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## The TODIM multi-criteria method applied to the ANBIMA ranking of Brazilian investment funds

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**Abstract:** ANBIMA, the Brazilian Financial and Capital Markets Association, monthly presents the ranking of investment funds management by category. This ranking makes available information about the management of resources from players that invested in funds in Brazil. The institutions that are included in this ranking are ordered based on the total amount of the net equity under management in all categories of investment funds. The research presented in this article applies the TODIM multi-criteria method for building the ANBIMA ranking of June 2017 using the ten best-positioned institutions. In order to accomplish this, each participating institution is considered as an alternative and each category of investment fund functions as a criterion. This allows for a comparison between the ANBIMA ranking against the ranking obtained by using the TODIM method. This comparison points to the possibility of making use of a new, enriched system to order the institutions based on pairwise analyses and taking into account expressions of gains and losses.

**Keywords:** ANBIMA ranking; management of investment funds; systems; ranking of investment funds; TODIM method.

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## 1 Introduction

ANBIMA (Brazilian Financial and Capital Markets Association) monthly presents the ranking of investment funds management by category, such as, by sector of investor and management structure. This ranking aims at providing the market information about management of third-party resources in Brazil applied in investment funds (ANBIMA, 2017a). In this way, the institutions are ranked based on the total net equity under management, informing the distribution by fund category. These categories are: fixed income, stocks, multi-market, foreign exchange, pension, exchange traded funds (ETF), FIDC (credit rights investment funds), FIP (private equity investment funds), FII (real estate investment funds) and offshore funds. More information about the ANBIMA ranking in investment funds management can be found in ANBIMA (2017, 2017b).

When ANBIMA arranged the ranking of investment funds management by category, it presented the total net equity of each participating entity in every category through the algebraic sum. For this reason, this paper aims at contributing to this ranking's creation. The main reasons that motivate the contribution to the ANBIMA ranking, which cannot be expressed by the algebraic sum, arise from the fact that not all institutions have operations in every category of investment funds. Besides that, some institutions have net equity turnover higher than others in some categories and not in others. That is, the net equity turnover varies from one category to another. Thus, some entities may obtain a good position in the ranking because they have a high net equity turnover only in the categories in which they operate. Conversely, other institutions with operations in more investment funds categories may obtain an inferior position compared to the others because of the algebraic sum.

Surely, occupying the best position of the ranking by having the highest net equity turnover under management is coherent. However, it does not reflect the classification of the cases mentioned above. In this regard, it is necessary to classify the participating entities of this ranking in a way that it is possible to measure how much it means to have a high net equity turnover in only some categories, and how much it means to have a reasonable amount of turnover in categories in which the others do not operate. To achieve this, it is necessary to compare pair by pair the value of the net equity under management of all the entities participating in the ranking separately in each evaluation category. One of the ways to evaluate a set of alternatives based on their performance in a set of criteria is through multi-criteria methods in decision-making (Wanishayakorn and Ngorsuraches, 2016). These methods have been used in many fields of study in situations

which involve selection, ranking, classifications or a set of alternatives' description evaluated according to their performances in a set of criteria. The aim is to support the decision making process in a structured, comprehensive and transparent way (Belton and Stewart, 2002).

It is important to emphasise that, in some cases, not to invest in a particular category of investment funds can be a strategically-based way to practice financial management. However, it is understood that the greater the number of classes to which the net equity of a given investor is allocated, the more diversified the shareholders' equity is. A consequence from this is that the more diversified the net equity is, the better the financial results can be (Zulkifli et al., 2008; Nguyen, 2014; Lee and Pati, 2017). Therefore, the proposed contribution to the ANBIMA ranking in this article longs for building a ranking process that is sensitive to the diversification of the net equity.

In this article, the multi-criteria method TODIM was used. The entities that occupy the ten first positions in the ANBIMA ranking of June 2017 will form the set of alternatives and the investment funds categories that belong to the ranking are the criteria. The TODIM method was chosen to generate this ranking because it is based on a comparison pair by pair between the alternatives' performances in each studied criterion. Other methods, such as AHP (Saaty, 1980) and MACBETH (Bana e Costa et al., 2012), also rely on pairwise comparisons, but in a global way (Pomerol and Barba-Romero, 2000). This is different from the pairwise comparison made in the TODIM method. However, in the pairwise comparisons of TODIM the positive and negative differences, i.e., results from subtracting performance measures, are expressed in a distinct way. In PROMÉTHÉE methods (Brans et al., 1986) and in ELECTRE methods (Roy, 1991), the same does not occur. In this way, a ranking with these ten institutions is created using a methodology which is able to sort the alternatives of the cases mentioned above thoroughly, since a simple algebraic sum is not able to sort them appropriately.

## **2 Literature review**

### *2.1 Multi-criteria decision making*

The multi-criteria decision making methods can be used in cases in which selecting, ranking, classifying or describing alternatives in a decision-making process is needed (Vincke, 1989; Roy and Bouyssou, 1993). Two great schools aggregate some of these methods: the French school, also called the European school, and the North-American school of multi-criteria aid to decision making (Saaty, 1980; Roy and Bouyssou, 1993; Belton and Stewart, 2002).

The French school methods have a concept of relation of exceedance in their methodology, that is, a comparison pair by pair between the alternatives' performances in the set of the studied criteria. The two families of the main methods that belong to the French school are: the ELECTRE family of methods and the PROMÉTHÉE family of methods (Brans et al., 1986; Vincke, 1989; Roy, 1991; Roy and Bouyssou, 1993; Pomerol and Barba-Romero, 2000).

On the other hand, the multi-criteria methods of the American school of multi-criteria aid to decision making believe in an aggregation of all the information regarding the problem through a synthesis. Examples of methods that belong to this school are: the multi-attribute utility theory (Keeney and Raiffa, 1993) and the AHP method (Saaty, 1994; Salomon et al., 2016; Khang et al., 2016).

There are also hybrid methods, which are methods that neither belong to the French school nor belong to the North-American school of multi-criteria aid to decision making. Many of them may have characteristics from both schools. Examples of hybrid methods are the TOPSIS method (Hwang and Yoon, 1981; Behzadian et al., 2012; Tayal and Singh, 2017), the TODIM method (Gomes and Lima, 1991) and the MACBETH method (Bana e Costa et al., 2012).

### *2.1.1 Application of multi-criteria methods in finance*

Many authors in the finance area have been using multi-criteria methods in their work, especially in situations of investments prioritisation (Zopounidis, 1999; Zopounidis and Doumpos, 2002; Zavadkas and Turskis, 2011). Hallerbach and Spronk (2002) state that, for people who work with finance, the combination of finance with multiple criteria is not obvious. Moreover, many multi-criteria methods can contribute to both the quality of the financial and economic decision making process and the quality of the resulting decisions. However, in this respect, it should be highlighted that almost always there are alternative ways to be considered in the process of modelling and solution of problems. For this reason, the creation of the team involved in the problem's solution, the choice of method and the way through which the decision maker's data and preferences are collected may heavily interfere in the result (Hämäläinen and Lahtinen, 2016).

Mesrinejad and Moradi (2015) used the TOPSIS method to rank 20 investment funds offered in the stock market Tepix in Tehran, Iran. With the implementation of this method, it was possible to rank the 20 studied funds according to their performance in three ratios: the Sharpe ratio, Jensen's alpha and Treynor ratio, over 12 months. The use of the multi-criteria method was necessary in a context in which the criteria were the different performance indicators, because the risk measures used in each indicator are not the same (Melo and Macedo, 2013).

Duarte (2018) uses the TODIM method combined with fuzzy mathematics to value six Brazilian banks. In this article a six-year dataset of audited financial statements is considered to illustrate the use of the methodology when analysing the six largest (in terms of net worth) banks operating in Brazil. The numerical illustrations have displayed consistent and robust results when the scores of the six banks are computed and the institutions are compared among themselves.

In Gündoğdu's article (2015) the TOPSIS method was implemented in order to analyse the performance of international banks in Turkey from 2003 to 2013 and to establish the ranking for the ten banks analysed year by year. This author used 16 criteria to evaluate the performance of these banks in Turkey and obtained different rankings for each year. In this way, it was possible to observe, with the implementation of the TOPSIS method, how these banks' performances varied from 2003 to 2013. That brought a

greater understanding about the process the Turkish banking system had been going through in relation to the foreign capital described in the article.

Pakizeh and Hosseini (2015) used the PROMÉTHÉE II method to evaluate venture capital projects. For these authors, the use of this multi-criteria method is of great importance to this type of evaluation and, consequently, to support financial decisions. That is because venture capital projects have a high risk of success. Therefore, the PROMÉTHÉE II method became an organised system in the selection of investment projects for being able to reduce the risk of errors. In this article, four projects with high potential for profitability and service provision to society were evaluated based on their performances in five criteria; where it was possible to obtain a ranking for supporting an efficient decision.

Duarte and Medeiros (2016) used the TOPSIS method to rank 11 investment funds belonging to the private equity category. In this article, the performance of these funds in 22 criteria was analysed so that they could be prioritised according to a case study conducted in FAPES-BNDES (Social Welfare and Security Foundation of the National Bank for Economic and Social Development). With the implementation of the TOPSIS method, it was possible to rank the 11 studied funds according to their performances in the 22 analysed criteria, aiming at creating a step by step process for the selection of private equity funds.

Gomes et al. (2016) used the AHP method to rank mutual funds aiming at a subsequent selection in light of criteria that identify the investor's characteristics and objectives. This piece of work sought to offer a diversification in the portfolio of mutual funds, allocating assets appropriately according to the investor's profile. The use of the AHP method brought a better understanding of the problem and assets ranking, which culminated into a portfolio selection.

## 2.2 *The TODIM method*

The TODIM method (interactive and multi-criteria decision making) is a multi-criteria method of alternatives ranking originally developed by Gomes and Lima (1991). This method aims at bringing to the multi-criteria study a method founded on the prospect theory. Kahneman and Tversky (1979) sought to study how the human behaviour reacts when dealing with risk on a decision making setting.

These authors concluded, in their researches, that human beings prefer a small gain, except for a specific superior gain when there is a specific loss risk. It could also be concluded that, when some of the respondents were in a situation of loss, they behaved in a risk-seeking manner in order to find a way to minimise their loss. In this regard, the TODIM method builds its step by step process on the gains and losses curve designed by Kahneman and Tversky (1979). For that, there is a distinct way of measuring a situation of loss from a situation of gain between two alternatives, preventing the difference of performance between two alternatives to be measured reciprocally.

Thus, human decision making under risk in many situations is not related to utility, but to the perception of losses and gains in a particular case (Liu et al., 2016; Lippi, 2017). As a consequence of this, the TODIM method is founded on prospect theory and its application to the multi-criteria context. Other multi-criteria methods combined with

prospect theory can be found in the articles by Lerche and Geldermann (2015), Gao and Liu (2016), Krohling and Souza (2012) and Qin et al. (2015).

In the TODIM method, a comparison pair by pair between the performances of all the alternatives in every studied criteria is made (Adali et al., 2016). The criteria can be of maximisation or minimisation. For the implementation of this method, it is necessary that the decision maker establishes a weight for each studied criterion according to his/her preference (Mahmoodi and Jahromi, 2014).

During the comparison of performances between the alternatives by criterion, the TODIM method uses many ways of measuring losses, gains and null differences. That is, the method treats the same difference value differently depending on the situation (Zhang et al., 2017). Therefore, the TODIM method can be always used when it is desired to rank the alternatives in the light of criteria with a comparison pair by pair able to measure in a distinct way the same difference of performance between two alternatives in different situations: losses, gains or null differences.

The first step to implement the TODIM method consists of creating a matrix of multi-criteria decision composed of  $n$  alternatives and  $m$  criteria. So, if a set  $A$  of  $n$  alternatives given by  $A = \{A_1, A_2, \dots, A_j, \dots, A_n\}$  and a set  $C$  of  $m$  criteria given by  $C = \{C_1, C_2, \dots, C_j, \dots, C_n\}$ , in which  $a_{ij}$  is the performance of alternative  $A_i$  in criterion  $C_j$ . Equation (1) presents the decision matrix of  $A$  with  $n$  alternatives and  $m$  criteria.

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1j} & \dots & a_{1m} \\ a_{21} & a_{22} & \dots & a_{2j} & \dots & a_{2m} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \dots & a_{ij} & \dots & a_{im} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nj} & \dots & a_{nm} \end{bmatrix} \tag{1}$$

On the second step, the values of the decision matrix  $A$  should be standardised. For the maximisation criteria, the standardisation of the alternatives' performances must be done according to equation (2) and according to equation (3) for the minimisation criteria.

$$P_{ic} = \frac{a_{ic}}{\sum_{i=1}^n a_{ic}} \tag{2}$$

$$P_{ic} = \frac{\frac{1}{a_{ic}}}{\sum_{i=1}^n \frac{1}{a_{ic}}} \tag{3}$$

In equation (2) and equation (3), the value of  $p_{ic}$  is the standardised performance value of alternative  $i$  in criterion  $c$ .

On the third step, the weight of each criterion should be defined. The set of criteria weights is given by  $W = \{w_1, w_2, \dots, w_j, \dots, w_n\}$ , with  $w_j$  as the weight of the criterion  $j$ .

After the values of the criteria weights are defined, they should be standardised according to equation (4).

$$w_{cr} = \frac{w_c}{w_r} \quad (4)$$

In equation (4),  $w_r$  is the sum of all the criteria weights [equation (5)],  $w_c$  is the weight of the criterion  $c$  and  $w_{cr}$  is the weight of the criterion  $c$  standardised.

$$w_r = \sum_{c=1}^m w_{cm} \quad (5)$$

On the fourth step, the degree of dominance  $\delta$  of alternative  $A_i$  over alternative  $A_j$ ,  $\delta(A_i, A_j)$  should be calculated, according to equation (6).

$$\delta(A_i, A_j) = \sum_{c=1}^m \Phi_c(A_i, A_j) \quad (6)$$

where

$$\Phi_c = \begin{cases} \sqrt{\frac{w_{cr}(P_{ic} - P_{jc})}{\sum_{c=1}^m w_{cr}}}, & \text{if } (P_{ic} - P_{jc}) > 0 \\ 0, & \text{if } (P_{ic} - P_{jc}) = 0 \\ \frac{-1}{\theta} \sqrt{\frac{(\sum_{c=1}^m w_{cr})(P_{ic} - P_{jc})}{w_{cr}}}, & \text{if } (P_{ic} - P_{jc}) < 0 \end{cases} \quad (7)$$

$$(8)$$

$$(9)$$

The value of  $\Phi_c$  represents the contribution of criterion  $c$  to the degree of dominance of alternative  $A_i$  over alternative  $A_j$ ,  $\delta(A_i, A_j)$ . This contribution is calculated distinctively in case the difference of the performance of alternative  $A_i$  with alternative  $A_j$  is positive, null or negative [equations (7), (8) and (9)]. This step of the TODIM method implementation allows the difference between the performance of two alternatives to be treated distinctively in situations where this difference is of loss (negative difference) [equation (7)], null (null difference) [equation (8)] or of gain (positive difference) [equation (9)].

The value of  $\theta$ , described in equation (9), represents the attenuation of loss ratio of criterion  $c$ . That allows the decision maker to attribute attenuation of losses degrees to each criterion. Consequently, the  $\theta$  represents the degree of aversion to loss of the decision maker in each criterion. Usually,  $\theta = 1$  is used in every criterion, but there are ways to define the value of  $\theta$  for each criterion (Gomes and Rangel, 2009). Using  $\theta = 1$  in every criteria means that the decision maker has the same degree of aversion to loss in every studied criterion.

On the last step, the degree of global dominance  $\zeta$  of each alternative should be calculated. With the value of the degree of global dominance, it is possible to obtain the ranking of all the studied alternatives [equation (10)].

$$\zeta_i = \frac{\sum_{j=1}^n \delta(A_i, A_j) - \min \sum_{j=1}^n \delta(A_i, A_j)}{\max \sum_{j=1}^n \delta(A_i, A_j) - \min \sum_{j=1}^n \delta(A_i, A_j)} \quad (10)$$

### 3 Contribution to the ANBIMA ranking

#### 3.1 The ANBIMA ranking of investment funds management by class of June 2017

To begin the TODIM method implementation, the ranking of the first ten places in the ANBIMA ranking of investment funds management by class of June 2017 should be observed. Table 1 presents the first ten places of this ranking.

**Table 1** First ten places in the ANBIMA ranking of investment funds management by class of June 2017

Rank	Institution	Net equity (millions R\$)
1st	BB DTVM S.A (BB)	800,776.85
2nd	Bradesco (Bradesco)	573,277.19
3rd	Itaú Unibanco SA (Itaú)	565,748.36
4th	CAIXA (Caixa)	257,581.29
5th	Banco Santander (Brasil) SA (Santander)	243,475.86
6th	J Safra Asset Management (Safra)	83,892.50
7th	Credit Suisse (Credit Suisse)	82,325.96
8th	BTG Pactual (BTG Pactual)	77,985.70
9th	Votorantim Asset (Votorantim)	48,624.55
10th	BNP Paribas (BNP Paribas)	37,898.81

Source: ANBIMA (2017c)

Therefore, the institutions described in Table 1 will form the set of alternatives for the TODIM method implementation, in order to generate a contribution to the ANBIMA ranking. The criteria for the implementation of the TODIM method are the investment funds categories used in the ANBIMA ranking: fixed income, stocks, multi-market, foreign exchange, pension, ETF, FIDC, FIP, FII and Offshore. Table 2 presents the net equity under management of the institutions described in Table 1 in million BRL in the investment funds categories published by the ANBIMA ranking on June 2017.

According to Table 1, BB is the first place of the ranking, because it has the highest total net equity under management. However, in Table 2 this institution does not operate with ETF or FIP funds, whereas institutions with an inferior position than BB do. Itaú is the third position of the ranking (Table 1), nevertheless, it is the institution with the highest net equity under management on funds ETF, foreign exchange and multi-market (Table 2). Santander has a higher operation on FIP – a category in which the first three places do not operate – nonetheless it is the fifth place of the ranking.

**Table 2** Net equity under management of the institutions in the studied investment funds categories

<i>Institution</i>	<i>Fixed inc.</i>	<i>Stock</i>	<i>Multi-market</i>	<i>Exchange</i>	<i>Pension</i>	<i>ETF</i>	<i>FIDC</i>	<i>FP</i>	<i>FII</i>	<i>Offshore</i>
BB	509,184.82	34,148.96	20,231.76	632.30	206,776.48	0.00	21,670.00	0.00	64.43	8,077.10
Bradesco	332,423.99	7,422.34	47,908.96	599.73	178,840.52	0.00	5,986.20	0.00	95.45	0.00
Itaú	346,815.41	7,746.37	61,916.41	1,059.17	146,490.33	1,720.68	0.00	0.00	0.00	0.00
Caixa	187,810.69	7,634.56	8,345.71	52.73	41,210.51	56.29	2,624.85	3,277.07	6,568.88	0.00
Santander	159,570.92	1,856.30	23,884.09	285.67	38,196.53	0.00	0.00	19,151.94	0.00	530.40
Safra	35,425.26	589.73	36,281.43	51.48	10,293.80	0.00	48.89	678.75	523.16	0.00
Credit	15,249.44	1,230.53	59,195.51	200.40	1,833.39	0.00	0.00	0.00	4,616.68	0.00
BTG	11,113.80	2,183.99	37,898.26	34.72	233.51	0.00	473.04	7,925.12	11,627.38	6,495.87
Votorantim	17,596.18	109.32	7,944.37	191.36	710.91	0.00	2,153.99	12,639.28	6,325.43	0.00
BNP	24,917.29	1,950.13	7,781.06	0.00	1,269.09	0.00	0.00	93.86	0.00	1,724.07

*Source:* ANBIMA (2017c)

By observing Tables 1 and 2 it is possible to notice many cases like the ones mentioned above. These issues bring attention to the necessity of using a methodology that addresses these cases more thoroughly. They are situations in which not having net equity under management in some categories but having a transaction size substantially superior than other institutions in a few categories makes the institution be well classified for not appropriately expressing the cases mentioned. The algebraic sum of the net equity under management of each institution in every class of investment funds, does not reflect the cases above accordingly, which motivates a contribution to the ranking of Table 1.

The comparison pair by pair used in the TODIM method, and its different ways to measure positive, negative and null differences, can contribute to the creation of a ranking that addresses the cases above appropriately, since the algebraic sum does not reflect this in its results. Thus, it is important to highlight that the work discussed here aims at contributing to the already existing ranking, which should be observed combined with this contribution – since both are capable of generating relevant information about the subject to the market. In this regard, the analysts should seek which information is more valuable to expose their considerations and support the decision-making process.

### 3.2 TODIM method implementation

#### 3.2.1 Creation of weights for the criteria

In this paper, it is understood that to generate weights for each criterion (investment funds categories in the ranking), the total net equity that each category has should be taken into consideration. That must be observed because the importance of each category is connected to the operation volume present in the institutions that form the ranking. In this way, the most important category will be the one with the highest volume of net equity under management in the ten studied institutions. Each category has a weight which is proportionally equivalent to its operation volume.

For that, it is necessary to do the sum of the net equity in each category of all the institutions. Next, the sum of the total net equity under management should be done. After that, all that it is needed is to calculate the proportion of the volume of the net equity under management in each category with the value of the sum of the net equity in every category [equation (11)].

$$w_j = \frac{\sum_{j=1}^n a_{ij}}{\sum \sum_{j=1}^n a_{ij}} \quad (11)$$

In equation (11),  $w_j$  is the weight of criterion  $j$  and  $a_{ij}$  is the performance of alternative  $i$  in criterion  $j$ . Table 3 presents the weight of each criterion.

The weights are established in this way because, besides the fact that TODIM reflects in its results sensitivity to the case of diversification, as mentioned in the introduction, it is also necessary to assign weights according to the risk profile of investors. Since the set of alternatives is composed by the largest Brazilian banks with investment funds transactions in Brazil, the most important category of investment funds must be the one that corresponds to the highest investment level made by Brazilians in their portfolio. By observing Table 3 one can notice that fixed income has the highest weight because most

Brazilian people invest in fixed income. Due to this, it is preferable to have a higher investment volume in fixed income than in stocks, for example.

This is a way to translate, according to the volume of capital allocated by the Brazilian population, the preference of Brazilian investors when diversifying their capital.

**Table 3** Criteria weights

<i>Criteria</i>	<i>Net equity</i>	<i>Weight</i>
Fixed income	1,640,107.80	0.5918
Stocks	64,872.24	0.0234
Multi-market	312,504.56	0.1128
Foreign exchange	3,098.57	0.0011
Pension	625,855.10	0.2258
ETF	1,776.97	0.0006
FIDC	32,956.98	0.0119
FIP	43,766.02	0.0158
FII	29,821.41	0.0108
Offshore	16,827.43	0.0061
$\Sigma$	2,771,587.07	1.0000

*Source:* Elaborated by the authors

### 3.2.2 *TODIM method application*

With the alternatives' performances in the studied criteria described in Table 2 and the weight of each criterion described in Table 3, the TODIM method should be implemented following the steps outlined in section 2.2 of this article. All the criteria are of maximisation, because the best alternative should be able to obtain higher net equity under management in comparison to the others in every investment funds categories of the ranking. It was established  $\theta = 1$  to each criterion (Gomes and Rangel, 2009). Table 4 presents the alternatives ranking by the TODIM method.

TODIM was the multi-criteria method chosen in this article because, as explained in the introduction, pairwise comparisons are used in its application. Besides, this method expresses in a distinct way a negative difference (i.e., a loss) and a positive difference (i.e., a gain) in those comparisons. Other multi-criteria methods also make a comparison between pairs of alternatives criterion by criterion. Examples of such methods are PROMÉTHÉE and ELECTRE.

However, when PROMÉTHÉE methods are used, the subtraction of performances of two alternatives is expressed in equal forms for positive and negative differences distinctly different from TODIM (Llamazares, 2018). In ELECTRE methods, when subtracting the performances of two alternatives in order to obtain the concordance and discordance indexes not all values of subtractions are used. Besides, the notions of weak preference and pseudo-criteria must be used. As a consequence of this, TODIM is the most appropriate method to be applied in this case.

Table 4 presents the ranking established by TODIM. One can therefore summarising by saying that Itaú is the best positioned financial institution with respect to the others.

**Table 4** Results of the TODIM method

<i>Rank</i>	<i>Institution</i>	<i>Global dominance (<math>\zeta</math>)</i>
1st	Itaú	1.0000
2nd	BB	0.9153
3rd	Bradesco	0.6511
4th	Santander	0.4505
5th	BTG Pactual	0.4197
6th	Votorantim	0.4044
7th	Caixa	0.4042
8th	Credit Suisse	0.3155
9th	Safra	0.0940
10th	BNP Paribas	0.0000

*Source:* Elaborated by the authors

### 3.3 Sensitivity analysis

In this stage a sensitivity analysis will be performed to allow knowing how much the ranking established by using TODIM (Table 4) will be changed given a change in criteria weights. This sensitivity analysis is performed by assigning equal weights to all criteria. Thus, each weight is 0.1000. One must therefore apply TODIM to data in Table 2 with weights equal to 0.1000 for all criteria. Table 5 shows the results from sensitivity analysis.

**Table 5** Sensitivity analysis results

<i>Rank</i>	<i>Institution</i>	<i>Global dominance (<math>\zeta</math>)</i>
1st	BB	1.0000
2nd	Itaú	0.8064
3rd	Bradesco	0.7150
4th	BTG	0.4866
5th	Caixa	0.4846
6th	Santander	0.4336
7th	Votorantim	0.2859
8th	Credit Suisse	0.2325
9th	Safra	0.1154
10th	BNP Paribas	0.0000

Table 6 shows a comparison of rankings in Table 4 against Table 5.

**Table 6** Comparison between TODIM rankings

<i>Rank</i>	<i>TODIM</i>	<i>Sensitivity analysis</i>
1st	Itaú	BB
2nd	BB	Itaú
3rd	Bradesco	Bradesco
4 <sup>th</sup>	Santader	BTG
5 <sup>th</sup>	BTG	Caixa
6 <sup>th</sup>	Caixa	Santander
7 <sup>th</sup>	Votorantim	Votorantim
8 <sup>th</sup>	Credit Suisse	Credit Suisse
9 <sup>th</sup>	Safra	Safra
10th	BNP Paribas	BNP Paribas

By comparing the results from TODIM (Table 4) against those from sensitivity analysis (Table 5) one can notice changes of rankings. However, one must emphasise that such changes are due to a very significant change in the weights of criteria. For example, fixed income used to have a weight of 0.5918 and the new weight became 0.1000. Similarly, foreign exchange had a weight of 0.0011 and it became 0.1000.

One can also notice as a major change the fact that BB has now the first position in the rank, occupying a position that used to belong to Itaú. However, the sensitivity analysis reinforces the understanding that Itaú is above Bradesco, something that does not show in ANBIMA ranking. At the same time, Itaú went down one position only as a result from sensitivity analysis, even with an expressive change of criteria weights. The most abrupt change was that of Santander, that went from the fourth to the sixth position in the sensitivity analysis.

Sensitivity analysis also leads to recognising that Votorantim, Credit Suisse, Safra and BNP Paribas must occupy ranks lower than the other institutions. This analysis reinforces the robustness of TODIM with respect to its differences against the ANBIMA ranking in the case under study.

### *3.4 The comparison between the ANBIMA ranking and the TODIM ranking*

The ranking elaborated by ANBIMA (Table 1) presents a different classification from the one established by the TODIM method (Table 4). That happens because of the different methodologies used to form the ranking. However, it is important to highlight that depending on the evaluation matrix of alternatives' performances in the studied criteria; different methodologies may generate the same ranking. Table 7 presents the comparison between the ANBIMA ranking and the TODIM ranking.

By observing Table 5, it is noticeable that there were alterations in most parts of the ranking. BB, which is the first place in ANBIMA, goes to second place in TODIM. This fact can be partially explained: BB has the highest total net equity, but it does not operate in the investment funds categories that other institutions in an inferior position in the ANBIMA ranking do. Besides that, BB does not have the highest net equity in all the categories it operates in. For instance, although it operates in the multi-market, foreign exchange and FII categories, it is not the institution with the highest net equity in these categories (Table 2).

**Table 7** Comparison between the ANBIMA ranking and the TODIM ranking

<i>Rank</i>	<i>ANBIMA ranking</i>	<i>TODIM ranking</i>
1st	BB	Itaú
2nd	Bradesco	BB
3rd	Itaú	Bradesco
4th	Caixa	Santander
5th	Santander	BTG Pactual
6th	Safra	Votorantim
7th	Credit Suisse	Caixa
8th	BTG Pactual	Credit Suisse
9th	Votorantim	Safra
10th	BNP Paribas	BNP Paribas

*Source:* Elaborated by the authors

These two cases of BB's performance are measured, along with the other participants in the ranking, by the TODIM method. That is, it is part of its methodology to carefully analyse the alternatives' performances by criterion, which is not done by the algebraic sum. It is also important to observe that BB dropped only one place in the comparison between the two rankings. That happens because BB has a net equity volume substantially superior than others in the criterion with the highest weight and better performance in the criterion with the second highest weight. That justifies its best position in the ANBIMA ranking and justifies maintaining the second position in the TODIM ranking.

Itaú is in third position in the ANBIMA ranking, but it is the first position in the TODIM ranking. Itaú has the second position in the criterion with the highest weight (fixed income) and has better performance in the multi-market, foreign exchange and ETF criteria. That explains why part of the difference in Itaú's position in the rankings, because these situations are measured in the TODIM method and are not perceived with the algebraic sum. Thus, the TODIM ranking can be used as a complement to the ANBIMA ranking, because the ANBIMA ranking is capable of generating information through the way it is done and the TODIM ranking seeks to generate information through the way its methodology is applied, that is, its implementation step by step. The information generated by each ranking must be used according to the information wished to be obtained about the net equity under management of the studied institutions. That is, seeking to know which institution has the highest net equity under management does not depend on which categories it operates or which institution is the closest to have a better performance in all categories simultaneously.

Just as BB and Itaú cases, the differences between the ANBIMA and the TODIM rankings can be verified in the Bradesco, Santander, Caixa, Safra, Credit Suisse, BTG Pactual and Votorantim cases. These differences reinforce even more the existence of specific situations in the behaviour of the alternatives' performances in a set of criteria in which a simple algebraic sum is not capable of measuring them appropriately. However, both methodologies used to establish each ranking are capable of generating information to the stakeholders. Each stakeholder should analyse the ranking that, according to his/her point of view, gathers the necessary content to bring support to his/her decision making.

Or the ranking that best represents the evaluation of the net equity under management of the analysed institutions among the investment funds categories.

#### **4 Conclusions**

This paper seeks to bring a contribution to the ANBIMA ranking of investment funds management by class of June 2017 with the implementation of the multi-criteria method, TODIM. The motivation behind a contribution to the ANBIMA ranking arises from the fact that it is elaborated by the result of the algebraic sum of the net equity under management of each institution in every analysed investment funds categories. Thus, some cases require closer attention to generate information to the market and they cannot be expressed appropriately by the algebraic sum, it is necessary to implement a methodology that is sensitive to these cases when ranking the set of managing entities.

The implementation of the TODIM method was possible due to the fact that the published data from ANBIMA is found in a multi-criteria context. It was sought to establish a ranking of the investment funds managing entities in which the alternatives are the participating institutions of the ranking. The criteria are the studied investment funds categories and the alternatives' performances in the set of criteria are the value of the net equity under management of each institution in each investment funds category. The criteria weights were generated according to the volume of the total net equity under management in each category. In addition, a sensitivity analysis was performed to allow knowing how much the ranking established by using TODIM was changed given a change in criteria weights.

Before implementing the TODIM method, the results presented by the ANBIMA ranking of June 2017 were analysed. This ranking's first ten places were used as alternatives to implement the TODIM method and, with that, generate a ranking that complements the ANBIMA ranking. Comparing the ranking established by the TODIM method with the ANBIMA ranking of June 2017 the alterations of the positions in most of the alternatives can be observed. These alterations occur due to the fact that each ranking is obtained by different methodologies. By observing the net equity under management of the institutions in the investment funds categories, it can be noticed that in many cases the algebraic sum is not able to measure their characteristics appropriately. Since the TODIM method is based on a comparison pair by pair between alternatives and measures in a distinct way the positive and the negative results from subtracting the performances of those pairs, it becomes an option to classify the analysed entities of the ranking for being able to appropriately measure the characteristics of the cases in which a simple algebraic sum is not able to reflect these features in its results.

Thus, the resulting methodology is theoretically sound and provides meaningful results when applied to the ANBIMA ranking data. However, it is important to observe that both rankings are capable of generating information regarding the content analysed in the ranking. Each stakeholder should perceive which ranking is capable of generating relevant information to support his/her decision making. This fact will be connected to the type of information each stakeholder seeks. In this regard, it can be concluded that the ranking obtained by the TODIM method was able to appropriately calculate the cases not measured by the total sum and that both rankings are important sources of information to the market and should be observed by all of those who are interested in them.

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