UNIVERSIDADE FEDERAL DO RIO DE JANEIRO

INSTITUTO COPPEAD DE ADMINISTRAÇÃO

FRANCIS AMIM FLORES

THE IMPACT OF ALTERNATIVE ASSETS ON THE PERFORMANCE OF BRAZILIAN PRIVATE PENSION FUNDS

Rio de Janeiro

2019

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Dissertação de Mestrado apresentada ao Instituto COPPEAD de Administração, da Universidade Federal do Rio de Janeiro, como parte dos requisitos necessários à obtenção do título de Mestre em Administração.

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Rio de Janeiro

2019

CIP - Catalogação na Publicação

F634t

Flores, Francis Amim
The impact of alternative assets on the performance of Brazilian private pension funds / Francis Amim Flores. -- Rio de Janeiro, 2019.
36 f.

Orientador: Carlos Heitor Campani.
Dissertação (mestrado) - Universidade Federal do Rio de Janeiro, Instituto COPPEAD de Administração, Programa de Pós-Graduação em Administração, 2019.

1. Private pension. 2. Alternative assets. 3. Performance measurement. 4. PGBL and VGBL. I. Campani, Carlos Heitor, orient. II. Título.

Elaborado pelo Sistema de Geração Automática da UFRJ com os dados fornecidos pelo(a) autor(a), sob a responsabilidade de Miguel Romeu Amorim Neto - CRB-7/6283.

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DEDICATION

I dedicate this work to my mother, who made me believe that my dream was possible.

ACKNOWLEDGMENTS

To my parents for supporting and encouraging me at all times in my life.

To my brother, Rafael, who gave me all the necessary support to accomplish this master's degree.

My girlfriend, Sêmilly, who encouraged me to enter this master degree program and endured all my absence during the hardships.

My first advisor, Molina, who introduced me to COPPEAD and encouraged me to seek my place at this institution.

To all the staff, especially the professors of COPPEAD, whose teaching I will take for a lifetime.

In particular, my advisor, Carlos Heitor Campani, for his dedication, patience and trust throughout this process.

Finally, thank you, my God, for allowing me to live with all these people and receive the affection of each one.

ABSTRACT

FLORES, Francis Amim. **The impact of alternative assets on the performance of Brazilian private pension funds**. 2019. Dissertation (Masters in Business Administration) - COPPEAD Graduate School of Business, Federal University of Rio de Janeiro, Rio de Janeiro, 2019.

The market of open private pension funds in Brazil has been growing rapidly in recent years and gaining much relevance, especially after the announcement of the reformulation of the Brazilian pension system. In 2018, the Free Benefit Generating Plan (PGBL) and the Free Benefit Generating Life (VGBL) represented more than 94% of total assets in its sector. However, the Brazilian specially constituted investment funds (FIEs) of PGBL and VGBL private pension plans are characterized by their dependence on fixed income assets. Intriguingly, Brazil is facing the lowest interest rate level of its history, forcing fund managers to look for other alternative investments, since to attract new participants they need to demonstrate a good performance. Noticing a scarcity of studies related to the Brazilian FIEs, we assess the impact of alternative assets in these funds performances, adding a hedge fund index, an equity mutual funds index, a commodity index, an electric power index, a public utilities index, a gold index and a real estate index. The results of this study may support managers in this little-discussed matter, showing that a simple strategy can have a positive effect on FIEs' performances. During 2009-2018, almost all alternative assets improved the performance of FIEs, but especially the public utilities index and the hedge fund index. Some of them even improved the portfolio tail risk.

Keywords*:* private pension; alternative assets; performance measurement;

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LIST OF ABREVIATIONS

CDI	Brazilian Interbank Deposit Rate
CMN	National Monetary Council
FenaPrevi	Brazilian National Federation of Private Pension and Life
FIEs	Brazilian specially constituted investment funds
FII	Real Estate Funds
ICB	B3's commodity index
IEEX	B3's electric power index
IFA	Brazilian Central Bank's equity mutual funds index
IHFA	ANBIMA's hedge funds index
IMOB	B3's real estate index
IPCA	Brazilian National Consumer Price Index
OZ1D	B3's gold index
PGBL	Free Benefit Generating Plan
UTIL	B3's public utilities index
VGBL	Free Benefit Generating Life

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1 Introduction

The inclusion of alternative assets into pension funds' portfolios is increasing around the world and many studies on this matter have arisen. However, despite changes in the Brazilian regulation, the diversification through alternative investments does not follow the same rhythm as in the rest of the world. In addition, studies on alternative assets and their impacts on pension funds in Brazil are very incipient. Most of these studies only investigated the addition of alternative assets and their impact on the performance of Brazilian closed private pension funds (e.g. commodities - Costa and Piacenti (2008); derivatives - Costa et al. (2014); private equity - Lopes and Furtado (2006); international investments - Silva et al. (2009); hedge funds - Leal and Mendes 2009). The results are consistent: all of them concluded that these assets improved the performance of closed pension funds. Therefore, observing a lack in the literature of open private pension funds in Brazil, more specifically, the Brazilian specially constituted investment funds (FIEs) of PGBL and VGBL private pension plans, we question: the addition of alternative assets can improve the performance of open private pension funds?

To ease the pressure on public accounts, the Brazilian government has been insistently trying to reformulate the pension system. In this scenario, the private pension funds have been gaining prominence. According to Brazilian National Federation of Private Pension and Life (FenaPrevi), in the last ten years, this market has been growing at a fast and consistent rate of 20% p.y. Plans known as the Free Benefit Generating Life (VGBL) and the Free Benefit Generating Plan (PGBL) are the most popular private pension plans in Brazil, which accounted for 94.70% of the sector and 99.13% of issued plans in July 2018 (FenaPrevi, 2018). The PGBL and VGBL plans are life insurances with survival coverage. For practical matters, the unique difference between them is the way in which the income tax is levied. Such plans are also structured as Brazilian specially constituted investment funds (FIEs) and marketed as any other financial instrument. For more details, see Campani and Costa (2016).

In this context, this market has become increasingly competitive, making performance a central point in this debate, for to attract and maintain new participants, managers of these funds must demonstrate a good performance in comparison to other products.

Historically, these funds have been strongly dependent on fixed income assets and their asset allocation has always been very constrained by law. Fortunately, in 2017 the National Monetary Council (CMN) launched a new regulation, empowering FIEs with more diversification options. However, due to the historical attractiveness of the Brazilian standard rate (Selic) this change was not enough to break the dependence of FIEs on fixed income assets.

Interestingly, the economical panorama changed drastically this year (2019). The fixed income market is facing one of the lowest interest rates trajectory of its history, leading participants to gradually migrate to other options in search for higher returns. According to FenaPrevi, 11,6% of private pension funds' assets are allocated in hedge funds. This percentage was 10,2% in 2018; 8.1% in 2017; and 5.7% in 2016.

The results reported here show that the addition of a small portion of an alternative asset may improve the performance of FIEs. When added in greater proportion, this improvement becomes more relevant. We considered several alternative assets that a fund manager might invest in: a hedge fund index, an equity mutual funds index, a commodity index, an electric power index, a public utilities index, a gold index, and a real estate index. Our sample period is from January 2009 until December 2018.

2 Literature Review

Since the subprime crisis in 2008, financial markets have witnessed historically low interest rates, challenging investors, especially pension fund managers who rely on yield-related promises. This scenario led investors to look for higher returns outside the traditional asset classes (Kräussl et al., 2017). In this light, the pursue for better returns may bring higher risks. Becker and Ivashina (2015) shows that insurance firms tend to buy bonds with higher systematic risk in order to achieve higher yields and this behavior depends on the business cycle, being much more prominent during economic expansions. However, this asset class becomes very limited when a financial crisis affects dramatically the interest rate. Thus, alternative assets such as real estate, commodities, hedge funds, mutual funds, and funds of funds have become of great importance for institutional investors.

Platanakis et al. (2018) explain that investments in alternative assets have increased in recent decades and it is forecast to continue. A global pension fund study by Willis Towers Watson (2018) shows that from 1997 to 2017, alternative assets allocations in portfolios of pension schemes in United States, Australia, UK, Canada, Netherlands, Switzerland, and Japan have increased from 4% to 25%, highlighting an increase of 10% in United States and 9% in UK. Interestingly, this trend is not an aspect only of developed countries. An OECD study from 2018 affirms that some African countries invested more than 40% of their assets in alternative investments. Also, a survey from Willis Towers Watson (2017) states that pension fund assets managed by the top 100 asset managers increased almost 9% from 2016, reaching an amount of $1.6 trillion, which is equivalent to 51% of their total assets under management. This scenery reinforces the importance of studies on alternative investments and the benefits brought by this strategy.

The earlier literature, outside of Brazil, has extensively studied whether alternative assets provide positive risk-adjusted returns to a traditional asset portfolio, including pension funds' portfolios. For instance, real estate - Andonov et al. (2013); commodities - Bessler et al. (2015); hedge funds - Bali et al. (2013); private equity - Harris et al. (2014), Nielsen (2011). All these studies reached the conclusion that alternative assets are beneficial for the risk-return profile of the portfolios.

Nonetheless, the decision to include alternative assets into portfolios depends not only on the risk-return benefits, but also on the diversification benefits granted by them. Many studies have investigated diversification benefits of adding alternative assets into traditional and pension portfolios (e.g. hedge funds - Amin and Kat (2003a),

Amin and Kat (2003b), Gregoriou and Rouah (2002), Favre and Galeano (2002); commodities - Belousova and Dorfleitner (2012), Daskalaki et al. (2017); international investments - Davis (2005); infrastructure - Newell and Peng, 2008). Just like studies of the risk-return effect, these studies concluded that alternative assets are advantageous to the portfolios in terms of diversification.

One of these studies is worth mentioning: Jackwerth and Slavutskaya (2016) compared the addition of many alternative assets into pension funds' portfolios, such as hedge funds, real estate, commodities, foreign equities, mutual funds, funds of funds, and some counter cyclical and non-cyclical assets. Their main objective was to analyze the total benefit derived from diversification, addition of positive skewness, and the elimination of left tails returns. The results of this study demonstrated that adding hedge funds portfolios produced significantly greater total benefit than any other alternative asset.

In Brazil, the National Monetary Council (CMN) empowered the open private pension funds with more diversification options through the CMN Resolution 4,444. Before it, only 49% of total assets under management could be allocated in variable income, now they are allowed to allocate 70% and, within this proportion, 10% can be distributed into assets with currency variation for example. Moreover, there were also the inclusion of new kinds of assets, such as real estate funds (FII) limited to 20% of the portfolio. Another highlight was the characterization of "Qualified Investors", which are defined by CVM Instruction nº 554 as investors with financial investments over one million BRL (Brazilian currency). This kind of investor is allowed to invest 100% in variable income, 40% in real estate and 10% in assets with currency variation.

According to Susep's statistical report (2018), the participation of the insurance market, which includes insurance, open private pension and capitalization markets, on the Brazilian GDP represented a strong evolution, increasing from 2.59% in 2003 to 3.77% in 2017. This is quite significant, taking in consideration that the Brazilian GDP continued to grow for most of the period. Curiously, the open private pension market accounted for 1.85% of the Brazilian GDP and from 2003 to 2017 their revenues more than tripled in real terms (Susep's statistical report, 2018).

This scenario is an indication that alternative assets can become a considerable portion of pension funds in Brazil. However, the historical high interest rate level in Brazil may have induced investors to prefer fixed income funds, which could have created a barrier for alternative investments. A research done by Susep (2015) revealed that PGBL and VGBL funds allocate 98% of their net worth in fixed income and, within this proportion, 75% is invested in public bonds, 15% in private bonds and 10% in fixed income funds. The cumulative interest rate as measured by Selic, a standard government benchmark for the Brazilian risk-free rate, reached 816% in nominal Brazilian currency terms from January of 2001 until November of 2018. In the same period, the Ibovespa Index (main stock index in Brazil) reached a cumulative return of 476% and the cumulative inflation was 203% (as given by the Brazilian National Consumer Price Index - IPCA). These rates were calculated using the information available in the Brazilian Central Bank and B3 website.

An analysis of the data provided by Susep (SES website)[1] revealed that from 176 companies (Insurance, Reinsurance, Capitalization and Open Private Pension Entities), 110 (63%) possess at least 95% of total assets under management allocated in fixed incomes, 92 (52%) do not invest in variable income, 122 (69%) do not invest in real estate and 131 (74%) invest less than 2% of total AUM in "Others". All these estimates demonstrate that alternative investments are not a common practice in Brazil and reinforces the high dependence on fixed income assets.

Nonetheless, this scenario is changing. The same movement that took place outside brazil after the subprime crisis is happening now. The Brazilian Central Bank reduced the Selic to 5% p.y this year (2019), bringing it to the lowest level of its history. As matter of comparison, this rate was almost three times bigger in 2015 (14.5%). In the future, this interest rate is expected to remain low as the 10-year Brazilian government bond has a 6.853% yield. All data were retrieved from the Brazilian Central Bank and B3 website.

In this context, Conti (2016) explains that most of the open private pension funds are managed by commercial banks, being offered to its customers as a financial investment as any other. Campani and Soares (2019) state that in December 2017, five companies linked to large commercial banks (Bradesco, BrasilPrev, Caixa Econômica Federal, Itaú and Santander) controlled 91% of total PGBL and VGBL net worth. So, these investments are not completely seen as pensions strategies, but are viewed as financial investment vehicles that compete with other products of the bank. Consequently, managers of these funds are induced to advertise these plans as a profitable option and, in order to attract new participants (and keep them!), these funds must present satisfactory performance when compared to the other products. If the performance of the open pension fund is not competitive in the short horizon, participants will migrate to other investment vehicles while the true goal should be the long horizon perspective. Of course, regulation should keep an eye on this matter. Our matter on this study is to assess the importance of alternative investments on these funds' performances, shedding important light on this debate.

3 Data and Methodology

3.1 Data and sampling

The main objective of this work is to investigate the overall attractiveness of adding alternative assets to the Brazilian FIEs of PGBL and VGBL. To do so, the monthly returns of 2331 funds, including the ones that ceased to exist, were downloaded from the Economatica database. Campani and Brito (2018) categorized these funds in three different modalities depending on the institution. Usually it is as follows: conservative funds (allowed to invest only in fixed income instruments),

[1] Data source: Susep, Susep's Statistical System (SES), accessed on 15 January 2019, <http://www2.susep.gov.br/menuestatistica/SES/principal.aspx >.

moderate funds (allowed to invest 15-30% in variable income) and aggressive funds (40-49% in variable income) - interestingly, some very recent funds are already extending this limit to 70% due to the new regulation (CMN nº 4.444).

For our calculations, we only used aggressive funds since they are the ones to allow investments in greater proportion of different types of assets, reducing our sample to 1329 funds (399 inactive and 930 active). We chose a time frame of 120 months (from January 2009 to December 2018), which encompasses different market states and provides the longest period of available data. During this period, the Brazilian economy experienced a recession in the first quarter of 2009, an enormous GDP growth from March 2009 to the beginning of 2014, the worst recession of Brazilian history (2014-2016) and a slow recovery period (2017-2018). In addition, only funds with at least ten years of existence and available data were chosen, leaving us with 128 active and aggressive funds.

We are aware of sample selection and survivorship biases. Then, to address these issues we conducted an one-way ANOVA test to compare the means of all FIEs of PGBL and VGBL, all aggressive funds, and our chosen sample. It is also important to mention that we took into account all the active and inactive funds and reached the conclusion that there is no significant difference between the groups' means at $p < 0.05$ [$F(2, 357) = 0.01$, p-value = 0.9923], reinforcing that our sample is representative for the following analyzes. The descriptive statistics of the groups are presented in Table 1.

Table 1
Descriptive Statistics

	Aggressive sample portfolio	All aggressive funds portfolios	All FIEs of PGBL and VGBL portfolio
μ	0.0077	0.0077	0.0075
σ	0.0205	0.0136	0.0093
Skewness	0.0713	0.1324	-0.0913
Kurtosis	-0.0112	0.0676	0.3120
Minimum	-0.0424	-0.0287	-0.0188
Maximum	0.0652	0.0429	0.0331

The summary statistics are for the monthly returns (in nominal terms) of the equally weighted portfolio of all FIEs of PGBL and VGBL portfolios, all aggressive funds and the aggressive sample. We calculate the following statistics: μ (the mean of the portfolio monthly returns), σ (the standard deviation of the portfolio monthly returns), skewness, kurtosis, minimum monthly return, and maximum monthly return.

For our alternative assets, we used ANBIMA's hedge funds index (IHFA), Brazilian Central Bank's equity mutual funds index (IFA), B3's commodity index (ICB), B3's electric power index (IEEX), B3's public utilities index (UTIL), B3's gold index (OZ1D), and a proxy of real estate investments, B3's real estate index (IMOB)[2]. All data are available in monthly returns from January 2009 to December 2018.

[2] IMOB is a representative index for the Brazilian real estate sector. We do not use the B3'S REIT index (IFIX) due to its small sampling size.

Finally, we adjust the returns of all funds and alternative assets to the IBGE's inflation index (IPCA), which means that everything in this work was calculated in real terms.

3.2 Methodology

In order to add alternative assets to the portfolio of FIEs, we must follow the regulation. According to it, the risk of each asset is determinant to define the limit for its allocation. For instance, assets considered of low risk, such as treasury bonds, may compose up to 100% of a fund's portfolio, while assets of high risk, such as hedge funds with the suffix "Investment abroad", are restricted to only 10%. Thus, understanding that the IHFA contains these types of hedge funds and it is the riskiest asset among those chosen in this work, we restrict the addition of our alternative assets to 10%. Additionally, Campani and Brito (2018) show that aggressive FIEs usually invest only 80% of the total variable income limit, so they do not take a high risk of reaching this limit and get out of the regulation. Therefore, we set an upper limit of 8% (instead of 10%).

In sequence, to model the addition of our assets, we start by selling 5% of the current fund portfolio (in proportion) and adding 5% of an alternative asset. After that, we do a robustness test to check the sensibility of funds' performances to the addition of different kinds of assets using different weights from 1% to 8%.

It is also crucial to think about the rebalancing strategy so that we can ensure that our work does not inflict the regulation. For this reason, we have inspired our rebalancing strategy according to Gutierrez et al. 2019, in which they rebalance pension funds' portfolios once a year and explain that the choice of the rebalancing period is somewhat arbitrary, since longer periods may affect the effectiveness of the asset allocation, while very short periods may undermine the passive approach to long-term objectives. Moreover, transaction costs play an important role in this strategy. Taking too long to rebalance can result in lower trading volumes and transaction costs. However, the share of alternative assets may exceed the limit imposed by the regulation. On the other hand, frequent rebalancing can lead to higher transaction costs. Therefore, we choose somewhere in between, working with semi-annual rebalancing.

To estimate the total benefit of adding alternative assets to FIES of PGBL and VGBL, we use several performance measures. Overall, performance measurements can be split into three main groups: mean-variance ratios, factor models and utility-based models. From the mean-variance group, we use the Sharpe ratio, the historical VaR (as a measure of tail risk) and the Upside Potential ratio (UPR), introduced by Sortino, van der Meer, and Plantinga (1999). Since the Brazilian risk-free rate is historically high, the excess return can be sometimes negative, causing the Sharpe ratio to lose its interpretation. Thus, to overcome this issue, we apply the modified Sharpe ratio presented by Israelsen (1995):

$$SR_i = \frac{(\overline{R_{i,t}} - \overline{R_{f,t}})}{\frac{R_{i,t}-R_{f,t}}{\sigma_i^{\overline{abs(R_{i,t}-R_{f,t})}}}} \quad (1)$$

where SR_i represents the Sharpe ratio for fund i, $\overline{R_{i,t}}$ is the average monthly return of fund i, $\overline{R_{f,t}}$ is the average monthly Brazilian risk-free rate (CDI rate), σ_i is the standard deviation of the historical values of the excess returns, and abs is the absolute value of the excess return. For this study, the CDI rate (Brazilian Interbank Deposit Rate) will be used as the risk-free asset instead of Selic. Their values are practically the same and most funds in Brazil use this rate as the risk-free benchmark.

Even though these ratios are widely used in the funds' performance literature, they are subject to criticism. Therefore, for robustness purposes, we also use a factor model risk measure and propose an eight-factor model to estimate alphas. Since we are adding different classes of assets, the portfolio will be subject to different sources of risks So, to explain most of these risks and determine the excess returns (alphas) we base our model in Campani and Soares (2019) six factor model for aggressive FIEs, adding the illiquidity (Illiquid-minus-Liquid - IML) factor, and ANBIMA's debenture index (IDA):

$$\begin{aligned} R_{i,t} - R_{f,t} = {} & \alpha_i + \beta_i \times (R_{M,t} - R_{f,t}) + h_i \times (HML_t) + s_i \times (SMB_t) + w_i \times (WML_t) \\ & + q_i \times (IML) + g_i \times (IMAB_t - R_{f,t}) + f_i \times (IRFM_t - R_{f,t}) \\ & + c_i \times (IDA_t - R_{f,t}) + e_{i,t} \end{aligned} \quad (2)$$

where $R_{i,t}$ is the fund i return at time t, $R_{f,t}$ is the Brazilian risk-free rate (CDI rate) at time t, α_i is the fund i alpha, $R_{M,t}$ is the market benchmark at time t, HML_t is the standard High-minus-Low factor at time t, SMB_t is the standard Small-minus-Big factor at time t, WML_t is the standard Winners-minus-Losers factor at time t, $IMAB_t$is the ANBIMA's index for government bonds indexed by the IPCA at time t, $IRFM_t$ is the ANBIMA's index for government bonds with pre-fixed rates at time t, and e_i is the error term at time t. We use the IBrX100 index as the market benchmark: Campani and Brito (2018) justify this choice based on previous research that this index has superior performance when compared to Ibovespa index, due to its better diversification. The other risk factors (HML, SMB, WML, and IML) were retrieved from the NEFIN Center website[3].

As in any regression, multicollinearity is an issue. We present below at Table 2 the correlation matrix for the eight factors presented. We can observe four pairs with relevant correlations (marked in bold letters). Three of them concern fixed income instruments: in Brazil, this market is small, and it is really expected that these indices present high levels of correlation. The other pair with high correlation is SMB and IML: this is a consequence of the fact that small companies are likely not to be liquid while big companies are, in general, more liquid. As a consequence to these high

[3] NEFIN is the Brazilian Center for Research in Financial Economics of the University of São Paulo. Accessed on 27 February 2019, < http://www.nefin.com.br/>.

correlations, we perform a robustness check for the factor model, taking out the IML factor and working with a single factor reflecting all other three fixed income factors.

Table 2
Correlation Matrix for the Eight-factor Model

	$(R_M - R_f)$	HML	SMB	WML	IML	(IMAB - R_f)	(IRF - R_f)	(IDA - R_f)
$(R_M - R_f)$	1.00							
HML	0.44	1.00						
SMB	0.36	0.44	1.00					
WML	-0.46	-0.39	-0.60	1.00				
IML	0.10	0.43	**0.83**	-0.37	1.00			
(IMA - R_f)	0.47	0.16	0.23	-0.20	0.17	1.00		
(IRF - R_f)	0.44	0.14	0.21	-0.14	0.17	**0.84**	1.00	
(IDA - R_f)	0.36	0.07	0.19	-0.04	0.22	**0.78**	**0.72**	1.00

Note: *In bold, the highest correlations.*
Source: *Prepared by the authors.*

Another issue is: it is questionable if the fund that delivered a high alpha in the past will continue to do it in the future. Goetzmann et al. (2007) demonstrate that alpha and ratios can be manipulated, increasing a fund's performance measure without adding value to the funds' investors. Thus, they propose a non-parametric utility-based model that cannot be gamed by active trading called Manipulation-Proof Performance Measure (MPPM), being very robust to excessive use of dynamic trading strategies and manipulation of return distributions.

To better measure the benefits of alternative assets, we follow Goetzmann et al. (2007) and use the MPPM:

$$MPPM = \frac{1}{(1-\rho)\Delta t} ln\left(\frac{1}{T}\sum_{t=1}^{T}\left[\left(1+R_{i,t}\right)/\left(1+R_{f,t}\right)\right]^{1-\rho}\right) \quad (3)$$

where the MPPM is an annualized estimate of the portfolio's premium after adjusting for risk. That is, the MPPM is a measure of the risk-adjusted excess return when compared to a risk-free asset. Here, Δt is the length of time between observations (in years), T is the total number of observations, $R_{i,t}$ is the fund's *i* return at time t, and $R_{f,t}$ is the CDI rate at time t. The coefficient ρ is explained by Goetzmann et al. (2007) as a risk parameter that should be selected to make the benchmark optimal for a uninformed participant (i.e., who has no knowledge about financial securities):

$$\rho = \frac{ln\left(1+\overline{R_{M,t}}\right) - ln\left(1+\overline{R_{f,t}}\right)}{Var[ln\left(1+R_{M,t}\right)]} \quad (4)$$

where $\overline{R_{M,t}}$ is the average monthly return of the benchmark (IBrX100) and $\overline{R_{f,t}}$ is the average monthly rate of the risk-free asset (CDI). To calculate this parameter, we take the averages from January 2001 to December 2018 and substitute their values into the Eq. (4) to get our ρ estimation of 0.85. Some Brazilian authors have used a relative

risk aversion parameter equal to 3, such as Ornelas et al. (2008) and Catalão and Yoshino (2004) however, their studies were elaborated more than ten years ago and this parameter may change accordingly to the market state, leading to a very different value. So, to leave no uncertainty in this regard, we also test for different values of ρ, varying from 0.85 to 3.

Finally, to check if alternative assets can really bring benefits and if the MPPM is capable of measure these benefits, we answer three questions. Firstly, we question if alternative assets are capable of bring any benefit to the FIEs. Thus, to answer this question, we measure the original portfolio MPPM (without alternative assets) of each fund of our sample. We then recalculate the returns and the MPPM of the new portfolio (containing one kind of alternative asset), selling 5% (in proportion) of the original portfolio and buying 5% of an alternative asset. Thereafter, we calculate the ΔMPPM as the MPPM of the new portfolio minus the MPPM of the original portfolio. This will create a cross-sectional list of ΔMPPM values, facilitating for further comparisons. We repeat this procedure for each method: the modified Sharpe ratio, UPR ratio, historical VaR and the excess return (alpha). In the end, we use a paired t-test for the means of each method to check if the difference (Δ) is significantly different from zero.

In our second question, we investigate which alternative asset confer the greatest benefit to the fund. To answer it, we take the alternative asset which provided the greatest cross-sectional mean of total benefit (MPPM) and compare its performance to the others. As in the first question, we calculate the ΔMPPM as the MPPM of the portfolio with the best alternative asset minus the MPPM of the portfolio with another alternative asset and repeat the procedure for each performance method. We can then use a paired t-test for the difference (Δ).

Our last question is concerned about the failures of alpha and its ability to estimate the persistence of funds' performance, since it is exposed to several estimation problems, such as, omitted variables and large standard errors (related to low R^2). Thus, the idea here is to check if the MPPM, which is less susceptible to these drawbacks, will have a better persistence over time.

To test it, we use rolling windows of 24, 48 and 60 months with step sizes of 12, 24 and 30 months respectively. We describe the steps for the 24-month window as follows: the window is divided into two sub-periods of 12 months each. For the first half (1-12 months) we calculate the $MPPM_{1i}$, where *i* represents the fund *i*, and for the second half (13-24 months) we calculate the $MPPM_{2i}$. The next window starts at the 13th month and we execute the same procedure repeatedly until complete the 120 months of our sample. Thereafter, we estimate $\Delta MPPM_{1i}$ and $\Delta MPPM_{2i}$, as the $MPPM_{1i}$ (or $MPPM_{2i}$,) of the new portfolio minus the $MPPM_{1i}$ (or $MPPM_{2i}$,) of the original portfolio. This will result in cross-sectional $\Delta MPPM_{1i}$ (and $\Delta MPPM_{2i}$,) values such that we can regress the $\Delta MPPM_{2i}$ on the $\Delta MPPM_{1i}$:

$$\Delta MPPM_{2i} = a_{MPPM} + b_{MPPM} \times \Delta MPPM_{1i} + e_i \quad (5)$$

where a_{MPPM} and b_{MPPM} are the parameters to be estimated and e_i is the error term. So, we stack all $\Delta MPPM_{1i}$($MPPM_{2i}$,) values and regress it to find a unique b_{MPPM}, which must be positive and statistically significant to ensure that there is performance

persistence over time. Finally, we repeat the same process for the alpha estimated by the eight-factor model proposed on this study:

$$\Delta\alpha_{2i} = a_\alpha + b_\alpha \times \Delta\alpha_{1i} + k_i \quad (6)$$

here, the $\Delta\alpha_{2i}$ and $\Delta\alpha_{1i}$ are the $\alpha_{1i}(\alpha_{2i})$ of the new portfolio minus the $\alpha_{1i}(\alpha_{2i})$ of the original portfolio, a_α and b_α are the parameters to be estimated and k_i is the error term.

Furthermore, it is important to challenge our study and investigate whether they are based on the set of assumptions defined above. For this matter, we perform some robustness tests:

1- Use different coefficients of risk-aversion instead of only using ρ = 0.85. We replicate the main results using ρ = 2 and ρ = 3.

2- Apply different weights to the addition of alternative assets, varying from 1% to 8%.

3- Instead of using the eight-factor model, we reduce it to five factors, taking out the IML factor and creating the new risk-free factor. Before describing the development of a new factor, it is important to notice that there is no market index that represents the Brazilian fixed income market (i.e., which includes the private market). Having said that, the new factor was calculated as described: analyzing the Economatica database, our sample of FIEs of PGBL/VGBL allocate 15.5 times more treasury bonds than debentures. Thus, the new risk-free factor is determined taking in consideration this ratio and using a weighted average, as follows:

$$NewR_f = \frac{[15.5 \times (IMAG_t - CDI_t) + (IDA_t - CDI_t)]}{16.5} \quad (7)$$

where, $IMAG_t$ is the ANBIMA's Brazilian federal government bonds index, used here as the benchmark for the Brazilian treasury bonds market, reflecting the $IMAB_t$ and $IRFM_t$ indexes.

$$R_i - R_f = \alpha_i + \beta_i \times (R_M - R_f) + h_i \times (HML) + s_i \times (SMB) + w_i \times (WML) + f_i \times (NewR_f) + e_i \quad (8)$$

4 Results and Discussion

In this section we present and discuss the results for each of our questions, presented below.

4.1 Do alternative assets add any kind of benefit to FIEs?

For this first question, we added 5% of each alternative asset to our sample of FIEs rebalancing the portfolio every six months. Table 3 reports the average differences for each new portfolio over the original FIEs, including all methods and their respective p-values. In the first column, we show that almost all assets improved the

performance of FIEs with statistical significance, except for ICB (commodity index), presenting a negative ΔMPPM (-0.044%). UTIL and IMOB indexes provided the highest average ΔMPPM, 0.314% and 0.244% respectively. The results continue consistent in the second and fourth performance measures. On the other hand, we can see in the last column that the four first assets increased the tail risk (VaR), since the average ΔVaR is positive, which means that the addition of these assets increased the potential losses. The Sharpe ratio analysis, due to these previous findings, are therefore mixed, presenting positive and negative results, some with statistical significance and others without. It is essential to highlight that transaction costs are very important in this matter and the results may change depending on the costs carried by each asset.

Table 3
Average Differences

	Avrg ΔMPPM over original portfolio		**Avrg Δalpha over original portfolio**		**Avrg ΔSharpe over original portfolio**		**Avrg ΔUPR over original portfolio**		**Avrg ΔVaR over original portfolio**	
	Mean	**p-val**	**Mean**	**p-val**	**Mean**	**p-val**	**Mean**	**p-va**	**Mean**	**p-val**
UTIL	0.314%	0.000	0.032%	0.000	0.285%	0.000	0.620%	0.000	0.072%	0.000
IMOB	0.244%	0.000	0.034%	0.000	-0.027%	0.418	0.868%	0.000	0.252%	0.000
IEEX	0.201%	0.000	0.028%	0.000	0.037%	0.302	0.427%	0.000	0.081%	0.000
IFA	0.179%	0.000	0.022%	0.000	0.072%	0.062	0.524%	0.000	0.046%	0.000
IHFA	0.165%	0.000	0.009%	0.000	0.227%	0.000	0.569%	0.000	-0.169%	0.000
Gold	0.078%	0.000	0.015%	0.000	-0.148%	0.066	0.252%	0.000	-0.256%	0.000
ICB	-0.044%	0.000	-0.003%	0.000	-0.302%	0.002	0.002%	0.490	-0.233%	0.000

This table presents the cross-sectional average ΔMPPM for each strategy. We calculate the average difference as the MPPM of the new portfolio rebalanced semiannually (95% invested in the original FIE and 5% invested in one type of alternative asset: public utilities index (UTIL), real estate index (IMOB), electric power index (IEEX), equity mutual funds index (IFA), hedge funds index (IHFA), gold index (OZ1D), or a commodity index (ICB)) minus the MPPM of the original portfolio of each FIE. We report the descriptive statistics and the p-value of the paired t-test for the mean at a 5% significance level. We also report the cross-sectional average difference for every method. Our main sample contains 128 aggressive FIEs from January 2009 to December 2018.

Furthermore, it is worth mentioning that the factor model (used in the alpha analysis) explained most of the returns with an average adjusted R^2 of 80.7%. This average took in consideration every portfolio: UTIL (adj. R^2 = 83.4%), IMOB (adj. R^2 = 84.2%), IEEX (adj. R^2 = 83.6%), IFA (adj. R^2 = 83.9%), IHFA (R^2 = 80.2%), Gold (adj. R^2 = 74.8%), ICB (adj. R^2 = 75.7%), and the original portfolio (adj. R^2 = 79.9%).

It is intriguing that the MPPM and the factor model (alpha analysis) provided a similar ranking. The most important change occurs for UTIL and IMOB, in which the MPPM classifies UTIL as the best option and the factor model has IMOB as its first in the ranking. This result leads us to question which alternative asset is the best choice: UTIL or IMOB?

4.2 Which alternative asset provided the greatest benefit?

Table 4 brings some statistical measures of our portfolios. In the first row we see that UTIL and IMOB presented the highest average return and the ICB was the worst one in terms of return. When we observe the average return on standard deviation ratio in the fifth row, the IHFA exceeds the others, followed by the Gold and UTIL indexes. Going further down the table, we notice that IMOB more than doubled the average skewness (0.29) when compared to the original portfolio (0.13). Interestingly, all assets reduced the average kurtosis, and almost all, not including IMOB and ICB, worsened the portfolio in terms of skewness. However, it is impossible to decide which asset outperforms others by only observing these attributes.

Table 4
Statistical Measures for Each Asset

	Original	UTIL	IMOB	IEEX	IFA	IHFA	Gold	ICB
Avrg Return	0.29%	0.32%	0.32%	0.31%	0.31%	0.31%	0.30%	0.29%
Maximum Avrg Return	0.57%	0.58%	0.57%	0.57%	0.57%	0.56%	0.56%	0.55%
Minimum Avrg Return	0.05%	0.09%	0.09%	0.08%	0.08%	0.08%	0.07%	0.06%
Avrg Std. Dev	2.30%	2.36%	2.51%	2.35%	2.33%	2.20%	2.15%	2.15%
Avrg Return/Std. Dev.	12.82%	13.62%	12.69%	13.24%	13.30%	13.90%	13.80%	13.37%
Avrg Kurtosis	0.86	0.72	0.71	0.70	0.66	0.83	0.70	0.78
Avrg Skewness	0.13	0.06	0.29	0.07	0.09	0.12	0.07	0.14
Avrg Carhart alpha	0.03%	0.07%	0.07%	0.06%	0.05%	0.04%	0.03%	0.02%

This table presents several statistical metrics of each portfolio containing 5% of one kind of an alternative asset. Everything was calculated as the cross-sectional average for each strategy. We report the cross-sectional average of return, standard deviation, return over standard deviation, kurtosis, and skewness. We also report the maximum and minimum average return. In addition, we present the Carhart alpha as an alternative method for the performance.

To facilitate the comparison between assets, we used a simple multi-criteria method, Simple Additive Weighting (SAW), to create a rank based on the results exhibited in Table 3. It involves four steps: firstly, we need to rank all assets under each criterion, in this case the performance measures. Then, all performance results are normalized as follows:

$$c_{ij} = \frac{P_{ij} - min(P_j)}{max(P_j) - min(P_j)} \tag{9}$$

here, c_{ij} is the normalized measure of asset *i* with respect to a performance measure *j*, P_{ij} is the performance result of asset *i* for the performance measure *j,* and *max*(or *min*)(P_j) is the maximum (or minimum) performance result for the performance measure *j*. After that, we convert the normalized ranking into numerical weights, using the Rank-Order Centroid method that minimizes the maximum error of each weight by uniformly distributing them:

$$w_{ij} = \frac{1}{n} \sum_{r_{ij}=k}^{n} \frac{1}{k} \quad (10)$$

where w_{ij} is the weight of asset *i* for a given performance measure *j*, n is the number of assets and r_{ij} is the asset position in the ranking for the performance measure *j*. In the end, we take the weighted average for all assets. The Table 5 brings all assets ranked by their respective SAW score. Just like the ranking provided by the MPPM method, the UTIL index presented the highest score among the others, followed by the IMOB index. Curiously, the hedge fund index (IHFA) became the third best option, which may be related to its strong risk-return relation. It is also important to inform readers to be cautious when analyzing this raking, as some assets are highly correlated and may affect it, which is the case of UTIL and IEEX indexes.

Table 5
Assets Ranking

Assets	SAW Score	Ranking Position
UTIL	1.14	1
IMOB	0.96	2
IHFA	0.49	3
Gold	0.46	4
IEEX	0.35	5
IFA	0.34	6
ICB	0.22	7

This table represents all assets of this study ranked by their SAW score. To calculate it, the SAW method was combined with the weighing method (Rank-Order Centroid).

Developing a rank using ten years of data can lead to a bias, in which luck strategies may be favored, leading to misinterpretation of results. For instance, suppose an asset provided a colossal performance improvement in 2010 due to an external factor, leading us to the conclusion that this asset contributes positively to the FIEs performance. However, if we break this period, we observe that, in the following years, this asset failed to improve the FIEs performance. In fact, this result was biased by the impact of the external factor. Therefore, to address this issue we have gone further, dividing our analysis into different time periods. This analysis may support strategies such as Smart Beta, which makes use of fundamentalist analysis and is influenced by macroeconomic factors.

We found that UTIL and IEEX are the only assets providing positive benefits in all market states, as seen in Table 6. The UTIL index is an important indicator, since the sector covered by it supplies basic needs. Historically, the public utility sector has always been a significant part of Brazilian industry and, along with the extractive sector, has presented consistent results over the years.

Surprisingly, the UTIL strategy was the best in the recession of 2014-2016 (ΔMPPM = 0.275%). This result is strongly related to the hydric crisis in early 2014, considered one of the worst crises in Brazilian history, which increased the value of water and related services, such as, energy, water distribution and basic sanitation.

In addition, productivity growth remains a top priority for Brazil, and greater investments in infrastructure will be needed, presenting a great opportunity for this sector. According to National Confederation of Industry (CNI), the share of industry in the Brazilian GDP rose from 21% to 22% between 2017 and 2018. This growth was driven, partially, by the increased participation of the public utility sector in GDP (from 2.6% to 2.8%), explaining the benefit brought by the UTIL index in the last years (ΔMPPM = 0.493%).

IMOB provided the greatest benefit in the first two columns (ΔMPPM = 1.717% and ΔMPPM = 0.526%). The success of the real state sector in this period was due to the launch of the governmental program *Minha casa, Minha vida*[4] in 2009 for subsidize the construction or buying of thousands of houses for low income habitants.

After it, Brazil suffered the greatest recession in its history, caused by the fall in commodity prices and the limited capacity to carry out the necessary fiscal reforms at all levels of government, bringing instability and political mistrust for the following years. Looking to the sell side, this sector presents a long construction cycle and any investment in that period would represent an enormous risk for new ventures. For the buyer, the unemployment risk would lead to the postponement of the purchase of a high value asset. Thus, this scenario reflects the bad results of the IMOB strategy in the recession of 2014-2016 (ΔMPPM = -0.615%). In the recovery period (2017 and 2018), it began to bounce back (ΔMPPM = 0.438%), showing that the real estate sector is strongly attached to the Brazilian economy.

The electric power sector follows the same pattern as the UTIL index, given that it is part of the public utility services sector. However, in the growth phase, the IEEX presented the second worst performance improvement compared to the others (ΔMPPM = 0.111%). This may be related to the implementation of the Provisional Measure 579 in 2012 that determined the reduction of tariffs and the renewal of electric power generation, transmission and distribution concessions. It reduced the offer of electric power, forcing distributors to pay a higher price for its supplies. The electric power sector, previously seen as a defensive option due to its predictability, registered strong losses in that period. Nonetheless, this index still improved the performance of FIEs in all market states.

The equity mutual funds suffered strong falls in the recession period (2014-2016), caused mainly by the increase in investors risk aversion. A massive wave of redemptions was realized during that period, reducing the net worth of these funds and explaining the loss in the FIEs performance (ΔMPPM = -0.358%).

[4] *Minha casa, Minha vida* is the largest housing program ever created in Brazil. It was launched in 2009 during the Lula government.

Table 6
Market States Analysis

	Recession Jan-2009 / Mar-2009		Growth Apr-2009 / Mar-2014		Recession Apr-2014 / Dec-2016		Slow Recovery Jan-2017 / Dec-2018	
	ΔMPPM	**p-val**	**ΔMPPM**	**p-val**	**ΔMPPM**	**p-val**	**ΔMPPM**	**p-val**
UTIL	0.523%	0.000	0.254%	0.000	0.275%	0.000	0.493%	0.000
IMOB	1.717%	0.000	0.526%	0.000	-0.615%	0.000	0.438%	0.000
IEEX	0.699%	0.000	0.111%	0.297	0.269%	0.000	0.273%	0.000
IFA	0.396%	0.000	0.186%	0.000	-0.358%	0.000	0.873%	0.000
IHFA	-0.195%	0.000	0.240%	0.000	0.232%	0.000	-0.072%	0.000
Gold	-0.183%	0.000	0.058%	0.000	0.039%	0.000	0.215%	0.000
ICB	-2.375%	0.000	0.119%	0.000	-0.060%	0.008	-0.163%	0.000

This table presents the cross-sectional average ΔMPPM for each strategy in different market states. We calculate the average difference as MPPM of the new portfolio rebalanced semiannually (95% invested in the original FIE and 5% invested in one kind of alternative asset: public utilities index (UTIL), real estate index (IMOB), electric power index (IEEX), equity mutual funds index (IFA), hedge funds index (IHFA), gold index (OZ1D), or a commodity index (ICB)) minus the MPPM of the original portfolio of each FIE. We report the descriptive statistics as well as the p-value of the paired t-test for the mean at a 5% significance level. The market states were defined according to the CODACE[5] classification.

Another interesting asset to analyze is the IHFA, which is expanding in Brazil and presented the second-best result for the recession of 2014-2016 (ΔMPPM = 0.269%). Its negative result in 2009 (ΔMPPM = -0.195%) and in the slow recovery period (ΔMPPM = -0.072%) can be due to trend changes faster than expected, such as the subprime crisis in 2009 and the strike of truck drivers in 2018 that had a serious impact in the market. However, it was not enough to make this asset a bad choice, as seen previously in Table 3 it provided benefits in all aspects of the portfolio.

The portfolios with the gold index presented one of the worst performances in the 2009 recession (ΔMPPM = -0.183%). The explanation for this is that the gold is quoted in dollars (USD). Therefore, if the USD appreciate against the Brazilian currency (BRL) the gold price will rise and the opposite will occur if the BRL appreciate against the USD. Following the subprime crisis in 2008, the BRL appreciated against the USD, causing a drop in the price of gold in Brazil.

Commodities represent a large proportion of the Brazilian export sector and it was drastically affected by the subprime crisis in 2009, resulting in an expressive drop (ΔMPPM = -2.375%). However, during the growth phase (ΔMPPM = 0.119%), the exports to China increased exponentially. After this period, the price of commodities began to fall, consolidating the economic recession and poor performance in the following years (ΔMPPM= -0.060% and ΔPMPM = - 0.163%).

After analyzing our assets with multiple metrics and over different time periods, it seems reasonable to state that the UTIL index is the best option in terms of performance benefits. To better vizualize it, we compared graphically the two best positioned assets (IMOB and UTIL) ranked by the SAW method and the MPPM, taking in consideration the average return and standard deviation of each fund, as shown in

[5] The CODACE (Economic Cycle Dating Committee) is a committee that aims to establish reference chronologies for Brazilian business cycles.

Figure 1. It is easy to see that most funds had a better average return with the addition of UTIL compared to IMOB. Also, for each fund, the standard deviation of returns decreased significantly, showing that UTIL provided a better diversification than IMOB.

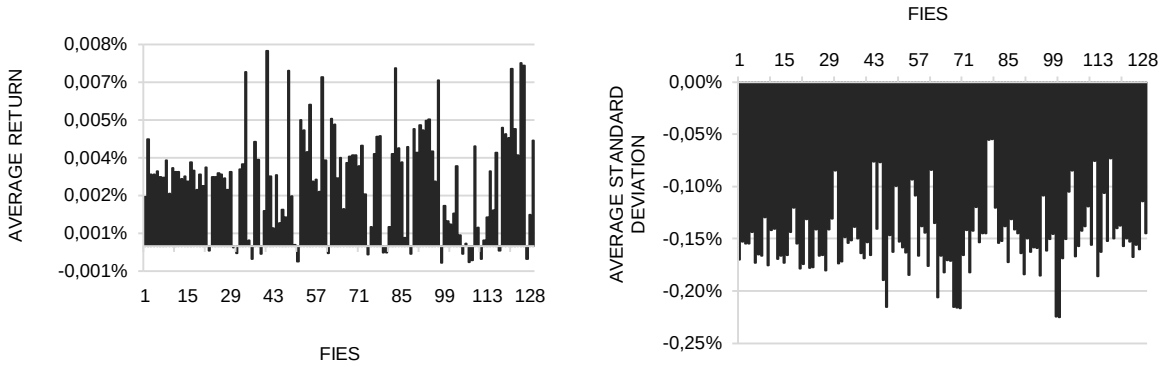

Figure 1. Difference between UTIL and IMOB. We demonstrate that the strategy of adding UTIL is much beneficial than adding IMOB. The figure depicts the difference of the average return and standard deviation between strategies. We calculate the difference as the average return and standard deviation of each FIE for the UTIL strategy minus the IMOB strategy. We present the funds in he horizontal axis as numbers to preserve their identity.

We also compared the FIEs (composed by 5% of UTIL index) against the portfolios with the other assets (composed by 5% of each asset). Table 7 demonstrates that the difference between UTIL and the other assets are truly significant.

Table 7
UTIL Against Other Assets

	Avrg ΔMPPM over UTIL index		Avrg Δalpha over UTIL index		Avrg ΔSharpe over UTIL index		Avrg ΔUPR over UTIL index		Avrg ΔVaR over UTIL index	
	Mean	**p-val**	**Mean**	**p-val**	**Mean**	**p-val**	**Mean**	**p-va**	**Mean**	**p-val**
IMOB	-0.070%	0.000	0.002%	0.000	-0.312%	0.000	0.247%	0.002	-0.179%	0.000
IEEX	-0.113%	0.000	-0.004%	0.000	-0.248%	0.000	-0.193%	0.000	-0.009%	0.049
IFA	-0.135%	0.000	-0.010%	0.000	-0.212%	0.000	-0.489%	0.000	0.026%	0.001
IHFA	-0.149%	0.000	-0.023%	0.000	-0.058%	0.269	-0.096%	0.025	0.241%	0.000
Gold	-0.236%	0.000	-0.017%	0.000	-0.433%	0.000	-0.369%	0.000	0.328%	0.000
ICB	-0.358%	0.000	-0.035%	0.000	-0.587%	0.000	-0.619%	0.000	0.305%	0.000

This table presents the ΔMPPM between UTIL and the other assets. We calculate the average difference as the MPPM of the alternative asset strategy (95% invested in the original FIE and 5% invested in other alternative asset: real estate index (IMOB), electric power index (IEEX), equity mutual funds index (IFA), hedge funds index (IHFA), gold index (OZ1D), or a commodity index (ICB)) minus the MPPM of the UTIL strategy rebalanced semiannually (95% invested in the original FIE and 5% invested in public utilities index (UTIL)). We also report the cross-sectional average difference for every method. We report the descriptive statistics as well as the p-value of the paired t-test for the mean at a 5% significance level.

Despite being the best one in terms of performance improvement, the UTIL index did not show improvement in the tail risk measure as seen in the last column. Thus, since the IHFA index called our attention and curiosity, as it was the only asset to provide benefits in all methods, we decided to combine both assets, dividing the 5% between them.

Figure 2 demonstrates what happens when we mix the two assets. The more we add IHFA to the current fund portfolio, the lower the performance enhancement. However, the improvement in the tail risk is much more pronounced. For instance, if we use only the UTIL index, the ΔMPPM will be equal to 0.314% and the ΔVaR equal to 0.072%. On the other hand, if we use 30% of the IHFA along with 70% of the UTIL index, performance (ΔMPPM) will be reduced to 0.270% (a decrease of 14%) and tail risk (ΔVaR) will improve to -0.006% (an enhancement of 108%).

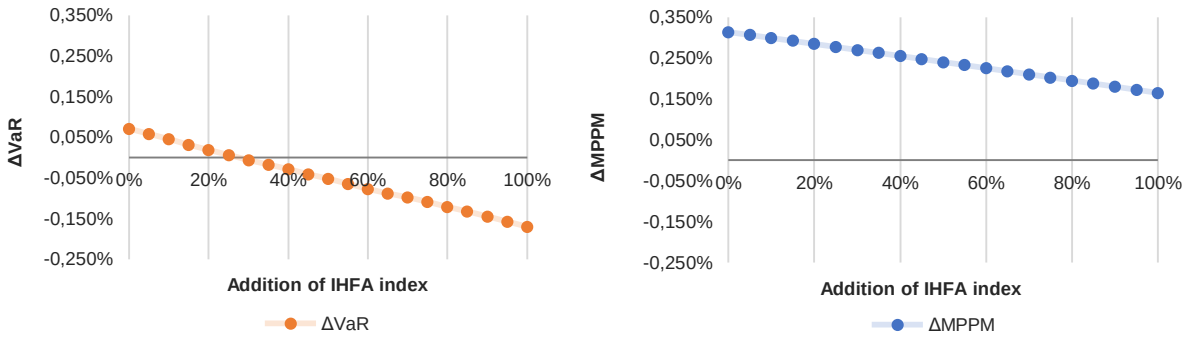

Figure 2. Combination of IHFA and UTIL indexes. We demonstrate that combining the IHFA and UTIL indexes provides an improvement in the tail risk of the FIEs protfolios, but the performance decreases. However, the enhancement in the tail risk is much more pronounced when compared to the loss of performance.

4.3 Does the MPPM have a better persistence over time than alpha?

We show in Table 8 the slope coefficients of the stacked regression for different windows sizes. Here, cross-sectional ΔMPPM (alphas) estimated for the first half of the window (24, 48, 60 months) are regressed on cross-section ΔMPPM (alphas) for the second half of the window.

Although MPPM proved to be a better method for ranking purposes, it did not show persistence over time. In contrast, the factor model demonstrated significant persistence for the 12 month-window, but for larger periods there was no persistence. The anti-persistence for longer periods can be due to mean reversion in estimated performance measures.

Table 8
Persistence Analysis

Window size [first half (formation period) / second half (evaluation period)]	**ΔMPPM**		**Δalpha**	
	b_{MPPM}	**t-stat**	b_{α}	**t-stat**
12 months/ 12 months	-0.39	-14.05	0.14	4.99
24 months/ 24 months	-0.01	-0.16	-0.77	-12.82
30 months/ 30 months	-0.54	-9.38	-0.76	-25.33

This table presents the slope coefficients (b) for the two stacked regressions: $\Delta MPPM_{2i} = a_{MPPM} + b_{MPPM} \times \Delta MPPM_{1i} + e_i$ and $\Delta\alpha_{2i} = a_{\alpha} + b_{\alpha} \times \Delta\alpha_{1i} + k_i$. We also present the t-stat for the significance of each coefficient. We estimate $\Delta MPPM_{1i}$ (for the formation period) and $\Delta MPPM_{2i}$ (evaluation period), as the $MPPM_{1i}$ (or $MPPM_{2i}$,) of the new portfolio minus the $MPPM_{1i}$ (or $MPPM_{2i}$,) of the original portfolio.

This resulted in cross-sectional $\Delta MPPM_{1i}$ (and $\Delta MPPM_{2i,}$) values. Then it was stacked in order to get the overall slope coefficient. The same was done to the alpha model.

5 Robustness

We performed several robustness tests for the main results presented previously. Firstly, to check if the risk-aversion parameter (ρ) was a good estimate for our study, we varied it from 0.85 to 2 and 3. We believe that the parameter of 0.85 was a fairly estimate, since the Brazilian economy was regaining market confidence due to the election result at the end of 2018. The increase in the parameter estimate means that the risk aversion is increasing, which could happen in the near future if the government fails to take the necessary steps to restore fiscal sustainability.

Therefore, Table 9 presents the results for these changes. It shows that the average ΔMPPM changed slightly and remained strongly significant. The UTIL strategy remained the first in the ranking, demonstrating how stable it can be. For the IMOB strategy, the change in risk-version parameter severely penalized its performance, showing that it is more exposed to risk than the other ones. In other cases, this change affected positively, which is the case of the IHFA strategy, becoming the second-best option in terms of ΔMPPM. This appears to be a fair result as the hedge fund industry seeks protection in a risky environment. The same happens to the Gold strategy.

Table 9
Different Risk-aversion Values

	Avrg ΔMPPM over original portfolio with ρ = 0.85		Avrg ΔMPPM over original portfolio with ρ = 2		Avrg ΔMPPM over original portfolio with ρ = 3	
	Mean	**p-value**	**Mean**	**p-value**	**Mean**	**p-value**
UTIL	0.31%	0.00	0.30%	0.00	0.29%	0.00
IMOB	0.24%	0.00	0.19%	0.00	0.14%	0.00
IEEX	0.20%	0.00	0.19%	0.00	0.18%	0.00
IFA	0.18%	0.00	0.18%	0.00	0.17%	0.00
IHFA	0.16%	0.00	0.20%	0.00	0.24%	0.00
Gold	0.08%	0.00	0.14%	0.00	0.19%	0.00
ICB	-0.04%	0.00	0.01%	0.10	0.06%	0.00

This table presents the cross-sectional average ΔMPPM for each strategy using different risk-aversion values (ρ = 2 and 3). In order to facilitate the comparison, we also present the results found in the previous section with a risk-aversion of 0.85. We report the descriptive statistics as well as the p-value of the paired t-test for the mean at a 5% significance level.

Our second robustness test was based on applying different weights in the addition of alternative assets. We modeled the main results using 5% of each asset and for this test we varied the weight of each alternative asset from 1% to 8%. Table 10 brings the same main results as Table 3 but with different weights. For the 1% strategy we still rebalanced the portfolio semiannually, but for the 8% strategy it was needed to rebalance it monthly. This was necessary due to the fact that the addition of some assets exceeded the limit of 10% in the first month, which was the case of IMOB in 2009. One may ask why not rebalance the 1% and 5% strategy monthly. The answer

is that the rebalancing period is really important as it involves transaction costs. Therefore, we prefer the semi-annual rebalancing (with lower costs) instead of rebalancing the FIEs' portfolios monthly (with higher costs).

The results remained very stable and statistically significant. The ranking in MPPM terms did not change and it is possible to observe that the higher the weight the better the improvement in the portfolio. When we reduce the weight (1% strategy), the results were significantly lower than the 5% and 8% strategy. For instance, in the first column the UTIL portfolio decreased by 80% when compared to the 5% strategy, going from 0.314% (Table 3) to 0.063%.

Interestingly, some assets, such as UTIL and IHFA, can be rebalanced every six months with the 8% strategy without exceeding the regulation limit.

Table 10
Main Results with Different Weights

Weights		Avrg ΔMPPM over original portfolio		Avrg Δalpha over original portfolio		Avrg ΔSharpe over original portfolio		Avrg ΔUPR over original portfolio		Avrg ΔVaR over original portfolio	
		Mean	p-val	Mean	p-val	Mean	p-val	Mean	p-val	Mean	p-val
1% strategy	UTIL	0.063%	0.000	0.006%	0.000	0.076%	0.000	0.104%	0.000	0.017%	0.000
	IMOB	0.051%	0.000	0.007%	0.000	0.032%	0.023	0.157%	0.000	0.045%	0.000
	IEEX	0.041%	0.000	0.006%	0.000	0.032%	0.010	0.061%	0.000	0.016%	0.000
	IFA	0.036%	0.000	0.004%	0.000	0.031%	0.005	0.024%	0.001	0.010%	0.000
	IHFA	0.033%	0.000	0.002%	0.000	0.044%	0.000	0.088%	0.000	-0.034%	0.000
	Gold	0.016%	0.000	0.003%	0.000	-0.005%	0.355	0.014%	0.294	-0.057%	0.000
	ICB	-0.010%	0.000	-0.001%	0.000	-0.048%	0.004	-0.025%	0.178	-0.051%	0.000
8% strategy	UTIL	0.488%	0.000	0.050%	0.000	0.470%	0.000	1.081%	0.000	0.154%	0.000
	IMOB	0.334%	0.000	0.046%	0.000	-0.130%	0.251	1.265%	0.000	0.447%	0.000
	IEEX	0.323%	0.000	0.046%	0.000	0.077%	0.266	0.841%	0.000	0.171%	0.000
	IFA	0.272%	0.000	0.034%	0.000	0.073%	0.204	0.219%	0.000	0.085%	0.000
	IHFA	0.261%	0.000	0.013%	0.000	0.369%	0.000	0.885%	0.000	-0.269%	0.000
	Gold	0.174%	0.000	0.031%	0.000	-0.161%	0.132	0.613%	0.000	-0.375%	0.000
	ICB	-0.202%	0.000	-0.008%	0.000	-0.843%	0.000	-0.030%	0.383	-0.260%	0.000

This table presents the cross-sectional average ΔMPPM for each strategy with different weights of each alternative asset (1% and 8%). We report the descriptive statistics as well as the p-value of the paired t-test for the mean at a 5% significance level. We also present the cross-sectional average change for every method.

The last robustness test is related to a concern about the eight-factor model. Instead of using the eight-factor model, we reduced it to only five factors by taking out the IML factor and creating the new risk-free factor, as explained in the methodology section. The five-factor model showed to be marginally inferior since its explanation power was lower when compared to the eight-factor model (with and average adjusted R^2 of 79.3% against 80.7%). This average took in consideration every portfolio: UTIL (adj. R^2 = 82.3%), IMOB (adj. R^2 = 83.2%), IEEX (adj. R^2 = 82.4%), IFA (adj. R^2 = 82.6%), IHFA (adj. R^2 = 78.5%), Gold (adj. R^2 = 73.5%), and the original portfolio (adj. R^2 = 78.2%).

Table 11 shows the comparison between both models in terms of average Δalpha over the original FIEs portfolios. It is possible to notice that the ranking almost

remained the same and the results changed slightly, with the exception of the Gold strategy in the five-factor column that presented a non-statistically significant Δalpha (p-value = 0.135).

Table 11
Five-factor Model Against Eight-factor Model

	Avrg Δalpha over original portfolio (five-factor model)		**Avrg Δalpha over original portfolio (eight-factor model)**	
	Mean	p-value	**Mean**	**p-value**
IMOB	0.042%	0.000	0.034%	0.000
UTIL	0.030%	0.000	0.032%	0.000
IEEX	0.026%	0.000	0.028%	0.000
IFA	0.019%	0.000	0.022%	0.000
Gold	0.001%	0.135	0.015%	0.000
IHFA	0.009%	0.000	0.009%	0.000
ICB	-0.004%	0.000	-0.003%	0.000

This table presents the cross-sectional average Δalpha for each strategy with different models (five-factor and eight-factor model). We report the descriptive statistics as well as the p-value of the paired t-test for the mean at a 5% significance level.

In short, these results corroborate the previous conclusion, that the addition of alternative assets improves the performance of FIEs and the performance measures used (MPPM and eight factor model) provide very robust results.

6 Conclusion

Historically, the Brazilian specially constituted investment funds (FIEs) of PGBL and VGBL have always been dependent on fixed income assets. However, the decrease of Brazilian standard rate (Selic) is forcing fund managers to search for other alternatives. Still, little have been studied if alternative assets have any positive effect on FIEs' performances. We advocate the use of the Manipulation-Proof Performance Measure (MPPM) method for performance measurement. Among the other performance measures, the MPPM provided the most similar ranking when compared to the ranking generated by the Simple Additive Weighting (SAW) method. The literature explains that this measure is much more robust when compared to other traditional measures: Sharpe Ratio, Upside Potential Ratio, and any factor model. They all have flaws that can lead to misinterpretation of the results, such as, assumption of normally distributed returns and poorly estimated parameters. Nevertheless, the factor model showed to have a better persistence over time when compared to the MPPM.

Respecting the Brazilian regulation and using a large database of FIEs' returns from January 2009 to December 2018, we analyze strategies of investing in 5% of an alternative asset and 95% in the current fund portfolio and compare it to the strategy of investing in 100% of these funds' portfolios, rebalancing the portfolio every six months. We find that the UTIL index outperformed the others, improving the average fund performance by a ΔMPPM of 0.523%, which is superior to adding the ANBIMA's hedge funds index (IHFA), Brazilian Central Bank's equity mutual funds index (IFA),

B3's commodity index (ICB), B3's electric power index (IEEX), B3's gold index (OZ1D), and a proxy of real estate investments, B3's real estate index (IMOB).

When we divided our analysis into different market states, some assets outperformed the UTIL index during specific periods, due to certain peculiarities such as the launch of the governmental program *Minha Casa Minha Vida*, which favored the IMOB index in 2009. However, when we look at all periods, UTIL and IEEX were the only assets to provide benefits in every market state, highlighting the first one for providing the greatest improvement during the worst recession of the Brazilian history from April 2014 to December 2016 with an ΔMPPM of 0.275%. In addition, the IHFA index drew our attention as it was the only asset to provide benefits in all aspects of the portfolio, including in terms of tail risk (ΔVaR = 0.169%). Thus, when we combine both assets, UTIL and IHFA, we find that the addition of IHFA reduces the performance improvement, but the tail risk improvement is much more pronounced.

The performance improvement generated by the addition of alternative assets are much more accentuated when we increase the weight from 5% to 8%. However, the transaction costs may increase since the need for a shorter period of rebalancing is required. Interestingly, IHFA and UTIL can still be rebalanced every six months with the 8% strategy without exceeding the regulation limit.

All our results proved to be robust to a wide range of changes in the methodology. As suggestion for future studies, transaction costs could be included to check if the performance improvement brought by these assets do overcome the costs. To enrich the literature and provide different comparisons, more assets could be used, such as, private equity and foreign equities. Moreover, the use of indexes is still considered a passive strategy and an analysis using an active strategy could be performed to test whether it would be more beneficial.

There is evidence that alternative assets can bring benefits to FIEs' portfolios and that the current economic scenario favors alternative investments. Therefore, we question: are fund managers prepared and willing to take risks in this competitive market? Well, we do not have the answer for this question yet, but at least we hope our study can assist them in this challenge.

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