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ORIGINAL ARTICLE

Influence of the sponsor's financial situation on the allocation of pension plan assets

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ABSTRACT

The objective was to investigate the factors related to the financial situation of sponsors that can be associated with the decision to allocate the assets of the defined benefit plans of Brazilian closed supplementary pension entities in the annual period from 2013 to 2019. Previous research has studied the sponsor's financial situation and the allocation of resources by segment type, but there is a gap in relation to portfolio composition in pension plans where there is no compulsory adherence to insurance. The relevance of this research lies in identifying the factors related to the sponsor's financial situation that may be associated with the resources allocation decision in order to understand what may jeopardize the future payment of benefits. This research contributes to the discussion on the relationship between the portfolio of pension plans and the financial situation of the sponsor; and, indirectly, to the debate on issues related to withdrawal of sponsorship, migration between defined benefit and defined contribution plans, and the acquisition of insurance to cover the payment of future benefits. A total of 134 benefit plans and their respective sponsors were analyzed over a seven-year period. Allocation was divided into decision categories according to portfolio composition, and the statistical technique of multinomial logistic regression was used to analyze the data. The results show that the level of funding, the degree of solvency, the size of the company and financial leverage, as well as factors such as past profitability, financial maturity and actuarial solvency, are aspects of the sponsor's financial situation that may influence the allocation decision and contribute to the advancement of research on the relationship between pension fund portfolio composition and the sponsor's financial situation.

Keywords: risk management, defined benefit plan, closed pension funds, asset allocation, financial situation.

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Influência da situação financeira da patrocinadora na alocação dos ativos dos planos previdenciários

RESUMO

O objetivo foi investigar os fatores da situação financeira das patrocinadoras que podem ser associados à decisão na alocação dos ativos dos planos de benefício definido das entidades fechadas de previdência complementar brasileiras no período anual de 2013 a 2019. Pesquisas anteriores têm estudado a situação financeira da patrocinadora e a alocação de recursos por tipo de segmento, existindo lacuna em relação à composição do portfólio em planos previdenciários em que não há adesão obrigatória a um seguro. A relevância desta pesquisa está em identificar os fatores da situação financeira da patrocinadora que podem estar associados à decisão na alocação de recursos a fim de entender o que compromete o pagamento de benefícios no futuro. Esta pesquisa contribui com as discussões sobre a relação entre o portfólio dos planos previdenciários e a situação financeira da patrocinadora; e, de forma indireta, com o debate de temas ligados a retirada de patrocínio, migração entre planos da modalidade de benefício definido para contribuição definida e contratação de seguros para cobertura do pagamento de benefícios futuros. Foram analisados 134 planos de benefícios, e suas respectivas patrocinadoras, durante o período de sete anos. A alocação foi dividida em categorias de decisão de acordo com a composição das carteiras, e foi utilizada a técnica estatística de regressão logística multinomial para análise dos dados. Os resultados encontrados mostram que o nível de financiamento, o grau de solvência, o tamanho da empresa e a alavancagem financeira, além de fatores como rentabilidade passada, maturidade financeira e solvência atuarial, são aspectos sobre a situação financeira da patrocinadora que podem influenciar a decisão na alocação e contribuem com o avanço das pesquisas sobre a relação entre a composição do portfólio dos fundos de pensão e a situação financeira da patrocinadora.

Palavras-chave: *gestão de riscos, plano de benefício definido, entidades fechadas de previdência complementar, alocação de ativos, situação financeira.*

1. INTRODUCTION

Closed supplementary pension entities (*entidades fechadas de previdência complementar*, or EFPCs) manage the financial resources passed on by participants in pension plans and by the companies that offer and finance these plans, known as sponsors. These funds are intended to guarantee the payment of future retirement and pension benefits, for which the EFPCs invest in assets with long maturities, following the guidelines established in the rules issued by the National Monetary Council (CMN).

However, the guarantee previously contracted by the participants may not be realized at the time of receiving the benefit due to risks such as market, credit, counterparty, liquidity, fraud, administrative inability, imprudence, among others, in addition to moral hazard and other problems related to late payment of contributions, underfunding of the plan, withdrawal of sponsorship, bankruptcy of the sponsor, and others (An et al., 2013; Zanetti, 2017).

In the case of defined benefit (DB) plans, there is a greater concern with establishing the balance of the plan, because in this modality, the benefit to be received in the future is established in advance when the participant joins the pension plan, and the sponsor has a legal duty to fulfill this obligation and cover possible deficits (with the participants), regardless of its financial situation (Zanetti, 2017; Wartchow, 2017).

Previous studies, such as those of Coronado and Liang (2006), An et al. (2013), Duan et al. (2015), and others, have discussed the possibility that the poor financial situation of the sponsor may lead pension plans to greater exposure to risk, more specifically with regard to decisions to allocate resources to financial assets. The authors reveal that this possibility becomes more imminent in three non-exclusive and complementary scenarios: when the sponsor takes out insurance to guarantee the fulfillment of its pension obligations, when there is a greater likelihood of the sponsor going bankrupt, and when the sponsor underfunds the pension plans and prioritizes pouring resources into other projects.

Plan underfunding occurs when contribution amounts and positive investment returns are insufficient

to pay future benefits at present value, indicating that assets are insufficient to cover pension obligations (Treynor, 1977).

Therefore, using previous research as a basis, this study investigates which aspects of the sponsor's financial situation can be associated with the resources allocation decisions of the defined benefit plans of Brazilian EFPCs.

Unlike other studies that look at allocation by segment type, this study looks at portfolio composition, i.e., the combined position of the segments in which the funds have been allocated. The sponsor's financial situation is considered to be the company's ability to meet its financial obligations.

From the perspective of accounting theory, this payment capacity can be measured by analyzing assets in relation to liabilities. Thus, an analysis of the equity and financial position provides information on liquidity, which is the availability of cash in the short term, and solvency, which is the availability of cash in the long term (Ott & Pires, 2009). For this study, the long-term view, i.e. solvency, will be considered.

Previous empirical studies on this topic, with the exception of Guan and Lui (2016), have been conducted on sponsoring companies that are required to take out insurance to guarantee the payment of future benefits, investigating the risk-shifting hypothesis raised by Sharpe (1976) and Treynor (1977). Since insurance is optional in Brazil, this study considers only underfunding and the probability of sponsor bankruptcy.

As such, this article contributes to the social security discussion agenda on issues related to the withdrawal of sponsorship, migration between plan types, and the acquisition of insurance to cover future benefit payments. It is worth noting that it seeks to investigate factors in the sponsor's financial situation that affect the allocation of assets in the defined benefit plans of Brazilian EFPCs.

2. THEORETICAL FRAMEWORK

2.1 Sponsor Dependency and Pension Plan Risks

Cases of bankruptcy of the sponsoring company, such as Viação Aérea Rio-Grandense (Varig), sponsor of the Aerus – Instituto de Seguridade Social pension fund (currently in extrajudicial liquidation), or withdrawal of sponsorship, such as what happened with the Petros Copesul and Petros PQU plans, with Braskem's withdrawal of sponsorship, jeopardize the continued payment of current and future pensions to participants in defined benefit plans, while exposing the vulnerability of these plans to their sponsors (Hoefling, 2008; Bartolotti, 2012; Previc, 2015).

However, this vulnerability is confronted with the normative context of liability for damages that may be caused by sponsors. Regarding this responsibility, the Brazilian Civil Code of 2002, in the sole paragraph of article 927, clarifies that the sponsoring company has the obligation to repair the damage, regardless of fault, in the cases established by law or when the activity normally carried out by the author of the damage implies, by its nature, a risk to the rights of others.

In fact, in Brazil, dependency on the sponsor has decreased in quantitative terms in recent years. According to the June 2021 Stability Report on Supplementary Pensions, the number of dependent entities fell from 88 to 68 between 2015 and 2020, representing a reduction of about 22%. However, there is still a need to warn about the importance of monitoring the risk of non-compliance with obligations on the part of sponsoring companies (Superintendência Nacional de Previdência Complementar, 2021).

On the other hand, Hoefling (2008) explains that regulatory constraints and the responsibility of sponsors make it difficult to reconcile the efficiency of resource management with the manager's own responsibility to seek the maximum utility expected by the beneficiaries, especially if the sponsor is in financial difficulties.

Sharpe (1976) and Bodie (1990) suggest that the consequences of a sponsor with a bad financial situation would be an underfunded plan, and plan managers would be encouraged to change the portfolio to a more risky allocation. Coronado and Liang (2006) and Rauh (2009) discuss whether such a practice would be part of the risk management policy or a transfer of risk to insurers and/or participants.

The possibility of risk transfer has been raised by Treynor (1977), An et al. (2013) and Guan and Lui (2016), because the insurer, the Pension Benefit Guaranty Corporation (PBGC), by assuming responsibility for pension payments, would be encouraging a high-risk investment strategy. Thus, in the event of a loss, it would be borne by the insurer, not the sponsor.

However, research by Romaniuk (2018), Bartram (2018), and Kitamura and Omori (2019) shows that extreme risk transfer or risk management strategies may

not be the most appropriate approach. Participants and the PBGC should remain cautious when the sponsor is in financial difficulty and consider factors such as the economic downturn, tax benefits, and funding level, among others.

If the losses from greater risk exposure were not borne by an insurance company, would plan managers still use a riskier investment strategy? Guan and Lui (2016) found no evidence to prove a difference in the financial investments of Dutch pension funds, where there is no compulsory insurance. However, in the Netherlands, pension underfunding, one of the necessary conditions for triggering risk transfer, is discouraged by severe fines for the sponsor if the plan remains underfunded at less than 105% for more than three years.

In the case of Brazil, plan underfunding can occur due to delays in the transfer of normal and/or extraordinary contributions. National Supplementary Pension Plan Council (CNPC) Resolution 29/2018 stipulates that in these situations, the EFPC must set aside a provision to cover credit rights for delays of more than 31 days. Complementary Law No. 109/2008 establishes that the sponsor's managers are liable for any non-payment of contributions, with the EFPC being responsible for negotiating the payment of such debts in accordance with the rules in force. Therefore, although there are regulations that prevent the possibility of underfunding, there is no obstacle to this happening.

With regard to insurance, in Brazil, as in the Netherlands, there is no compulsory insurance. However, the National Private Insurance Council (CNSP) Resolution 385/2020, in its second article, establishes the coverage that insurance companies can offer EFPCs, which are the disability of the EFPC participant, death of the EFPC participant, or beneficiary, survival of the EFPC beneficiary, and deviations from biometric assumptions.

Thus, given the similar characteristics in terms of underfunding and insurance between defined benefit plans in the Netherlands and Brazil, this study can validate the results presented by Guan and Lui (2016) or present new results that contribute to previous studies by broadening the debates on this topic.

2.2 Hypothesis Development

Authors such as Sharpe (1976), Coronado and Liang (2006) and Guan and Lui (2016) argue that when the sponsoring company is in financial difficulty, there is a tendency to increase its exposure to risk by investing the pension plan's resources in more volatile assets. In contrast, Rauh (2009), Duan et al. (2015) and Gilje (2016) found that plans have less risky asset allocations when the sponsor is in weaker financial condition or has a lower credit rating, which would make asset management more conservative.

In view of this disagreement between researchers on the greater or lesser exposure to risk of EFPC assets in the face of the financial difficulties of sponsoring companies, the following hypothesis is proposed:

> H_1: Benefit plans with sponsors that are less likely to go bankrupt tend to choose a portfolio composition that is more exposed to more volatile assets.

The less risky management pointed out by Rauh (2009) and other researchers mentioned above can be observed in Brazilian EFPCs. According to Reis (2018), this fact has a normative explanation, since Brazilian legislation, by linking the interest rate to the actuarial target, which dictates the minimum acceptable risk, means that entities have to invest more heavily in risky assets to meet the actuarial target.

According to a survey conducted by the Brazilian Private Pension Association (Abrapp), in December 2019, 72.9% of funds were allocated to fixed income, 19.6% to variable income and 7.5% to other investments. However, there is room for slightly more aggressive portfolio decisions, as CMN Resolution No.4,661/2018 increased the possibility of allocating resources to risky assets, allowing pension funds to invest up to 70% of assets in variable income in companies listed on the B3, and also increased the limit for alternative assets (20%) (National Monetary Council Resolution No.4,661, 2018; Abrapp, 2019).

Despite this possibility of greater risk exposure, some authors defend the idea that the motivation to take more risks occurs when the sponsoring company is healthy and has well-funded plans. Based on the studies by Rauh (2009), Duan et al. (2015) and Gilje (2016) and the idea that managers are conservative, the following hypothesis is proposed:

> H_2: Benefit plans with higher funding levels tend to choose a portfolio composition that is more exposed to more volatile assets.

3. METHOD

3.1 Data and Sample Selection

Annual data were collected from the websites of the EFPCs and the sponsoring companies. In this study, sponsors are defined in accordance with the law as companies or groups of companies, the Federal Government, states, the Federal District, municipalities, local authorities, foundations, mixed capital companies, and other public entities that set up a social security benefit plan for their employees or civil servants. Also considered a sponsor is a professional, class or sector legal entity that offers a social security benefit plan to its associates or members, known as the institutor (Complementary Law No.109, 2001).

The reports used for data collection were: i) the annual financial report of the EFPCs' DB plans; ii) the annual financial report of the sponsoring companies.

The analysis period is from 2013 to 2019. In 2013, the uncertainty of the global markets in relation to the Brazilian economy and the increase in the interest rate (Selic) severely affected the assets of EFPCs, such that these entities had the lowest financial performance after the 2008 crisis, which is why this year was chosen to begin the investigation. On the other hand, in 2020, the pandemic also profoundly affected the world economy; therefore, to avoid distortions in the results due to this fact, the period was limited to 2019.

The population consists of 314 registered plans (Superintendência Nacional de Previdência Complementar [Previc], 2019). However, some criteria were used to adjust the study population: i) only plans active between 2013 and 2019 and created before 2013 were considered; ii) DB plans with discontinuity characteristics (total extinction; total migration to CD or CV) were excluded; iii) non-contributory plans characterized as savings or by withdrawal of sponsorship were excluded.

Thus, the population was 218 plans based on the criteria. The accessibility sample was 134 DB plans, representing 61.47% of the population. The reason for this number is the unavailability of access to the data needed for this research.

The criterion used to determine the sponsor sample was the number of plans studied, which resulted in 134 sponsors, although some plans are multi-sponsored. For multi-sponsored plans, the following options were used to collect data: consolidated balance sheet information in the case of holding companies and business groups; and the company with the highest percentage of active and covered participants in the case of different companies sponsoring the same plan.

3.2 Presentation of Variables

The variables presented (Table 1) are those most consistent with the research objective and hypotheses. The choice of variables was based on previous studies.

Table 1
Presentation of variables

Variable	Acronym	Presentation	What does it indicate?	Reference
Plan Asset Allocation	PAA	Allocation percentages for each segment (fixed income, variable income, etc.)	Indicates the distribution of pension plan asset investments.	Rauh (2009); Guan & Lui (2016)
Plan Funding Level	PFL	(Market Value Of Pension Assets – Projected Benefits) / Projected Benefits	If positive, it indicates that plan resources are sufficient to cover actuarial obligations. If negative, it indicates underfunding.	Rauh (2009); An et al. (2013); Anantharaman & Lee (2014); Bartram (2018)
Probability of Sponsor Bankruptcy	PSB	Probit model used by Martins and Ventura Júnior (2020)*	A result above 0.80 indicates that the sponsor is solvent.	Altman et al. (1979); Martins & Ventura Júnior (2020)
Past Return on Assets	PRA	Average rate of return achieved by the plan in the previous year	Indicates the return on the plan's investment in financial assets in the previous year.	Anantharaman & Lee (2014); Bartram (2018)
Plan Actuarial Solvency	PAS	Plan Net Assets / Pension Liabilities	If the result is greater than 1, it indicates that the plan is actuarially solvent.	Rodrigues (2008); Lima & Rodrigues (2015); Guan & Lui (2016)

Table 1
Cont.

Variable	Acronym	Presentation	What does it indicate?	Reference
Plan Financial Maturity	PFM	(Financial Investment Income + Contributions Income) / Benefit Expenses	If the result is less than 0, it indicates that the plan is financially mature.	Rodrigues (2008); Lima & Rodrigues (2014)
Sponsor's Operating Cash Flow	OCF	(Operating Cash Flow – Pension Contributions) / Total Assets	Indicates the sponsor's share of return on investments.	Anantharaman & Lee (2014); Guan & Lui (2016); Bartram (2018)
Operating Cash Flow Volatility	CFV	This is the standard deviation of the operating cash flow for the four years prior to the acquisition or merger of the company.	Indicates the overall risk of the company's cash flow.	Anantharaman & Lee (2014); Guan & Lui (2016)
Sponsor's Financial Leverage	SFL	Long-Term Debt / Total Assets	A high ratio indicates that most asset purchases are financed with debt.	Guan & Lui (2016)
Sponsor Company Size	SCS	Natural logarithm of sponsor's total assets	Measures the company's total assets.	Guan & Lui (2016)
Interest Rate Effect	IRE	1 if there was an increase in the Selic rate in the current year compared to the previous year and 0 if there was no increase in the Selic rate in the current year compared to the previous year	Indicates whether there was an increase in the Selic rate compared to the previous year.	Pereira (2013); Domeneghetti (2020)
Plan's Actuarial Target	PAT	Interest rate adopted in the actuarial valuation + inflation index	Shows the minimum return required on financial investments to cover actuarial liabilities.	Rodrigues (2008); Domeneghetti (2020)
Regulatory Changes for Plan Assets	RCA	1 if there was a change in the rules governing financial investments and 0 if there was no change in the rules governing financial investments	Indicates whether or not there was a change in the legislation for the application of funds during the period.	Pereira (2013); Reis (2018)
Publicly Traded Company	PTC	1 if it is a publicly traded company and 0 if it is not a publicly traded company	Indicates whether the company has shareholders or not.	An et al. (2013); Anantharaman & Lee (2014)
Sponsor Overdue Contributions	SOC	Overdue Contributions / Projected Benefits	Identifies the impact of not passing on contributions in relation to total future obligations.	Rauh (2009); Kitamura & Omori (2019)

Note: *The variable Probability of Bankruptcy is represented by:* $P(Z_i=1)=\frac{1}{1+e^{-(-0.854-1.555x_{1i}-2.278x_{3i}+0.002x_{4i}-0.234x_{5i})}}$, *where:*

$x_1=\frac{Current\ Assets_{it}-Current\ Liabilities_{it}}{Total\ Assets_{it}}$; $x_3=\frac{Earnings\ before\ Interest\ and\ Tax_{it}}{Total\ Assets_{it}}$; $x_4=\frac{Market\ Value_{it}}{Total\ Liabilities_{it}}$ e $x_5=\frac{Sales_{it}}{Total\ Assets_{it}}$.

Source: *Prepared by the authors.*

3.3 Recognition of the Dependent Variable

The variable of interest is the allocation of resources, represented by the composition of the plan's investment portfolio. The data collected on the percentage of funds allocated were divided into three groups: Group 1 = percentage allocated to fixed income; Group 2 = percentage allocated to variable income; and Group 3 = percentage allocated to other investments. Seven types of composition were found in the investment portfolios (Group 1 + Group 2 + Group 3) of the plans in the sample, as shown in Table 2. The compositions, referred to here as decisions, were classified with the letter "D" followed by a number.

Table 2
Dependent variables

Decision	Fixed Income (Group 1)	Variable Income (Group 2)	Others (Group 3)
D1	100%	0	0
D2	> 50%	< 50%	0
D3	> 50%	0	< 50%
D4	> 50%	< 50%; and > G3	< 50%; and < G2
D5	> 50%	< 50%; and < G3	< 50%; and > G2
D6	< 50%	< 50%; and > G3	< 50%; and < G2
D7	< 50%	< 50%; and < G3	< 50%; and > G2

Source: *Prepared by the authors.*

D1 indicates that a benefit plan's asset portfolio is composed entirely of fixed-income assets. D2 indicates a composition with more than 50% of investments in fixed income and the remainder in variable income only. D3 indicates a composition with more than 50% of investments in fixed income and the remainder in other investments other than variable income. D4 indicates a composition with more than 50% of investments in fixed income and the remainder divided between variable income, with the highest percentage allocation, and other investments, with the lowest percentage. D5 indicates a composition with more than 50% of investments in fixed income and the rest divided between variable income, with the lowest percentage allocation, and other investments, with the highest percentage. D6 indicates that the portfolio composition is less than 50% fixed-income investments, and most of it is divided between variable income, with the highest percentage allocation, and other investments, with the lowest percentage. Finally, D7 indicates that the portfolio composition is less than 50% fixed-income investments, and most of it is divided between variable income, with the lowest percentage allocation, and other investments, with the highest percentage.

3.4 Sample Characteristics

Data were used from 134 defined benefit pension plans from 2013 to 2019, totaling 938 observations. The panel was unbalanced, with 86 missing data items, resulting in 916 observations and 16 variables distributed as follows: 1 polychotomous dependent variable, 12 continuous independent variables, and 3 dichotomous independent variables.

With regard to the dependent variable, the data show variability in the choice of portfolio composition, with the following frequencies: D1 = 7.53%; D2 = 2.84%; D3 = 15.07%; D4 = 36.57%; D5 = 35.81%; D6 = 0.76%; and D7 = 1.42%.

Therefore, the majority of the plans' financial resources are allocated to the following portfolio composition: D4 (36.57%), which corresponds to more than 50% of funds invested in the fixed income segment and the remainder of the funds divided between variable income and others, with a predominance of the first segment. Composition D6 has the lowest frequency (0.76%), which can be explained by the fact that only one plan chose to invest less than 50% of its funds in fixed income every year and more in variable income than in other segments. This is specifically Previ/BB's Benefit Plan 1. It is a closed plan with a much higher number of participants and beneficiaries (109,626) and invested assets (R$192,142,318 thousand) than the other plans (2019 data).

Descriptive statistics were used to understand the characteristics of the independent and continuous variables in the sample, as shown in Table 3.

Table 3
Sample characteristics for independent and continuous variables

Variable	Minimum	Maximum	Mean	Median	Standard deviation	Coefficient of variation	Missing data
PFL	–0.9425	11.3013	0.1976	0.0500	0.6751	3.416498	02
PSB	0.0000	5.7153	0.3228	0.2246	0.5132	1.589839	14
SFP	–0.2696	4.2002	0.0772	0.0116	0.3397	4.400259	14
PRA	–0.4586	0.3681	0.1075	0.1113	0.0693	0.644651	00
PAS	0.0015	10.6774	1.0615	0.9998	0.4483	0.422327	02
PFM	0.0010	83.4000	2.3430	1.7250	4.0478	1.727614	05
OCF	–3.9307	1.3616	0.0126	0.0281	0.2546	20.20635	17
CFV	0.0000	1.4158	0.0303	0.0000	0.1457	4.808581	00
SFL	0.0000	5.4305	0.4189	0.3680	0.4313	1.029601	15
SCS	10.6500	21.9000	15.9700	15.8100	2.4345	0.152442	15
PAT	0.0000	0.1795	0.1116	0.1105	0.0300	0.268817	00
SOC	0.0000	1.7161	0.0810	0.0000	0.1766	2.180247	02

Source: *Prepared by the authors.*

As can be seen in Table 3, there is a wide range in the independent variables, especially in the following: Plan Funding Level (PFL), Plan Actuarial Solvency (PAS), Plan Financial Maturity (PFM) and Sponsoring Company Size (SCS). This wide range may be related to the diversity of financial dimensions (size) of the sponsoring companies and plans in the sample, since no restrictions or segregations were used in this regard.

It can also be seen that the averages and standard deviations indicate that there are variations in the values of the variables, with Plan Financial Maturity (PFM) and Sponsor Company Size (SCS) showing the greatest dispersion in relation to the average. However, the Operating Cash Flow (OCF) variable is the one with the greatest dispersion in relative terms (more than 20%), indicating that this variable has very heterogeneous values over the period analyzed.

This heterogeneity in operating cash flow can be explained by the fact that the sample includes sponsoring companies from different economic sectors with specific and different characteristics in their operating activities.

Still on the sample data, it is possible to observe the absence of data on the following variables: PFL, PSB, SFP, PAS, PFM, OCF, SFL, SCS and SOC. These missing data are the result of missing information, i.e. information not provided in the reports by the plans or their sponsors.

The characteristics of the sample with respect to the binary variables (dummies) Interest Rate Effect (IRE), Regulatory Changes to Plan Assets (RCA), and Publicly Traded Company (PTC), which refer to the sample for this study, are presented in Table 4.

Table 4
Sample characteristics for independent and dichotomous variables

Term	0 (zero)	1 (one)	Total			
Variable	**Quantity**	**Frequency (%)**	**Quantity**	**Frequency (%)**	**Quantity**	**Frequency (%)**
IRE	520	56.78	396	43.22	916	100
RCA	785	85.70	131	14.30	916	100
PTC	501	54.69	415	45.31	916	100

Source: *Prepared by the authors.*

It can be seen that during most of the period analyzed, there was no increase in the Selic rate, the interest rate used in this study as a parameter to control inflation and possible repercussions on the financial investments of plan resources. There was only one change in the legislation (RCA) that establishes the rules for managing and investing the financial resources of pension plans, from CMN Resolution No.3,792/2009 to CMN Resolution No.4,661/2018, with the latter remaining in force during 2019.

Most of the sponsors (54.69%) are publicly traded companies, but this figure is not much higher than that of privately held sponsors (45.31%), which further reinforces the diversity of economic sectors represented by the sponsoring companies in this study sample.

The probability distribution for each of the non-binary variables was also examined using the Anderson-Darling statistical test; the *p*-value for all variables was less than 0.001 (α = 5%), so hypothesis H_0 that the data have a specific distribution cannot be accepted. Similarly, the Mardia and Henze-Zirkler tests showed a *p*-value of less than 0.001 (α = 5%), so the hypothesis of multivariate normality of the data cannot be accepted.

3.5 Statistical Model

Considering all the characteristics of the sample, as well as the aim of this study, it was decided to use the statistical method of multinomial logistic regression. The *R* statistical program (version R.4.2.1) and RStudio (version 2022.02.3) were used to estimate the model, using the "nnet" (Venables & Ripley, 2002) and "mlogit" (Croissant, 2020) statistical packages, as well as the "xtmlogit" package from the StataBE program version 17.

In the multinomial logistic model, one of the categories of the dependent variable must be chosen as the reference. For this study, it was decided to use decision D1 as the reference category because it is the most conservative choice that pension plan managers can make, with 100% of funds invested in the fixed income segment.

The database for this study is an unbalanced panel, so the stacked data model was chosen, which, according to the statistical tests, proved to be the appropriate model for this study. In the multinomial logistic model for panel data, the probability of occurrence of the reference category can be expressed as follows:

$$p_{it0} = \frac{1}{1+e^{Z_{it1}}+\cdots+e^{Z_{itk}}} \quad (1)$$

The probability of occurrence of the other categories can be expressed by:

$$p_{itj} = \frac{e^{Z_{itj}}}{1+e^{Z_{itj}}+\cdots+e^{Z_{itk}}} \quad (2)$$

and,

$$Z_{itj} = \alpha_j + \hat{\beta}_{i1}X_{it} + \hat{\beta}_{i2}X_{it} + \cdots + \hat{\beta}_{ik}X_{it} \quad (3)$$

where Z_{ij} = estimated logits of the variable of interest; α_j = intercept of the *j* category; and $\hat{\beta}_j X_i$ = predictor variables and their respective betas for the *j* categories. For this study, the variables X_{1t}, X_{2t}, …, X_{14t} correspond to the independent variables PFL, PSB, ..., SOC, respectively.

To build the model, called "mod1," initially all the decision categories (D1 to D7) were used. Subsequently, a model was tested excluding decision category D6, called "mod2." The exclusion of decision D6 was due to the fact that this group contained only one pension plan (Benefit Plan 1 of the Previ/BB entity) with very particular characteristics. Table 5 shows the differences between the two models.

Table 5
Differences between models

Model	k	Observations	Log probability	Comparison with M0	Pseudo R^2	AIC	Accuracy
Mod1	7	916	–1,104.31	*p*-value = 0	0.1475	2,388.63	0.0004678
Mod2	6	909	–1,096.83	*p*-value = 0	0.1256	2,343.66	0.0003667

Source: *Prepared by the authors.*

As can be seen, the statistical differences between the two models are generally small. It was, therefore, decided to use the "mod2" model because of the possibility of distortions in the result due to D6. Thus, the probabilities for each decision category, based on "mod2" and considering D1 as the reference category, are:

$$D1 \quad p_{it1} = \frac{1}{1+e^{Z_{it2}}+e^{Z_{it3}}+e^{Z_{it3}}+e^{Z_{it4}}+e^{Z_{it5}}+e^{Z_{it7}}} \tag{4}$$

$$D2 \quad p_{it2} = \frac{e^{Z_{it2}}}{1+e^{Z_{it2}}+e^{Z_{it3}}+e^{Z_{it3}}+e^{Z_{it4}}+e^{Z_{it5}}+e^{Z_{it7}}} \tag{5}$$

$$D3 \quad p_{it3} = \frac{e^{Z_{it3}}}{1+e^{Z_{it2}}+e^{Z_{it3}}+e^{Z_{it3}}+e^{Z_{it4}}+e^{Z_{it5}}+e^{Z_{it7}}} \tag{6}$$

$$D4 \quad p_{it4} = \frac{e^{Z_{it4}}}{1+e^{Z_{it2}}+e^{Z_{it3}}+e^{Z_{it3}}+e^{Z_{it4}}+e^{Z_{it5}}+e^{Z_{it7}}} \tag{7}$$

$$D5 \quad p_{it5} = \frac{e^{Z_{it5}}}{1+e^{Z_{it2}}+e^{Z_{it3}}+e^{Z_{it3}}+e^{Z_{it4}}+e^{Z_{it5}}+e^{Z_{it7}}} \tag{8}$$

$$D7 \quad p_{it7} = \frac{e^{Z_{it7}}}{1+e^{Z_{it2}}+e^{Z_{it3}}+e^{Z_{it3}}+e^{Z_{it4}}+e^{Z_{it5}}+e^{Z_{it7}}} \tag{9}$$

where:

$$Z_{it2} = 0.7493 + 0.5503.PFL_{it} - 2.2145.PSB_{it} - 3.1016.SFP_{it} - 0.6405.PRA_{it} + 0.0553.PAS_{it} + 0.1781.PFM_{it} + 1.5303.OCF_{it} + 0.3610.CFV_{it} + 3.0438.SFL_{it} - 0.1081.SCS_{it} - 0.5543.IRE_{it} - 3.8270.PAT_{it} - 0.8943.RCA_{it} - 5.6606.SOC_{it} \tag{10}$$

$$Z_{it3} = 8.2038 - 2.8669.PFL_{it} - 2.8256.PSB_{it} + 11.0762SFP_{it} + 2.3842.PRA_{it} - 0.9135PAS_{it} - 0.0453PFM_{it} + 1.0331.OCF_{it} + 2.6894.CFV_{it} + 2.7081.SFL_{it} - 0.4242.SCS_{it} - 0.0842.IRE_{it} + 1.1077PAT_{it} - 0.3312.RCA_{it} - 0.2868SOC_{it} \tag{11}$$

$$Z_{it4} = 7.7369 - 2.9480.PFL_{it} - 3.4991.PSB_{it} + 11.1062.SFP_{it} - 2.5334.PRA_{it} - 0.2652.PAS_{it} + 0.0017.PFM_{it} + 1.0962.OCF_{it} + 2.1258CFV_{it} + 2.9577SFL_{it} - 0.3340.SCS_{it} - 0.6898.IRE_{it} - 1.6758PAT_{it} - 0.5326.RCA_{it} + 2.2847.SOC_{it} \tag{12}$$

$$Z_{it5} = 7.3994 - 2.2672.PFL_{it} - 1.7936.PSB_{it} + 9.4586.SFP_{it} - 2.5948.PRA_{it} - 1.8820.PAS_{it} - 0.0586.PFM_{it} + 1.0515.OCF_{it} + 2.9128CFV_{it} + 3.0332.SFL_{it} - 0.2853.SCS_{it} + 0.4195.IRE_{it} - 3.6037.PAT_{it} + 0.2877.RCA_{it} + 2.0723.SOC_{it} \tag{13}$$

$$Z_{it7} = 10.4953 - 3.2272.PFL_{it} - 0.2442PSB_{it} + 9.3625.SFP_{it} - 13.8574.PRA_{it} - 4.0938.PAS_{it} - 1.3176.PFM_{it} + 0.4238.OCF_{it} + 1.1379.CFV_{it} + 2.5683.SFL_{it} - 0.2696.SCS_{it} - 0.4159.IRE_{it} - 13.7295.PAT_{it} - 0.9051.RCA_{it} + 0.2993.SOC_{it} \tag{14}$$

To assess the quality of the fit of the estimation model, several statistical tests recommended by Fávero and Belfore (2017) were carried out: pseudo R^2, estimation fit, comparison between models, coefficient significance test and agreement test. The results are presented in Table 6.

Table 6
Quality of model fit

Test	Result	Reference	What does it indicate?
Pseudo R^2	0.1256	$0 \geq R^2 \leq 1$	The higher the value, the better the fit.
Likelihood value	–1.09683	The higher, the better	How well the maximum likelihood estimation procedure fits is the value of the log of the likelihood.
F test	< 0.0001	p-value < 0.05	Analysis of variance. Comparison between the estimated model and a null model.
Wald test	< 0.0001	p-value < 0.05	Checks how the coefficients affect the estimated probability and thus the prediction of group membership.
Accuracy	0.4873	The higher, the better	Accuracy of the model.
Kappa coefficient of agreement	< 0.0001	p-valor < 0.05	Compares observed events to expected events.

Source: *Prepared by the authors.*

As can be seen in Table 6, the "mod2" model had an $R^2 = 0.1256$, showing low explanatory power. With regard to the likelihood ratio, the value was negative at 1.09683, which can be considered a good value since it is less than zero. The F-test had a p-value < 0.0001 ($\alpha = 0.05$), which confirms the hypothesis that the estimated model is better than the null model. The Wald test showed $X^2 = 210.55$ and p-value < 0.0001 ($\alpha = 0.05$), confirming the hypothesis that the logistic coefficient is different from zero. The classification accuracy was 0.4873, indicating that the model is reasonably accurate. The kappa agreement coefficient of 0.21 is also considered reasonable, with a p-value < 0.001 ($\alpha = 0.05$), rejecting the hypothesis that the agreement between the decisions was purely random.

The classification table (Table 7) compares the observed and expected events, analyzing the number of events for each category of the dependent variable.

Table 7
Classification table for the "mod2" model

Predicted	D1		D2		D3		D4		D5		D7		Total	
Observed	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
D1	11	1.21%	0	0.00%	1	0.11%	35	3.85%	22	2.42%	0	0.00%	**69**	**7.59%**
D2	1	0.11%	5	0.55%	0	0.00%	10	1.10%	10	1.10%	0	0.00%	**26**	**2.86%**
D3	4	0.44%	0	0.00%	4	0.44%	58	6.38%	72	7.92%	0	0.00%	**138**	**15.18%**
D4	1	0.11%	0	0.00%	0	0.00%	216	23.76%	118	12.98%	0	0.00%	**335**	**36.85%**
D5	2	0.22%	1	0.11%	5	0.55%	113	12.43%	204	22.44%	3	0.33%	**328**	**36.08%**
D7	2	0.22%	0	0.00%	0	0.00%	1	0.11%	7	0.77%	3	0.33%	**13**	**1.43%**
Total	**21**	**2.31%**	**6**	**0.66%**	**10**	**1.10%**	**433**	**47.63%**	**433**	**47.63%**	**6**	**0.66%**		

Sensitivity	0.15942	0.192308	0.02899	0.6448	0.622	0.2307
Specificity	0.9881	0.998867	0.99222	0.622	0.6059	0.9966
Accuracy	0.57376	0.595588	0.5106	0.6334	0.6139	0.6137
Pos. pred. value	0.5238	0.8333	0.4000	0.4988	0.4711	0.5000
Neg. pred. value	0.9346	0.9767	0.8509	0.7500	0.7395	0.9889

Source: *Prepared by the authors.*

Table 7 shows that most of the decision categories were reasonably predictive, with accuracy ranging from 51% to 63% and positive predictive value ranging from 40% to 83%. The negative predictive value ranged from 74% to 99%, indicating good prediction. Overall, the predictability of the model is considered acceptable.

4. RESULTS

It was decided to analyze the results of each category (Table 8) and then the impact of these results on the hypotheses that were formulated. In this study, D1 was chosen as the reference category.

Table 8
Presentation of the results by category

Category	Covariates	Estimate	Standard error	Z statistic	p-value	Conf. interval (2.5%)	Conf. interval (97.5%)	Odds ratio
D2	Intercept	0.7493	2.4279	0.3086	0.7576	−4.0094	5.5081	
	PFL	0.5503	1.0958	0.5022	0.6155	−1.5974	2.6981	1.7400
	PSB	−2.2145	2.0387	−1.0862	0.2773	−6.2104	1.7814	0.1100
	SFP	−3.1016	6.9258	−0.4478	0.6542	−16.6760	10.4727	0.0400
	PRA	−0.6405	4.3359	−0.1477	0.8825	−9.1387	7.8577	0.5200
	PAS	0.0553	0.2431	0.2275	0.8200	−0.4213	0.5319	1.0600
	PFM	0.1781	0.1468	1.2124	0.2253	−0.1098	0.4660	1.2000
	OFC	1.5303	1.8445	0.8297	0.4067	−2.0848	5.1456	4.6100

Table 8
Cont.

Category	Covariates	Estimate	Standard error	Z statistic	p-value	Conf. interval (2.5%)	Conf. interval (97.5%)	Odds ratio
D2	CFV	0.3610	4.6880	0.0770	0.9386	−8.8273	9.5493	1.4400
	SFL	3.0438	1.0028	3.0353	0.0024	1.0783	5.0093	21.0000
	SCS	−0.1081	0.1048	−1.0321	0.3020	−0.3136	0.0972	0.9000
	IRE	−0.5543	0.5680	−0.9758	0.3291	−1.6677	0.5590	0.5700
	PAT	−3.8270	9.4579	−0.4046	0.6857	−22.3643	14.7102	0.0200
	RCA	−0.8943	0.8605	−1.0393	0.2986	−2.5809	0.7922	0.4100
	SOC	−5.6606	5.0227	−1.1270	0.2597	−15.5050	4.1837	0.0000
D3	Intercept	8.2038	1.5972	5.1362	0.0000	5.0733	11.3344	
	PFL	−2.8669	0.6079	−4.7156	0.0000	−4.0586	−1.6753	0.0600
	PSB	−2.8256	0.5722	−4.9375	0.0000	−3.9473	−1.7039	0.0600
	SFP	11.0762	2.9099	3.8064	0.0001	5.3729	16.7796	64,281.00
	PRA	2.3842	2.7953	0.8529	0.3936	−3.0945	7.8629	10.8000
	PAS	−0.9135	0.5213	−1.7521	0.0797	−1.9354	0.1083	0.4000
	PFM	−0.0453	0.1167	−0.3888	0.6974	−0.2742	0.1834	0.9600
	OFC	1.0331	0.6898	1.4978	0.1341	−0.3188	2.3851	2.8100
	CFV	2.6894	1.8823	1.4288	0.1530	−0.9998	6.3788	14.7000
	SFL	2.7081	0.8011	3.3803	0.0007	1.1378	4.2783	15.0000
	SCS	−0.4242	0.0703	−6.0318	0.0000	−0.5621	−0.2864	0.6500
	IRE	−0.0842	0.3620	−0.2326	0.8160	−0.7938	0.6254	0.9200
	PAT	1.1077	5.5987	0.1979	0.8431	−9.8656	12.0812	3.0100
	RCA	0.3312	0.4674	0.7087	0.4785	−0.5849	1.2475	1.3900
	SOC	0.2868	1.5068	0.1904	0.8490	−2.6664	3.2402	1.3300
D4	Intercept	7.7369	1.3932	5.5531	0.0000	5.0061	10.4677	
	PFL	−2.9480	0.5837	−5.0503	0.0000	−4.0920	−1.8039	0.0500
	PSB	−3.4991	0.6216	−5.6285	0.0000	−4.7176	−2.2806	0.0300
	SFP	11.1062	2.9286	3.7923	0.0001	5.3663	16.8462	66,265.00
	PRA	−2.5334	2.5288	−1.0018	0.3164	−7.4899	2.4230	0.0800
	PAS	−0.2652	0.2382	−1.1132	0.2656	−0.7323	0.2017	0.7700
	PFM	0.0017	0.1045	0.0167	0.9867	−0.2032	0.2067	1.0000
	OFC	1.0962	0.6434	1.7037	0.0884	−0.1649	2.3574	2.9900
	CFV	2.1258	1.8691	1.1373	0.2553	−1.5375	5.7892	8.3900
	SFL	2.9577	0.7786	3.7986	0.0001	1.4316	4.4837	19.3000
	SCS	−0.3340	0.0617	−5.4051	0.0000	−0.4551	−0.2129	0.7200
	IRE	−0.6898	0.3292	−2.0950	0.0361	−1.3351	−0.0444	0.5000
	PAT	1.6758	5.1516	0.3253	0.7449	−8.4213	11.7729	5.2900
	RCA	−0.5326	0.4309	−1.2361	0.2164	−1.3771	0.3119	0.5900
	SOC	2.2847	1.3227	1.7273	0.0841	−0.3078	4.8773	9.8200
D5	Intercept	7.3994	1.4405	5.1364	0.0000	4.5759	10.2229	
	PFL	−2.2672	0.5426	−4.1782	0.0000	−3.3307	−1.2036	0.1000
	PSB	−1.7936	0.4199	−4.2714	0.0000	−2.6166	−0.9706	0.1700
	SFP	9.4586	2.8472	3.3221	0.0008	3.8782	15.0390	12,756.00
	PRA	−2.5948	2.5687	−1.0102	0.3124	−7.6294	2.4396	0.0700
	PAS	−1.8820	0.4449	−4.2295	0.0000	−2.7541	−1.0098	0.1500
	PFM	−0.0586	0.1087	−0.5394	0.5896	−0.2717	0.1544	0.9400
	OFC	1.0515	0.6296	1.6702	0.0948	−0.1824	2.2855	2.8600

Table 8
Cont.

Category	Covariates	Estimate	Standard error	Z statistic	p-value	Conf. interval (2.5%)	Conf. interval (97.5%)	Odds ratio
D5	CFV	2.9128	1.8497	1.5748	0.1153	–0.7125	6.5382	18.4000
	SFL	3.0332	0.7780	3.8985	0.0000	1.5082	4.5582	20.8000
	SCS	–0.2853	0.0615	–4.6346	0.0000	–0.4059	–0.1646	0.7500
	IRE	0.4195	0.3304	1.2694	0.2043	–0.2282	1.0672	1.5200
	PAT	3.6037	5.0153	0.7185	0.4724	–6.2261	13.4336	36.8000
	RCA	0.2877	0.4326	0.6652	0.5059	–0.5601	1.1357	1.3300
	SOC	2.0723	1.3226	1.5668	0.1171	–0.5199	4.6646	7.9400
D7	Intercept	10.4953	3.5772	2.9339	0.0033	3.484	17.5066	
	PFL	–3.2272	1.1741	–2.7485	0.0059	–5.5285	–0.9259	0.0400
	PSB	–0.2442	0.5221	–0.4677	0.6400	–1.2676	0.7792	0.7800
	SFP	9.3625	3.6531	2.5628	0.0103	2.2024	16.5226	11,538.00
	PRA	–13.8574	4.3306	–3.1999	0.0013	–22.3453	–5.3695	0.0000
	PAS	–4.0938	1.5071	–2.7163	0.0066	–7.0477	–1.1399	0.0200
	PFM	–1.3176	0.5819	–2.2642	0.0235	–2.4581	–0.177	0.2700
	OFC	0.4238	2.0859	0.2032	0.8390	–3.6646	4.5122	1.5200
	CFV	1.1379	6.3977	0.1779	0.8588	–11.4013	13.6772	3.0800
	SFL	2.5683	1.2366	2.0768	0.0378	0.1444	4.9921	13.0000
	SCS	–0.2696	0.1650	–1.6340	0.1022	–0.5931	0.05379	0.7600
	IRE	–0.4159	0.8334	–0.4991	0.6177	–2.0494	1.2175	0.6600
	PAT	–13.7295	14.0974	–0.9739	0.3301	–41.36	13.9009	0.0000
	RCA	–0.9051	1.2462	–0.7263	0.4676	–3.3477	1.5375	0.4000
	SOC	0.2993	2.2363	0.1339	0.8935	–4.0837	4.6825	1.3500

Source: *Prepared by the authors.*

In general, most of the variables are not statistically significant, i.e. they do not affect the choice between a more diversified and a more conservative portfolio (D1). Exceptions are the variables PFL, PSB, SFP, PRA, PAS, PFM, SCS and IRE, which were statistically significant in most of the regression models (categories D2 to D7). Particularly noteworthy is the variable Sponsor Financial Leverage (SFL), which affects all decision categories.

However, in the case of multinomial logistic regression, in addition to the magnitude of the coefficient, the odds ratio must be observed in order to identify the influence of the parameter of each explanatory variable on the behavior of the dependent variable. In this sense, the odds ratios of the SFL variables are again noteworthy, as they were over 13 for all categories, and the SFP variable was over 11,000 for categories D3, D4, D5 and D7.

It is noteworthy to remember that odds ratios that are statistically significant are those that differ from 1. When they are greater than 1, they indicate that the comparison outcome is more likely than the reference outcome as the predictor variable increases. When they are less than 1, they indicate that the comparison outcome is less likely than the reference outcome (Fávero & Belfore, 2017).

Considering H_1, in this study the probability of bankruptcy is represented by the PSB variable. Due to the differences between sponsoring companies, the way PSB was calculated in this study was different. Thus, for for-profit sponsors, the company is considered solvent when PSB > 0.80. For non-profit sponsors, the company is considered solvent when PSB > 0.00. Of the plans in the sample, only 8% are considered fully solvent. See Figure 1 for more details.

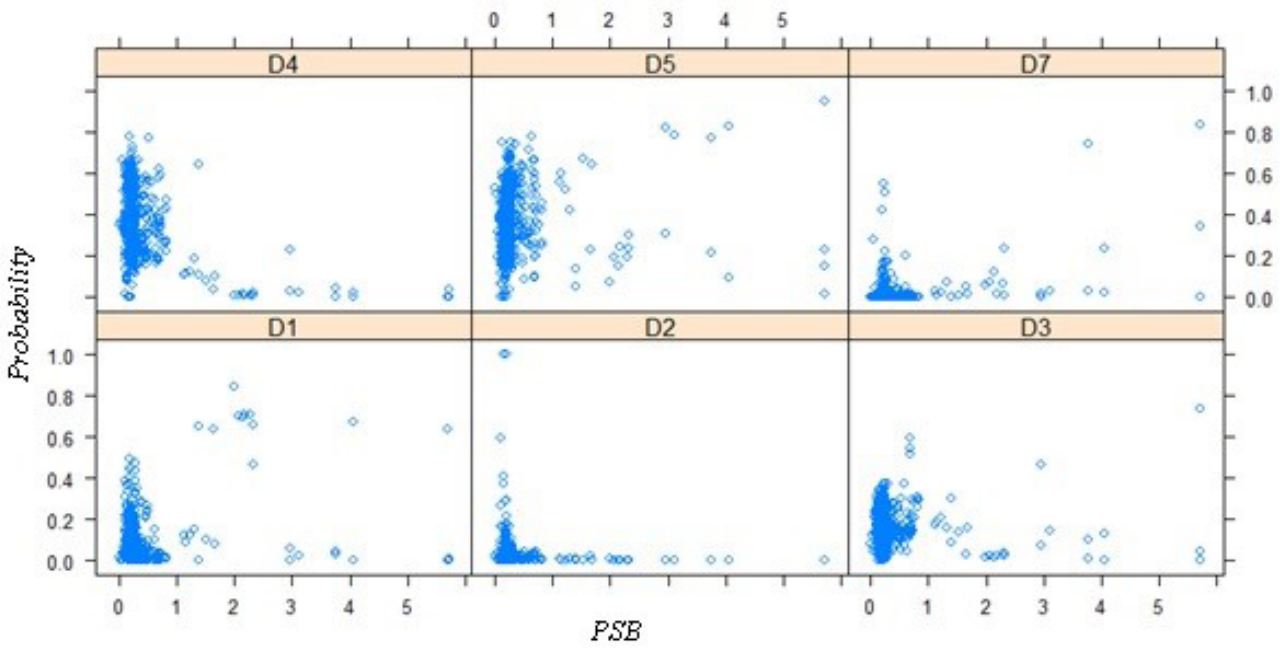

Figure 1 *Probability of decision category × PSB*
Source: *Prepared by the authors.*

The PSB variable proved to be statistically significant in decision categories D3, D4, and D5, with a p-value < 0.01 ($\alpha = 0.05$) and coefficients of -2.82, -3.50, and -1.79, respectively (see Table 8), indicating that the greater the probability of bankruptcy, the greater the likelihood of a more diversified portfolio. In addition, the more solvent plans are also more likely to opt for a variation in asset allocation, but with a slightly bolder portfolio composition (D7).

The results found here show that some plans with sponsors that are less likely to go bankrupt have a portfolio composition with a lower percentage in fixed income and a higher percentage in variable income and others, which may indicate a greater exposure to more volatile assets compared to other plans. However, given the small number of plans in this situation, it is not possible to confirm hypothesis H_1 of this study.

However, the results found are consistent with the work of Rauh (2009), Duan et al. (2015), and Gilje (2016), who found that pension plans have less risky asset allocations when the probability of bankruptcy is higher.

Considering H_2, the level of funding of the plans was measured by the PFL variable; in this study, 29% of the plans had a negative index, indicating underfunding. However, it should be noted that in Brazil, underfunding is due to delays in the transfer of contributions by the sponsor, a situation regulated by Complementary Law 109/2008, indicating that EFPCs should take steps to negotiate these debts.

The results found in this study show that the PFL variable is statistically significant with a p-value < 0.01 ($\alpha = 0.05$) for all decision categories except D2. However, the coefficients are negative (see Table 8), indicating that the probability of choosing a portfolio more exposed to more volatile assets over a more conservative one decreases as the level of financing increases.

Guan and Lui (2016) point out the importance of checking the level of funding together with the probability of bankruptcy. In this study, this relationship between the two variables was measured by creating a new SFP variable. Figure 2 presents the results.

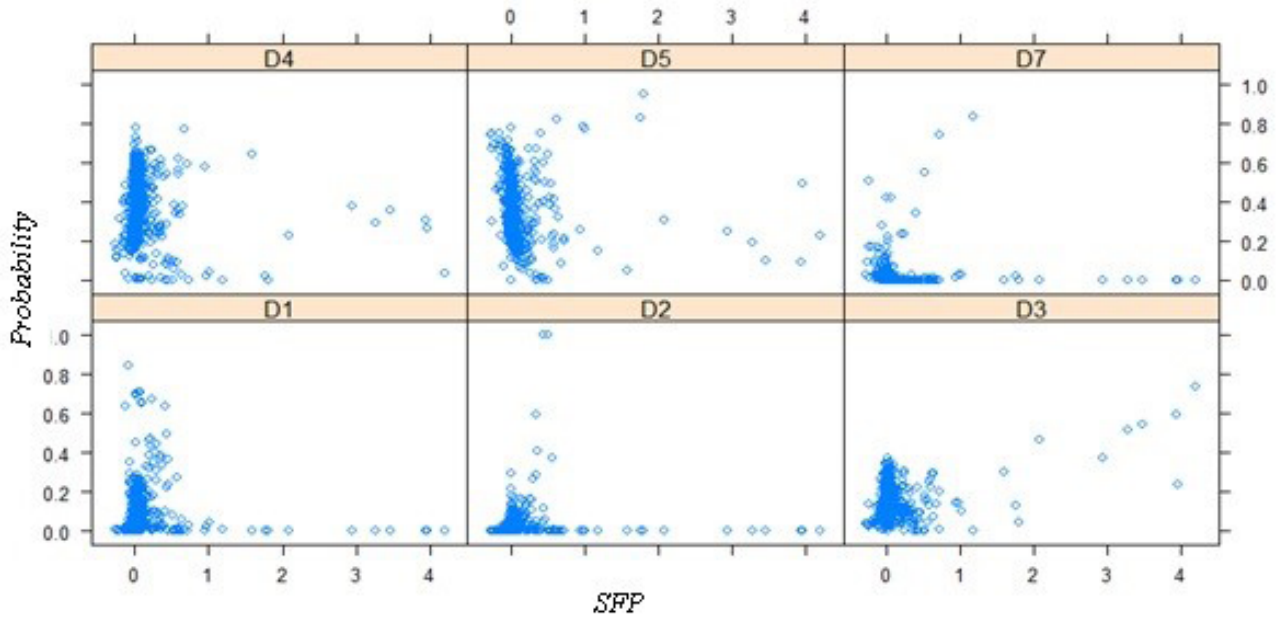

Figure 2 *Probability of decision category × SFP*
Source: *Prepared by the authors.*

The SFP variable is also statistically significant with a p-value < 0.01 (α = 0.05) for all decision categories except D2, with a positive coefficient ranging from 9 to 11 for these categories (see Table 8). As can be seen, the probability of choosing a more conservative portfolio (D1) is higher for lower SFPs and, as the index increases, so does the probability of switching to a more diversified composition (D3 and D5).

Based on these results, it is not possible to confirm the hypothesis that better-funded benefit plans tend to choose a portfolio composition that is more exposed to more volatile assets, but these results are consistent with the findings of Guan and Lui (2016) in the Netherlands, where there are also few underfunded pension plans and stricter legislation in this regard.

5. CONCLUSION

This study set out to investigate the aspects of the sponsor's financial situation that can be associated with the resource allocation decision of the defined benefit plans of Brazilian EFPCs in the annual period from 2013 to 2019. The following factors were found to be statistically significant in relation to the composition of the pension plans' resource allocation portfolios: Plan Funding Level (PFL), Probability of Sponsor Bankruptcy (PSB), Past Return on Assets (PRA), Plan Actuarial Solvency (PAS), Plan Financial Maturity (PFM), Sponsor Company Size (SCS), Interest Rate Effect (IRE) and Sponsor Financial Leverage (SFL). In addition to these factors, the relationship between the Funding Level and the Probability of Sponsor Bankruptcy (SFP = PFL × PSB) proved to be statistically significant.

The results of this research also indicate that the SFL and SFP factors significantly affect the likelihood of plan managers choosing a more diversified portfolio composition over a more conservative one. Therefore, the higher the financial leverage ratio, the greater the likelihood of portfolio diversification. Similarly, well-funded plans with a higher solvency ratio are more likely to choose portfolios with a more diversified composition rather than one composed of only one specific segment. These findings are consistent with previous studies, such as those of Rauh (2009), Duan et al. (2015), Gilje (2016) and Guan and Lui (2016).

However, no statistical evidence was found that sponsors with a lower probability of bankruptcy or better funded plans tend to choose a portfolio composition with more exposure to more volatile assets. Therefore, it cannot be said that the probability of bankruptcy or underfunding influences the decision to allocate pension fund resources to more volatile assets in the plans investigated in this study.

However, it was possible to conclude that the level of funding, the degree of solvency, the size of the company and financial leverage are aspects of the sponsor's financial

situation that may in some way influence the decision to allocate the resources of defined benefit plans. Other aspects related to the pension plan itself, such as past profitability, financial maturity, and actuarial solvency, may also be associated with the allocation decision.

One of the limitations of this study was the fact that it did not take into account the actuarial and financial assumptions adopted by the sponsoring companies in the measurement and recognition of post-employment benefits of a social security nature, as regulated by the Technical Pronouncement of the Accounting Pronouncements Committee (CPC) No. 33/2012 (R1). It also does not take into account actuarial aspects such as duration of pension liabilities, costing method for scheduled benefits, claims, population maturity, among other actuarial assumptions.

It is, therefore, recommended that future research establish this dialogue between sponsor discretion and plan resource allocation, as well as on the influence of actuarial variables in the context of plan resource allocation.

Given the limitations and suggestions for future work, it is hoped that the results of this research will contribute to advancing studies on the relationship between pension fund portfolios and the sponsor's financial situation, as well as broadening the discussions on risk management, improving resource allocation, and the acquisition of insurance.

REFERENCES

Altman, E. I., Baydia, T. K. N., & Dias, L. M. R. (1979). Previsão de problemas financeiros em empresas. *Revista de Administração de Empresas*, *19*(1), 17-28. https://doi.org/10.1590/S0034-75901979000100002

An, H., Huang, Z., & Zhang, T. (2013). What determines corporate pension fund risk-taking strategy? *Journal of Banking & Finance*, *37*(2), 597-613. https://doi.org/10.1016/j.jbankfin.2012.09.018

Anantharaman, D., & Lee, Y. (2014). Managerial risk-taking incentives and corporate pension policy. *Journal of Financial Economics*, *111*(2), 328-351. https://doi.org/10.1016/j.jfineco.2013.10.009

Associação Brasileira das Entidades Fechadas de Previdência Complementar. (2019). *Consolidado estatístico* [December 2019]. ABRAPP. http://www.abrapp.org.br/SitePages/consolidado-estatistico/

Bartolotti, L. R. A. L. (2012). *Pouso forçado – "Desproteção" do trabalhador: uma tragédia silenciosa no cotidiano dos demitidos e aposentados da VARIG/AERUS* [Doctoral thesis, Pontifícia Universidade Católica de São Paulo]. Repositório PUC-SP. https://tede2.pucsp.br/handle/handle/17601

Bartram, S. (2018). In good times and in bad: Defined-benefit pensions and corporate financial policy. *Journal of Corporate Finance*,*48*, 331-351. https://doi.org/10.1016/j.jcorpfin.2017.10.015

Bodie, Z. (1990). The ABO, the PBO and pension investment policy. *Financial Analysts Journal*, *36*(3), 27-34. http://www.jstor.org/stable/4479362

Complementary Law No.109, of May 29, 2001 (2001, May 30). Provides for the Supplementary Pension Scheme and makes other provisions. *http://www.planalto.gov.br/ccivil_03/leis/lcp/lcp109.htm*

Coronado, J., & Liang, N. (2006). The influence of PBGC insurance on pension fund finances. In D. Blitzstein, O. S. Mitchell & S. P. Utkus (Eds.), *Restructuring retirement risks* (pp. 88-108). Oxford University Press.

Croissant, Y. (2020). Estimation of random utility models in R: The mlogit package. *Journal of Statistical Software*, *95*(11), 1-41. https://doi.org/10.18637/jss.v095.i11

Domeneghetti, V. (2020). *Gestão de risco dos fundos de pensão: análise da alocação dos fundos de pensão fechados de 2010 a 2017* [Doctoral thesis, Universidade de São Paulo]. Biblioteca Digital de Teses e Dissertações da USP. https://doi.org/10.11606/T.96.2020.tde-10112020-105535

Duan, Y., Hotchkiss, E. S., & Jiao, Y. (2015). Corporate pensions and financial distress. *AFA 2015 Boston Meetings Paper*. http://dx.doi.org/10.2139/ssrn.2550311

Fávero, L. P. L., & Belfiore, P. P. (2017). *Manual de análise de dados: estatística e modelagem multivariada com EXCEL, SPSS e STATA*. Elsevier.

Gilje, E. (2016). Do firms engage in risk-shifting? Empirical evidence. *Review of Financial Studies*, *29*(11), 2925-2954. http://dx.doi.org/10.2139/ssrn.2837013

Guan, Y., & Lui, D. (2016). The effect of regulations on pension risk shifting: evidence from the U.S. and Europe. *Journal of Business Finance & Accounting*, *43*(5), 765-799. https://doi.org/10.1111/jbfa.12199

Hoefling, C. J. D. (2008). *Fundos de pensão e a obrigação do patrocinador no resultado deficitário do plano de benefício definido: experiência norte americana e brasileira*. LTR.

Kitamura, T., & Omori, K. (2019). Optimal risk-taking in corporate defined benefit plans under risk-shifting. *Managerial Finance*, *45*(1), 1076-1091. doi: 10.1108/MF-01-2019-001.

Law No. 10.406, of January 10, 2002 (2002, January 11). Establishes the Civil Code. *http://www.planalto.gov.br/ccivil_03/leis/2002/l10406compilada.htm*

Lima, J. C. C. O., & Rodrigues, J. A. (2015). A importância das premissas econômicas na gestão de planos de benefícios definidos. *Revista do BNDES*,*43*, 161-204. https://web.bndes.gov.br/bib/jspui/bitstream/1408/6241/2/RB%2043%20A%20import%c3%a2ncia%20das%20premissas%20econ%c3%b4micas%20_P.pdf

Martins, O. S., & Ventura Júnior, R. (2020). Influência da governança corporativa na mitigação de relatórios financeiros fraudulentos. *Revista Brasileira de Gestão de Negócios*,*22*, 65-84. https://doi.org/10.7819/rbgn.v22i1.4039

Ott, E., & Pires, C. B. (2009). Conceitos e objetivos da contabilidade. In F. Ribeiro Filho, J. Lopes & M. Pederneiras (Orgs.), *Estudando teoria da contabilidade* (pp. 57-74). Atlas.

Pereira, M. M. (2013). Impacto na redução das taxas de juros da economia para os fundos de pensão [Master's Dissertation, Universidade de Brasília). Repositório Institucional da UnB. http://repositorio2.unb.br/jspui/bitstream/10482/15542/1/2013_Maur%c3%adcioMarcelliniPereira.pdf

Previc Decreta Fim da Administração Especial nos Planos Petros Copesul e Petros PQU. (2015). *Portal Petros*. https://www.petros.com.br/PortalPetros/faces/Petros/arqnot/not?_afrLoop=138170673996658 3&content=WCC022024&_afrWindowMode=0&_adf.ctrl-state=17vgtowvmk_4

Rauh, J. (2009). Risk shifting versus risk management: Investment policy in corporate pension plans. *Review of Financial Studies 22*(7), 2487-2533. https://doi.org/10.1093/rfs/hhn068

Reis, J. A. (2018). *Avaliação de retorno e risco em alocação de recursos de fundos de pensão* [Master's thesis, Centro Federal de Educação Tecnológica de Minas Gerais]. Sistema Integrado de Gestão de Atividades Acadêmicas. https://sig-arquivos.cefetmg.br/arquivos/20180362276263218507 4039efc6266a9/Dissertao_Jsus_Final.pdf Rieche, F. C. (2005). Gestão de riscos em fundos de pensão no Brasil: situação atual da legislação e perspectivas. *Revista BNDES*, 12(23), 219-242. Retrieved from: http://web.bndes.gov.br/bib/jspui/handle/1408/8194

National Monetary Council Resolution No. 3792, of September 28, 2009 (2009, September 28). Provides guidelines for the investment of funds guaranteeing plans administered by closed supplementary pension entities. *https://www.bcb.gov.br/pre/normativos/res/2009/pdf/res_3792_v3_P.pdf*

Resolution of the National Monetary Council No.4,661, of May 25, 2018. (2018, May 29). Provides for the application guidelines of the funds guaranteeing the plans administered by closed supplementary pension entities. *https://www.bcb.gov.br/estabilidadefinanceira/exibenormativo?tipo=Resolu%C3%A7%C3%A3o&numero=4661*

Rodrigues, J. A. (2008). *Gestão de risco atuarial*. Saraiva.

Romaniuk, K. (2018). Optimal portfolio in corporate pension plans: Risk shifting and risk management. *SSRN's Research Paper Series*. https://ssrn.com/abstract=3116544

Sharpe, W. F. (1976). Corporate pension funding policy. *Journal of Financial Economics*, *3*(3), 183-193. https://doi.org/10.1016/0304-405X(76)90002-7

Superintendência Nacional de Previdência Complementar. (2019). *Cadastro de planos das EFPC*. Previc. https://www.gov.br/previc/pt-br/dados-abertos/cadastro-de-entidades-e-planos-cadprevic

Superintendência Nacional de Previdência Complementar. (2021). *Relatório de estabilidade da previdência complementar – junho/2021*, 2021. Previc. http://www.previc.gov.br/central-de-conteudos/publicacoes/relatorio-de-estabilidade-daprevidencia-complementar-rep

Treynor, J. (1977). The principles of corporate pension finance. *Journal of Finance*, *32*(2), 627-638. https://doi.org/10.2307/2326796

Valadão, D. G., & Rodrigues, A. (2013). *Passivos atuariais: Os efeitos das diferenças metodológicas na contabilização dos fundos de pensão e de suas patrocinadoras* [Paper presented at a congress]. Décimo terceiro Congresso USP de Controladoria e Contabilidade.

Venables, W. N., & Ripley, B. D. (2002). *Modern applied statistics with S* (4th ed.). Springer.

Wartchow, D. (2017). Governança de fundos de pensão brasileiros e a rentabilidade dos respectivos investimentos (Master's thesis, Universidade do Vale do Rio dos Sinos). Repositório Digital da Biblioteca da Unisinos. http://www.repositorio.jesuita.org.br/handle/UNISINOS/6227

Zanetti, A. F. (2017). Gestão temerária de fundos de pensão [Master's thesis, Pontifícia Universidade Católica de São Paulo]. Repositório PUCSP. https://tede2.pucsp.br/bitstream/handle/20461/2/Adriana%20Freisleben%20de%20Zanetti.pdf