB plans sponsored by state companies and entities; only DB plans located in DF, RJ, or SP; and only DB plans located in other Brazilian states. A similar procedure was adopted for the VC plans; however, in addition to the previous histograms, these plans also had histograms prepared only for the "CV Origin" plans and only for the "Defined Contribution (DC) with VC essence" plans. This is explained by the fact that there are several plans in the Brazilian pension funds market using DC nomenclature but which actually have a portion of lifetime income, which characterizes the condition of VC, as advocated by Teixeira, Santos, and Macedo (2020).

Therefore, two calculations were performed to verify which were the DC plans with a VC essence. Initially, the coverage index was verified, which provides the current plan situation and must be equal to 1 (one) to present equilibrium, neither surplus nor deficit. Afterward, the ratio between the coverage equity and the sum of the benefits granted and the benefits to be granted was calculated, which reveals the accumulated status of plans and must also be equal to 1 (one) for balance to occur. Thus, for a plan with DC nomenclature to be considered a "pure DC" plan, that is, without risks, it must simultaneously satisfy the two conditions of equality mentioned above. Otherwise, it will be a DC plan with a VC essence.

Regarding the histograms' intervals (classes), authors such as Westerduin, Wouterson, and Langendijk (2012) and Decourt, Seidler, Daneberg, and Pietro Neto (2014) used ranges with a width of two percentage points (2%). However, because the data were very concentrated in the central region of the histograms, which would impair visualization in this study, we decided to adopt classes with a width of 0.1% for all samples of the DB and VC plans.

The τ test proposed by Degeorge, Patel, and Zeckhauser (1999) was performed in the second stage to formally confirm the existence of discontinuity in the distribution when plans are close to the equilibrium coverage index. The τ-test is represented by the following equation (1):

$$\tau = \frac{\Delta p(x_n) - \mu[\Delta p(x_i)]}{\sigma \Delta p(x_i)} \quad (1)$$

where refers to the probability density of the interval that includes the equilibrium rate (*n*), minus the probability density of the neighboring interval immediately below(*n-1);* e and refer to the mean and standard deviation, respectively, of the variation between the probability density of neighboring intervals located between (*n+5*) and (*n-5*), excluding classes *n-(n-1)*.

A visual inspection of the histograms and the τ test by Degeorge, Patel and Zeckhauser (1999) are the two instruments used to answer research hypothesis *H1*. If *H1* is true, the τ test is statistically significant at 1%, providing evidence that the density of the class with the equilibrium coverage index is higher than the density of the class just below that same index.

In the third step, Mann-Whitney statistics were calculated to investigate whether the DB and VC plans tend to more frequently disclose positive results than negative ones (persistence of solvency *vis-à-vis* insolvency), when the type of sponsorship and the geographic location of *EFPC* are considered. It means that a right-sided test was performed for the empirical distribution of plan coverage ratios. Hence, the differences between class groups (*n+5*) and (*n-5*); (*n+7*) and (*n-7*)*;* and (*n+10*) and (*n-10*), excluding the central classes were assessed, that is, with the coverage index (*n*) and its neighbor immediately below (*n-1*).

For research hypotheses *H2* and *H3* to be true, DB and VC plans maintained by private companies and those located in the Federal District or Rio de Janeiro and São Paulo would have a preference for persistently disclosing a solvency situation to sponsors, participants, beneficiaries, and regulatory and supervisory bodies, compared to DB and VC plans sponsored by state entities and companies and those located outside the DF, RJ, and SP, respectively. In other words, this would indicate that the null hypothesis of equal densities between the sets of classes analyzed for the Mann-Whitney would be rejected at 1% of significance.

Finally, although discriminating between the plans called "VC of Origin" and plans called "DC with a VC essence" is not part of the research hypotheses, the use of the DC nomenclature by a VC plan may be a strategy for *EFPC* conceal from not very engaged sponsors and lay participants these plans' actuarial risks. Therefore, DC plans with a VC essence will consistently report more positive than negative solvency results to cover up their risks, as, in principle, a plan with a DC name could not be in deficit.

4. Results And Analyses

4.1 Results concerning the DB plans

Table 3 shows that 66.5% of 3,070 observations concerning DB plans from 2010 to 2020 are linked to private sponsors, and the remaining to public sponsors (33.5%). Similar percentages are found when observations are separated between plans in the Federal District, Rio de Janeiro, or São Paulo (67.8%) and those in other Brazilian states (32.2%). Regarding the DB plans' guaranteeing assets and actuarial obligations, the first presented an average coverage equity of R$462.52 billion, with obligations represented by mathematical provisions of R$ 460.07 billion on average. As for the measures of central tendency of solvency, the mean for the period was 1.01 and the median 1.02, that is, both slightly higher than the equilibrium rate of 1.00 (100%).

Table 3
DB Plans Statistics

Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total\ Mean
Total DB Plans	300	296	286	284	282	277	275	272	268	265	265	3,070
Private DB plans	202	203	194	192	189	184	181	178	173	172	169	2,037
State DB plans	98	93	92	92	93	93	94	94	95	93	96	1,033
DB in DF-RJ-SP	203	202	193	191	187	185	185	185	182	183	186	2,082
DB in other FUs	97	94	93	93	95	92	90	87	86	82	79	988
Coverage equity (R$ billion)	375.9	393.8	433.0	438.5	435.9	429.3	459.0	477.1	507.7	550.1	587.3	462.5
Mathematical provisions (R$ billion)	329.0	354.1	390.1	419.2	436.2	487.8	510.5	494.2	511.8	550.4	577.5	460.1
Solvency mean	1.14	1.11	1.11	1.05	1.00	0.88	0.90	0.97	0.99	1.00	1.02	1.01
Solvency median	1.08	1.07	1.05	1.00	1.00	1.00	1.02	1.01	1.01	1.02	1.01	1.02

Note: The coverage equity and mathematical provisions are in nominal values.

Source: developed by the authors.

As established in the methodology, a histogram of the frequency distribution of the natural logarithm of the coverage index was prepared, considering all the observations concerning DB plans from 2010 to 2020. A visual analysis of Figure 2 reveals considerable discontinuity between the two central classes, that is, the upper class, which encompasses the equilibrium coverage index (zero) and its neighbor just below, with the first having 409 observations and the second with 42 observations.

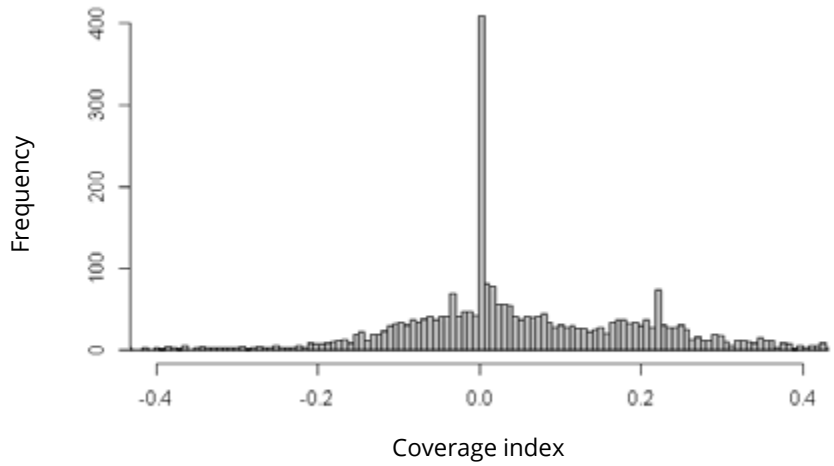

Figure 2. Histogram for the Total Observations of DB Plans

Source: developed by the authors.

This considerable discontinuity between the two central classes, with a wide density of observations for the class encompassing equilibrium coverage index (zero), is a strong indication that *EFPC* executives manage the solvency of DB plans seeking to predominantly report balanced or moderately positive results when insolvent plans are close to the solvency threshold. On the other hand, pension fund managers seem concerned with concealing DB plans' insolvency problems from sponsors, participants, beneficiaries, and regulatory and supervisory bodies whenever possible, thus, maximizing their career possibilities, power, and remuneration within *EFPC*.

Similar results are found when DB plans are separated into a) sponsored by private entities and companies; b) sponsored by state entities and companies; c) located in the Federal District, Rio de Janeiro, or São Paulo; and d) located in other Brazilian states. Figure 3 presents the histograms of the situations mentioned above.

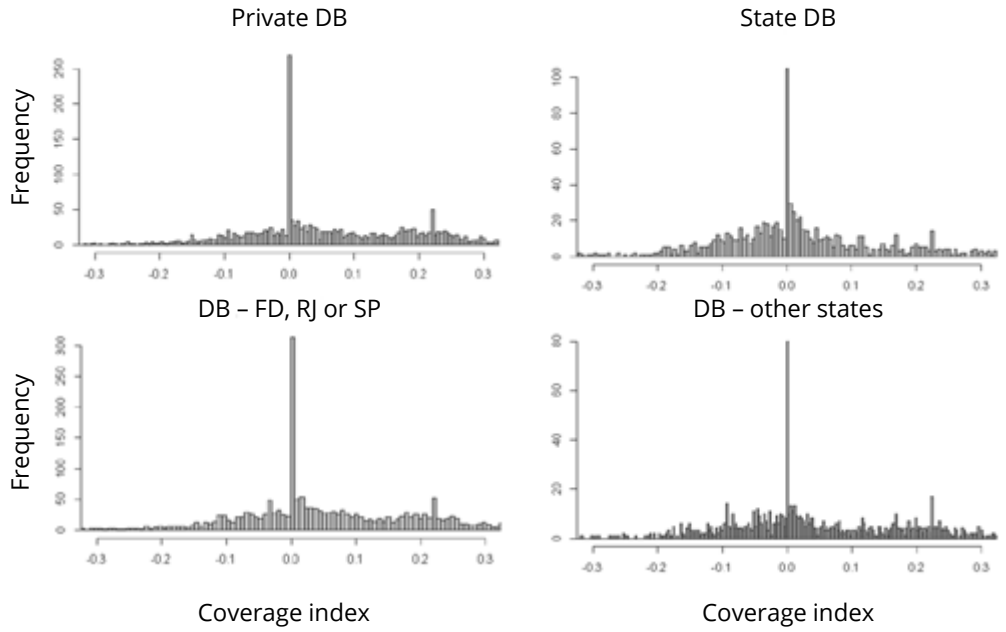

Figure 3. Histograms for the DB Plans' Different Compositions

Source: developed by the authors.

However, to formally confirm the results reported in the histograms, the τ statistic proposed by Degeorge, Patel, and Zeckhauser (1999) was calculated (Table 4). Additionally, the same table provides the values for the Mann- Whitney, which assesses the null hypothesis of equality in densities between classes *(n+5)* and *(n-5)*; *(n+7)* and *(n-7)*; and *(n+10)* and *(n-10)*, excluding the central classes (*n*) and (*n-1*); against the alternative hypothesis that positive values reported are more frequent than negative values (persistence regarding solvency *vis-à-vis* insolvency).

Table 4
Statistics for the DB Plans

Information	Total DB	Private DB	State DB	DB DF, SP and RJ	DB other states
Mean	0.07	0.11	0.01	0.08	0.06
Median	0.02	0.04	0.00	0.03	0.01
τ test	18.58	48.63	12.68	19.18	23.81
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
Mann-Whitney (n+5) and (n-5)	22.0	24.0	21.5	22.0	22.5
p-value	0.0297	0.0106	0.0375	0.0297	0.0216
Mann-Whitney (n+7) and (n-7)	34.5	44.0	32.5	41.5	41.5
p-value	0.1116	0.0075	0.1684	0.0173	0.0159
Mann-Whitney (n+10) and (n-10)	64.0	84.0	57.0	81.5	73.0
p-value	0.1517	0.0056	0.3113	0.0094	0.0434
Nº. of Observations	3.070	2.037	1.033	2.082	988

Source: developed by the authors.

The results show that the τ test by Degeorge, Patel, and Zeckhauser (1999) was highly significant for all histograms, enabling rejecting the null hypothesis of equal distributions between the upper central class, which includes the equilibrium coverage index and the neighboring class just below this same index at 1% significance. That is, considerable discontinuity is found in favor of the class that covers the equilibrium coverage index for all histograms, which does not allow rejecting *H1*. This finding suggests that earnings management is recurrent in DB plans, regardless of the type of sponsorship and geographic location of these plans.

As for the Mann-Whitney test, it was impossible to reject the null hypothesis for the set of classes (*n+5*) and (*n-5*) in any histograms at 1% significance. Additionally, for the set of classes (*n+7*) and (*n-7*) and (*n+10*) and (*n-10*), the same hypothesis was rejected in the histograms of the DB plans maintained by private entities and companies; only for the interval set (*n+10*) and (*n-10*), rejection occurred for the DB plans located in the Federal District, in Rio de Janeiro or São Paulo.

Such results indicate that DB plans sponsored by private entities and companies tend to persistently report more positive than negative values for the coverage ratio compared to DB plans maintained by state entities and companies. On the other hand, due to the limited involvement of stakeholders and a more concentrated governance structure, there is an indication that private DB plans are more likely to disclose a greater volume of positive than negative solvency results, as they are under the exclusive aegis of LC No. 109/2001. On the other hand, we cannot deny that the shared governance structure provided by LC No. 108/2001 inhibits, to a certain extent, the disclosure of recurrently positive results in the case of state DB plans, which confirms *H2*.

Regarding DB plans located in the DF, RJ, and SP, a weak tendency was found for these plans to persistently present more positive than negative solvency results compared to DB plans located in the other states, which does not enable rejecting *H3*. It provides evidence that the higher administrative costs of *EFPC* maintaining DB plans in the DF, RJ, and SP, as found by Cunha (2018) and Teixeira and Rodrigues (2021), seems to motivate the use of discretion to improve the solvency of these plans. Such behavior was not found in DB plans located in other Brazilian states

4.2 Results concerning the VC Plans

Table 5 includes 4,667 observations concerning VC plans from 2010 to 2020. Of these, 83.7% refer to plans maintained by private sponsors, and the remaining to plans from public sponsors (16.3%). Percentages very close to the previous composition are found when the observations are separated between plans maintained in the Federal District, Rio de Janeiro or São Paulo (83.0%), and other states (17.0%). The observations were also separated according to nomenclature. Of the observations, 74.4% were called "VC Plans of Origin," while the remaining 25.6% were called "DC Plans with a VC Essence." Despite the name "DC" in the latter, these actually have a VC essence because they allow the conversion of a specific income (or a given period) into lifetime income.

Analysis of the average coverage equity over the period and the mean mathematical provisions showed that the first is slightly higher than the second (R$ 196.4 billion *versus* R$ 195.8 billion). When dealing with solvency centrality measures, the mean and median were equal, and the same value was obtained for the equilibrium index of 1.00.

Table 5
Statistics for the VC Plans

Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total/ Média
Total DB Plans	437	443	441	444	440	430	412	422	404	399	395	**4,667**
Private DB plans	370	372	374	376	367	358	343	352	333	330	330	**3,905**
State DB plans	67	71	67	68	73	72	69	70	71	69	65	**762**
DB in DF-RJ-SP	365	367	365	369	363	356	342	353	336	331	328	**3,875**
DB in other FUs	72	76	76	75	77	74	70	69	68	68	67	**792**
VC of Origin	316	322	319	320	321	317	314	313	309	308	313	**3,472**
DC with a VC essence	121	121	122	124	119	113	98	109	95	91	82	**1,195**
Coverage equity (R$ billion)	100.2	114.9	138.3	143.3	162.4	184.7	209.3	236.7	258.7	299.8	312.3	**196.4**
Mathematical provisions (R$ billion)	98.4	113.9	136.6	145.0	163.1	186.5	211.1	233.3	256.1	297.3	313.2	**195.8**
Solvency mean	1.02	1.01	1.01	0.99	1.00	0.99	0.99	1.01	1.01	1.01	1.00	**1.00**
Solvency median	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**

Note: Coverage equity and mathematical provisions are in nominal values.

Source: developed by the authors.

The first histogram of frequency distribution prepared for the DV plans includes all 4,667 observations from 2010 to 2020 and refers to the natural logarithm of the coverage index. In it, it is possible to observe a great discontinuity between the class that contains the solvency equilibrium value (total of 2,208 observations) and the class just below it (total of 219 observations), which leads to the conclusion that most of the DV plans makes use of earnings management to reach the established standard ratio or an amount immediately above, when these plans are close to solvency. Figure 4 illustrates the histogram for the total observations of the VC plans.

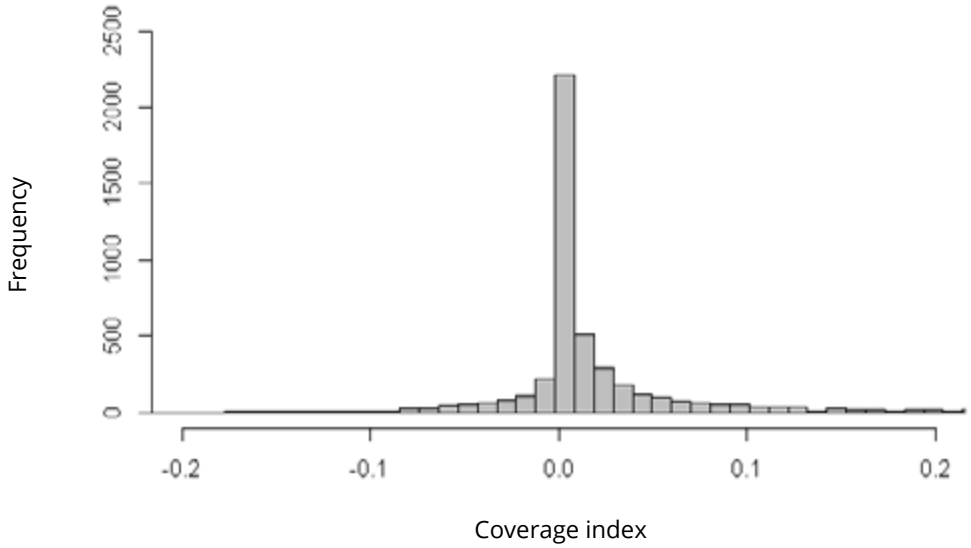

Figura 4. shows the histogram for the total of observations concerning VC plans.

Source: developed by the authors.

Histograms containing observations of the VC plans were also created for the following cases: a) plans sponsored by private companies and entities; b) plans sponsored by state companies and entities; c) plans located in DF, RJ, and SP; and d) plans located in other Brazilian states. For all these cases, there is a considerable discontinuity between the class that includes the coverage ratio and its immediate neighbor below. Hence, the EFPC executives may manage these plans' results in an attempt to disclose a solvency situation to the sponsors, participants, beneficiaries, and control agencies, when the insolvency is small. Figure 5 illustrates the histograms of the four cases described.

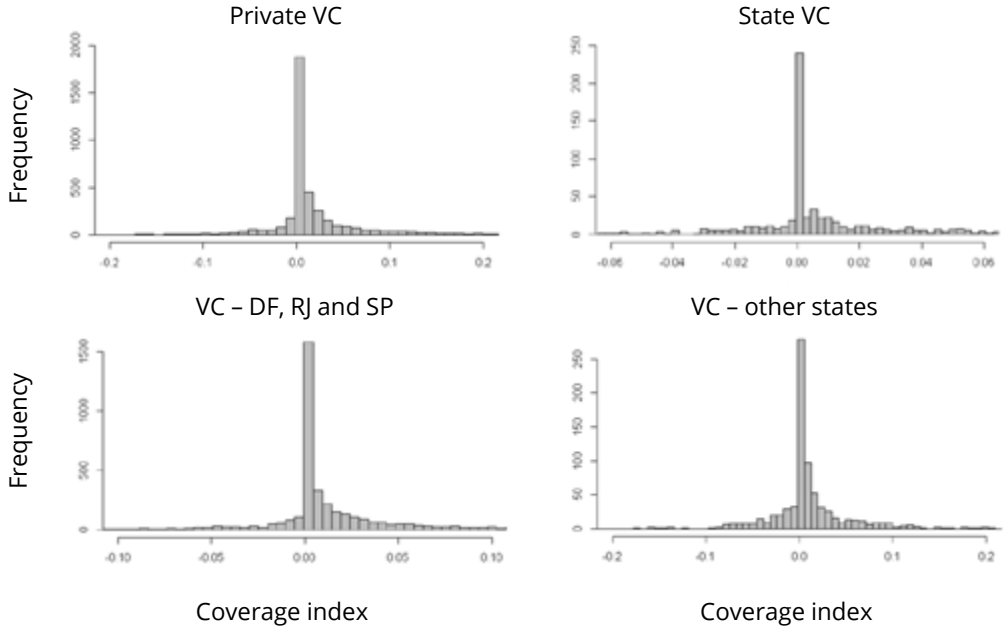

Figure 5. Histograms for Different Compositions of DV Plans

Source: developed by the authors

The last two histograms discriminate the original VC plans (with nomenclature CV), and DC plans with a VC essence (Figure 6). In both, the trend of a considerable discontinuity between the interval that encompasses the coverage ratio (zero) and its neighbor just below it refers to managers' use of earnings management to conceal potential insolvency problems in the present, relocating them to the future.

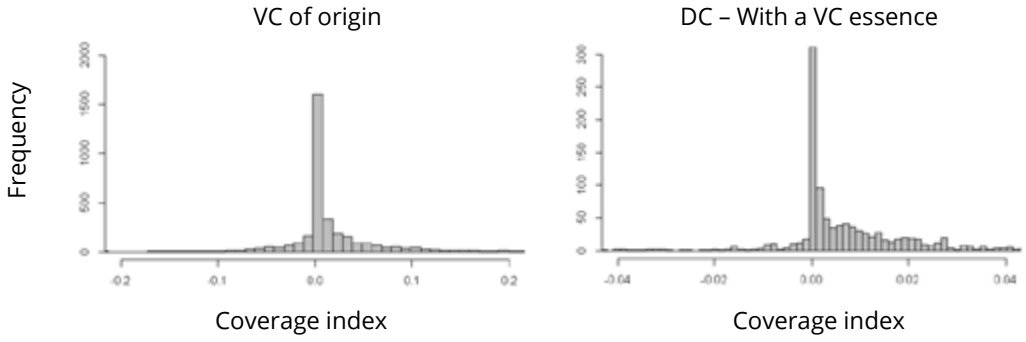

Figure 6. Histograms concerning VC plans of origin *versus* DC with a VC essence

Source: developed by the authors.

The τ statistic proposed by Degeorge, Patel, and Zeckhauser (1999) was calculated to formally confirm the results reported in the VC plans' histograms, as detailed in Table 6. The same table also provides the mean, median, and Mann-Whitney test information. The latter assesses the null hypothesis of equality in densities between classes (*n+5*) and (*n-5*); (*n+7*) and (*n-7*); and (*n+10*) and (*n-10*) against the alternative hypothesis that classes with positive values have greater density than those with negative values (persistence concerning solvency *vis-à-vis* insolvency).

Table 6
Statistical tests of VC Plans

Information	Total VC	Private VC	State VC	VC DF, SP, and RJ	VC in other states	VC of origin	DC with a VC essence
Mean	0.01	0.02	-0.04	0.01	0.03	0.01	0.02
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00
τ test	12.73	11.49	26.62	19.52	8.49	16.71	17.33
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mann-Whitney (n+5) and (n-5)	24.0	25.0	25.0	25.0	21.0	23.0	25.0
p-value	0.0079	0.0040	0.0058	0.0040	0.0468	0.0159	0.0040
Mann-Whitney (n+7) and (n-7)	43.5	46.0	40.5	48.0	36.0	41.5	49.0
p-value	0.0090	0.0020	0.0225	0.0016	0.0795	0.0174	0.0011
Mann-Whitney (n+10) and (n-10)	82.5	87.0	84.5	93.0	69.5	81.5	100.0
p-value	0.0078	0.0029	0.0048	0.0006	0.0745	0.0095	0.0000
Number of Observations	4.667	3.905	762	3.875	792	3.472	1.195

Source: developed by the authors.

The τ test was highly significant for all VC plans, corroborating that the class composed of the equilibrium solvency index (zero) and moderately higher values than this index has a statistically higher density than its neighbor immediately below. This evidence does not allow us to reject the first research hypothesis (*H1*), as occurred with the DB plans.

The Mann-Whitney test rejected the null hypothesis at 1% of significance for all sets of classes assessed when considering: the total of VC plans; VC plans maintained by private companies and entities; the VC plans located in DF, RJ, and SP; and DC plans with a VC essence. In other words, the VC plans maintained by private entities and companies persistently report positive coverage rates, which is equivalent to saying that the governance structure imposed by LC No. 109/2001 has not shielded these plans from recurring earnings management. In turn, persistent reports of positive solvency were not found for VC plans sponsored by state entities and companies in the interval set (*n+7*) and (*n-7*). Thus, we cannot reject research hypothesis *H2* since the greater power-sharing between sponsors and participants provided by LC No. 108/2001 mitigates, at least partially, the disclosure of excessively positive results for the solvency of VC plans.

Regarding VC plans managed by *EFPC* in the DF, RJ, and SP, the insistently positive coverage ratios indicate that the pension funds in these locations seek to offset their high administrative costs by disclosing plans with better performance. The same does not occur in VC plans located in other Brazilian states, which, due to their lower costs, as observed by Cunha (2018) and Teixeira and Rodrigues (2021), present a more symmetrical behavior for solvency. Thus, it is also not possible to reject research hypothesis *H3*.

Finally, comparing the original VC plans with the DC plans with a VC essence; the latter recurrently disclosed a solvency condition. At the same time, such behavior was found in the former only for the set of classes (*n+10*) and (*n-10*).

These findings suggest that managers of DC plans with a VC essence have incentives to persistently manage these plans' solvency, to ratify the adoption of the DC nomenclature, concealing actuarial risks that should not exist in plans named "DC." In the case of the original VC plans, as the actuarial risks are already explicit in the name of these plans, the need to report successively positive results would not be an obligation *a priori*.

5. Final Considerations

A visual inspection of the histograms and the calculation of the statistic τ proposed by Degeorge, Patel, and Zeckhauser (1999) lead us to the conclusion that there is a considerable discontinuity between the class that includes the established standard ratio for solvency and the class immediately below this same index, which favors the hypothesis that *EFPC* make use of actuarial discretion in their DB and VC plans, avoiding reporting unsecured liabilities to sponsors, participants, beneficiaries, and regulatory and supervisory bodies, when possible.

These results show evidence of management in mathematical provisions, mainly in DB plans that are collective, solidary, and mutualist. As the benefit of each participant in these plans is known in advance, its cost is calculated individually, generating a single monthly contribution rate for all participants, which is recalibrated annually according to each plan's needs (Valença, 2013). In other words, in theory, symmetry is expected in the histogram distributions for the coverage index. However, involuntarily making a mistake is, to a certain extent, something intrinsic in the choices regarding the actuarial assumptions of the DB plans, which result from the possibilities provided by the CNPC, PREVIC, and political and market conditions. Therefore, both deliberate choices of actuarial assumptions that project a greater growth of liabilities and the opposite are equally undesirable because a) higher projected liabilities entail higher social security contributions in the present by participants and sponsors, which may significantly reduce the disposable income of the former and increase the operating expenses of the latter, giving rise to the possibility of legal actions against *EFPC*; b) lower projected liabilities result in lower current social security contributions, which may lead to the need for extraordinary contributions in the future to cover deficits; and c) even though achieving balance in the plans is complex, this should be a goal, as recommended by CNPC Resolution No. 30, 2018.

Regarding the VC plans, which individualize the participants' reserves (most of the ported resources) and create a mutual fund for survival and other events of a random nature (a smaller part of the resources), the observations contained in CNPC Resolution No. 30, 2018 are also valid. These observations deal with the continuous search for maintaining balance in plans that are influenced by actuarial assumptions, being equally likely, in theory, the occurrence of deficits or surpluses. In this type of plan, the cost is predefined, and the benefit is unknown; however, the granting of an annuity for life brings uncertainty as to the perfect match of guaranteeing assets and actuarial liabilities, which may result in plans with insufficient or excessive resources (Chan, Silva & Martins, 2010).

In this sense, this study's findings indicate that the governance structure imposed by LC No. 108/2001, with greater power sharing between sponsors, on the one hand, and participants and beneficiaries, on the other (parity in the composition of Deliberative and Fiscal Councils), makes the DB and VC plans maintained by state-owned entities and companies less susceptible to the regular reporting of a solvency situation. However, the same does not occur for the DB and VC plans that exclusively follow LC No. 109/2001. In the case of plans subject to LC No. 108/2001, the greater representativeness of participants and beneficiaries in the collegiate bodies of *EFPC* seems to inhibit the disclosure of recurrently positive results for solvency, contributing to increased transparency, and improving the quality of accounting information.

Regarding the DB and VC plans located in the DF, RJ, and SP, the incentives in disclosing an always positive solvency condition were found, considering that disclosing a better performance of these plans could justify the *EFPC*'s higher administrative costs, as found by Cunha (2018) and Teixeira and Rodrigues (2021). On the other hand, this would not be found in the DB and VC plans located in states with lower administrative costs. Therefore, disclosing an insistently positive solvency condition for the DB and VC plans found in large urban centers is possibly adopted to divert the attention of sponsors, participants, and beneficiaries regarding the high costs of maintaining their plans.

As for DC plans with a VC essence, there is evidence that the "DC" name is used to conceal these plans' actuarial risks from sponsors little engaged with the matter and lay participants. Persistently presenting positive results for the solvency of DC plans with a VC essence would be a way for managers to disguise any volatility of these plans, to maximize their career possibilities, power, and remuneration with an *EFPC*.

In short, in practical terms, the evidence found indicates that DB and VC plans, regardless of how they are presented or separated, always choose to manage their coverage ratio when insolvency occurs to a small extent for an amount equal to or immediately above the established standard ratio, reducing its visibility costs in the face of sponsors, participants, and beneficiaries, and preventing actions on the part of regulatory and supervisory agencies. It suggests that these parties should pay greater attention to the practice of earnings management within *EFPC* since changes in the plans' coverage ratio may be used to reduce "alarmism" and concerns of sponsors, participants, and beneficiaries, regarding the solvency of the DB and VC plans, in addition to hiding these problems from the government agencies and *EFPC* Deliberative and Fiscal Councils.

A limitation of this study concerns the fact that we could not discriminate naturally balanced and slightly positive coverage indices from those that are possibly being manipulated. In this regard, Dechow, Richardson, and Tuna (2003) argue that studies that anticipate a discontinuity as proof of earnings management fail to show how the management occurred.

According to Burgstahler and Chuk (2017), this is a limitation reported in many studies of this nature, as it is not possible to identify whether management is the exclusive result of manipulations in actuarial assumptions, actual changes in the plans' investment portfolios and/or movements linked to political and economic contexts. Thus, these questions can only be answered by a study with more detailed follow-up modeling proposed by Westerduin, Wouterson, and Langendijk (2012).

In this sense, future studies are suggested to deepen explanations regarding the elaboration of mathematical provisions, analyze the actuarial assumptions of DB and VC plans, and unveil their determinants and motivating factors.

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