


BEHAVIORAL FINANCE: EMPIRICAL EVIDENCE USING MAGIC FORMULA IN THE BRAZILIAN STOCK MARKET¹


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ABSTRACT

Purpose: Explain the causes of inefficiencies in asset pricing on the Brazilian stock exchange through the behavioral finance hypothesis.

Originality/value: Research made in the stock market over the last decades suggests that there is evidence of obtaining returns above the market average, through the purchase of undervalued assets, that is, when it has a low relation between the price and the fundamentals of the company. However, there is a notable discrepancy regarding the interpretation of causes among academics. The efficient markets hypothesis was presented, which is based on the premise of the strict rationality of economic agents. On the other hand, the behavioral finance theory was also discussed, which presents different assumptions.

Design/methodology/approach: Using the historical quotes of the shares traded on B3, extracted from economática®'s database, the present work used the Magic Formula methodology to investigate the behavioral effect through the inefficiencies found in the pricing of these assets.

Findings: The results suggest that the Brazilian stock market, in conformity with works of the same nature performed in markets in other countries, has inefficiencies in the pricing of assets, so that it is possible to obtain advantages from economic agents. The interpretation for the causes of such inefficiencies is based on the premises of behavioral finance, and points to the existence of a limitation in the rationalization of these agents.

KEYWORDS

Behavioral finance. Magic Formula. Pricing. Overreact. Efficient market hypothesis.

1. INTRODUCTION

The discussion regarding the predictability of returns above the market average has been the subject of various researches over the past few decades. One of which is the value strategy, which has been tested for a long time and has numerous evidence in its favor. Such confirmations have been generating a great discussion about the causes, however, there is no consensus among academics (Thaler, 2019).

The interpretation of the Efficient Markets Hypothesis (EMH) was questioned by such evidence. The behavioral finance appeared with different interpretations of the causes of this evidence. Therefore, new explanations were necessary to maintain the EMH (Fama & French, 1993).

The present work sought, in the same way, to find such evidence, through the application of the Magic Formula methodology (MF), created by Greenblatt (2007), which has the same foundations (value) of methodologies present in other works utilizing, however, other parameters. This method was applied based on the assets of the Brazilian Stock Exchange (Brasil, Bolsa, Balcão [B3]) in the period from 1999 to 2018. From that, answers to the recurrent questions were sought through the theory of behavioral finance.

The main objective is to find evidence to support the behavioral finance theory, by obtaining consistent returns above the market average, countering the total rationalization assumptions and the impossibility of inefficiencies in asset pricing.

In order to develop the proposed study, this text is divided as follows: after this introduction, section 2 discusses the theoretical foundations of the topics covered, in which the main author involved was cited; in section 3, the methodological procedures adopted are described, followed by section 4, in which the results of the research are presented and discussed. Finally, section 5 presents the final considerations of the study.

2. THEORETICAL FRAMEWORK

The great premise of Fama (1965, p. 34) was that market pricing was random and, therefore, “past prices cannot be used to predict the future”. For such behavior, the author gave it the title Random Walk. The discussion had already started in Bachelier (1900). However, his claims were ignored for years. It was only in Samuelson (1965) and Mandelbrot (1966) that the relationship of randomness in asset pricing started to be associated with

the fact that the market always reflects the real values of the assets. More clearly, “In competitive market there is a buyer for every seller. If one could be sure that a prices will rise, it would have already risen” (Samuelson, 1965, p. 41). The acquired information is efficiently incorporated into the asset price. This concept is the basis of EMH.

According to Barberis and Thaler (2003), this assumption, which they call “the prices are right”, departs from the use of models in which economic agents are considered “rational”. By rationality, it is understood that, when these agents receive new information, they incorporate it in their analyzes in a “correct” way, that is, it is assumed that these agents make decisions rationally in accordance with the same utility function, in other words, all seek to optimize values.

Markowitz (1952), when presenting his hypotheses for portfolio optimization, considers that economic agents seeks to compensate for the risk when seeking returns, and this is based on expected utility functions. Thus: “[..]we assume that the investor does (and should) act as if had probability beliefs concerning these variables” (Markowitz, 1952, p. 81). The author also states that the paper did not consider the way in which investors form these probabilistic assumptions. There is a clear need to develop a reasoning that fills these gaps, that is, the causal relationships that explain the behavior of investors. Such causality could affect the direction the works took. By changing the premises, the results are supposed to change, and it is at this point, in the fundamentals on which the EMH is based that the behavioral finance theory raises its questions.

Fama (1965) confirms the same risk-return relationship as Markowitz (1952): the diversification as an adjustment to risk. The reasoning is as follows: if asset pricing follows a random movement and, therefore, asset prices at any time are the best estimate of their real value, there is no need for a supposed investor to worry about finding out if an asset is priced incorrectly. In this case, the investor’s only concern should be the analysis of the portfolio regarding risk. Risk, in this sense, is understood as the standard deviation of the price of each asset in relation to its past average (Fama, 1965). Thus, the investment must optimize by diversifying the amount to be invested between a certain number of shares.

It is reinforced that behavioral finance seeks, first of all, to question the fundamental point to which the logic of EMH derives, that is, the consideration that there is strict rationality in search of optimization (Simon, 1956; Barberis & Thaler, 2003). Simon (1956) and Arrow (1986) indicate a limitation of rationality in human decisions.

The analysis set forth here casts serious doubt on the usefulness of current economic and statistical theories of rational behavior as bases for explaining the characteristics of human and other organismic rationality. It suggests an alternative approach to the description of rational behavior that is more closely related to psychological theories of perception and cognition (Simon, 1956, p. 10).

To a great extent, if it were possible to find evidence of irrationalities in the financial market itself, such a discovery would have the greatest impact, since it is where it is believed that there is greater efficiency in the incorporation of the information in prices. For behavioral economists, it would be the way for their work to gain greater prestige (Thaler, 2019).

For that, the possible forms of tests should contradict the postulates of Fama (1969), better saying, the three ways of pointing out the efficiencies of the market.

- *The weak form*, which questions how much current prices reflect the behavior of past prices, such assumption is the Random Walk theory.
- *The semi-strong*, which investigates whether prices “fully reflect” published information, that is, whether there are no discrepancies between prices and their intrinsic value that would generate consistent returns if identified.
- *The strong form*, which aims to have higher returns if there is any monopoly of the information, in other words, the information is only available to some.

The application of the MF methodology in this study aims to question the semi-strong form of EMH, as it uses published financial information in order to obtain superior returns in a consistent and statistically relevant way.

2.1 Representativeness heuristics

The behavioral bias that will be taken as a possible explanation for the results of this work, as in De Bondt and Thaler (1985), and Barberis, Shleifer and Vishny (1998), will be the Representativeness Heuristic by Kahneman and Tversky (1973). The definition of heuristics refers to the process by which people discover something for themselves, usually through trial and error. It can also be understood as approximate calculations based on experiences, also known as “rules of thumb” and mental calculations, which sometimes come close to providing the correct answer (Shefrin, 2002).



Representativeness heuristics are understood as intuitive predictions that follow a judgment. These, in turn, are not sensitive to reality, evidence or the previous probability of the result, in violation of the logic of statistical forecasting. In this way, people wrongly predict extreme events and exaggerated values (Tversky & Kahneman, 1974). For Shiller (2015), it is the way in which some family situations are used to make judgments, therefore, assuming that future patterns are similar to those from the past, without even reflecting on the reasons for such patterns having occurred.

According to De Bondt and Thaler (1985), individuals tend to place more emphasis on recent information and ignore the pattern that previously existed about some factors, thus making decisions that have a statistical weight to support such speculations.

In short, the effort in applying the method was to demonstrate that, when buying an asset-based on published information, it was priced incorrectly. As such, evidence is made explicit in the returns that are substantially obtained when buying such shares, that is, within one year, with gains much higher than the stock market index.

2.2 Magic Formula

The value strategy consists of buying shares that have a low price in relation to profits, dividends, historical prices, shareholders' equity and other fundamentals of companies, with the objective of obtaining returns greater than the market index. Thus, a low ratio between stock price and these parameters is known as "value", and a high ratio is known as "growth". Similarly, the MF strategy, proposed and tested by Greenblatt (2007), presented returns above the market average, countering the HME argument, in other words, that it is not possible to obtain returns that are higher than the market in a consistent manner.

Graham and Dodd (1934), and Graham (1949), as well as Dreman (1982) had already evidenced the possibilities of obtaining these returns and argued about the psychological influences that affected the market, thereby distorting prices in the short term. They argue that, in the long run, there would be a behavior of regression to average, such behavior compelled by the fundamentals of the companies. Thus, if an investor trusted these fundamentals and not the price forecast, it would be possible to obtain advantages, that is, with great patience, but trusting the method.

Joel Greenblatt, author of the methodology that will be applied here, is based on the work of Graham and Dodd (1934), not only as a theoretical



basis, but using it as an investment philosophy of the assets under his management.

In a practical way, in Buffet (1984), the superior returns achieved by adherents of the philosophy of Graham and Dodd (1934) are exposed. These “value investors” are constantly looking for discrepancies between stock values and prices. Thus, these investors necessarily focus on the fundamentals of companies as a precondition for making investment decisions and seek, through a deeper analysis, independent thinking, against the extravagances that the market imposes in the short term. If a company has been profitable for years, it has to do with its own qualities, in other words, its competitive positioning, its business model, management, organizational culture, competitive advantages with suppliers and customers, among other factors that culminate in the production of cash. Eventually, there may be setbacks or advantages that decrease or increase an investor’s expectations and, thus, make this investor incorporate those expectations into asset prices. Such variations do not necessarily affect the company’s real ability to produce value over time, so that, according to the authors, there may be great buying opportunities. The logic of their investment thesis is in the fundamentals of the companies, not in the stock market prices (Buffet, 1984).

As it is not possible to know exactly the future cash flows, as well as the amount of dividends that will be distributed, the best thing to do is to seek greater discrepancies, in other words, the greater the value of the fundamentals in relation to the price, the greater the protection against price volatilities traded on the stock market, what Graham and Dodd (1934) and Graham (1949) call “Margin of Safety”. Again, it is noteworthy that these consider psychological pressure as the reason for these discrepancies. In this way:

If we speak frankly, we have to admit that our basis of knowledge for estimating the yield ten years [...] amounts to little and sometimes to nothing [...] the market will be subject to waves of optimistic and pessimistic sentiment, which are unreasoning and yet in a sense legitimate where no solid basis exists for a reasonable calculation (Keynes, 1985, pp. 110–113).

As soon, the best thing to do would be to buy assets priced with a large discrepancy. According to the behavioral finance assumptions, these fluctuations do not match the company’s real capacity to produce value, as they are influenced by human behavioral biases. If it were possible to take advantage of this, the market would offer the opportunity. This motivated the following studies, which, through empirical tests, report such advantages.



Basu (1977) obtained evidence that the stock returns of companies that had a low price-to-earnings ratio⁴ were higher than that of companies that had a high Price-to-earnings ratio. This study was very relevant, which motivated further research.

The publication by De Bondt and Thaler (1985) sought, in addition to showing such returns, to offer an explanation through behavioral biases, as discussed below. The test consists of the elaboration of two portfolios, the first has shares with the last 10% lowest returns in the last 36 months, and the other one has shares with the 10% highest returns in the same period. Thus, the return of each of the portfolios is evaluated in the subsequent 60 months. The result obtained shows that the first portfolio, or that of the “losing stocks”, obtains a return of approximately 30%. For the second portfolio, that of “winning shares”, the result is the reverse, with a loss of 10%.

The authors explain that investors who rely on the heuristics of representativeness become overly pessimistic about the losing stocks of the past, as well as overly optimistic about the profitable stocks of the past, which causes the price of these stocks to deviate from their fundamental values. Consequently, the losing stocks of the past are underestimated, while the winning stocks of the past are overestimated. “But mispricing is not permanent. Over time, the mispricing corrects itself. Then losers will outperform the general market, while winners will underperform” (Shefrin, 2002, p. 34).

Still, other studies have evidenced other relationships with the same intention. Banz (1981) proposed that there is a “size effect”, that is, the shares of smaller companies obtained higher returns risk-adjusted, on average, than the larger companies, in the period between 1936 to 1977. Fama and French (1993, 1996) and Lakonishok, Shleifer, and Vishny (1994) made comparisons in the same way, but using other indicators: book-to-market and earnings-to-market, or cash flow-to-market¹, and obtained strong evidence of superiority in the returns of value portfolios. Chan, Hamao, and Lakonishok (1991) also showed such returns using four variables: book-to-market, earnings-to-price, cash flow-to-price⁵ and company size. In the same way, Piotroski (2000) tested the variable book-to-market in conjunction with other fundamentalist indicators and also found that there were higher returns.

⁴ The price-to-earnings ratio is seen as a form of valuation in which you can quickly measure how much the company offers a return on an investment, dividing the stock market price of a considered company by its earnings per share. The price-to-earnings ratio has its imperfections, however, it is the most widely reported and used indicator for value assessments by professional investors (Gitman, 2010).

⁵ Book-to-market: book value (adjusted in some cases) in relation to the market value; Earnings-to-price: the company’s earnings per share in relation to the stock price; Cash flow-to-price: cash flow per share in relation to the stock price.

Value stocks have higher returns than growth stocks in markets around the world. For the period 1975 through 1995, the difference between the average returns on global portfolios of high and low book-to-market stocks is 7.68 percent per year, and value stocks outperform growth stocks in twelve of thirteen major markets (Fama & French, 1998, p. 1975).

Despite Fama and French (1998) confirm that there are such possibilities for higher returns, the interpretation given by these authors is that there would be an adjustment for risk, and this would no longer be measured by volatility. After all, value shares outperformed growth shares with consistent risk-adjusted returns. Thus: “Many continue to use the Sharpe-Lintner one-factor model to assess portfolio performance and cost of capital despite the lack of evidence” (Fama & French, 1993, p. 54). The authors state, based on their 3-factor model, that risk is now associated with the company’s “best” or “worst” fundamentals. For example, the size effect, already presented, produces higher returns because smaller companies run greater risks. In this way, EMH could explain the “inefficiencies” found. However, for Thaler (2019, p. 239): “there is no evidence that a portfolio of small firms or value firms is observably riskier than a portfolio of large growth stocks”.

In the same way, a value test in Barberis et al. (1998) state that there are two ways in which investors react to information: underestimating and overestimating, that is, overreacting. The market underestimates new information that is less extreme or salient, despite its greater statistical weight. In this way, investors do not incorporate this information immediately into the pricing of assets, but rather, over a 12-month period. Thus, this information is slowly taken into account, and so, it is possible to obtain advantages. In contrast, evidence of overreaction shows that, over longer periods, from three to five years, stock prices are overestimated in the same sense as the information. That is, “securities that have had a long record of good news tend to become overpriced and have low average returns afterwards” (Barberis et al., 1998, p. 308). Putting it differently, the shares that obtained good subsequent evaluations receive increasingly better evaluations, that is, they are exaggeratedly priced, so that they end up obtaining low performance after a period of over reaction because their prices do not justify the profits, which makes these prices fall back to the average later. The authors used Tversky and Kahneman’s (1974) representativeness heuristic to explain the effect of investors’ reaction to information.

Similar to the studies presented, which demonstrate superior returns for the purchase of depreciated assets, that is, value stocks, the application of

Greenblatt's MF (2007) obtained, for 17 years, an annual return of 30.8%. In comparison with the same period, the average return of American shares was 12.3% per year. These actions were selected from a list of 3,500 stocks, using two metrics similar to others used in the works mentioned previously.

Olin (2011) tested the MF on the Finnish market between 2000 and 2009 and obtained annual returns from 9.4% to 20%, varying according to the choice of the sale date. The Finnish market index in the same period returned 3.5% per year. Zeidler (2014) applied the methodology to the Brazilian market and obtained a return of 27.7% per year for the worst portfolio considered, between the years 2002 and 2009. The market in the same period obtained an annual return of 14.1%.

The rationale justification for the functioning of the MF is in line with the central subject of this study. According to the author, the investor's behavior, the emotions that are part of the asset pricing process, "is still my favorite explanation" (Greenblatt, 2007, p. 45). The challenge is to identify whether the methodology that obtained positive results in other countries would apply to the Brazilian stock market, and to offer an interpretation of the possible causes from the hypotheses of behavioral finance.

3. METHODOLOGY

The methodology that was applied sought, through statistical analyzes, to provide evidence for the assumption of human behavior in financial decisions. The method can also be characterized as inductive, as it starts from particularities and generalizes the responses. However, it is limited to offering only likely conclusions. In this sense, "the explanations obtained through the use of the statistical method cannot be considered absolutely true, but have a good probability of being true" (Gil, 1999, p. 35).

The sample period considered was 20 years. For each company of B3, in the period from 1999 to 2018, the data required were the following:

- price variation of each asset for 12 months after the purchase date⁶;

⁶ The first day after the deadline for disclosure of the annual financial reports of companies listed on the stock exchange. In this case, for annual reports, there are three months: from December 31, therefore, to the last week of March and 45 days from the release of the quarterly data. The objective is to eliminate the "look-ahead-bias" effect, as in Olin (2011) and Zeidler (2014). Such effect occurs when data or information are considered, although it had not been disclosed on the date considered by the study.

- EV/Ebit referring to the twelve months prior to the beginning of the formation of the portfolio⁷;
- Roic referring to the twelve months prior to the start of the portfolio formation;
- market value.

For each year, four purchase dates were considered⁸, that is, four portfolios were formed per year⁹. For each date, three types of portfolio were formed. For each type of portfolio, a filter was also used, which resulted in three more portfolios: one for companies with market value below BRL 1 billion, another one for companies with market value above BRL 1 billion; and another one covering all assets. In total, there were 693 data for the formation of nine averages that were compared with the Ibovespa index for the same periods for 12 months, data used for the formation of Figure 4.1.1.

The number of companies chosen depended on the availability of the parameters requested by MF by Greenblatt (2007), in the database used.

The effort was to extract the largest number of possible companies available in the Economatica® database, in order to obtain the greatest possible precision in the analysis. Other studies used other databases. For example, Zeidler (2014) applied the MF methodology to the Brazilian stock market. However, he used the Bloomberg terminal database.

The variables that were used in this study are described below.

EV/Ebit: The ratio between enterprise value (EV) and earnings before interest and taxes (Ebit). EV represents the company's market value, plus net debt; and Ebit is the company's profits prior to the payment of interest and fees, thus explaining only the profitability of the operation.

According to Greenblatt (2007), the EV/Ebit ratio was used instead of the P/E, since the first takes into account not only the market value paid by the shareholders, but also the amount of debt utilized by the company to finance its operations, which "allows companies with different debt levels and different tax rates to be placed equally [...]" (Greenblatt, 2007, p. 148). It is usually the Ebitda indicator for many analyzes instead of Ebit. However, Ebitda does not subtract non-cash expenses, like depreciation and amortiza-

⁷ The data used to classify the securities as suitable or not for purchase refer to the year prior to the choice of the asset. For example, the portfolio formed in April 2010 will have the annual company data for December 2009 as a choice criterion.

⁸ Except for 2018, when only one purchase was considered, which ended on March 31, 2019.

⁹ For 12 months only.

tion, which, according to the author, could cause distortions, after all, it disregards a possible high cost for Capital Expenditures (Capex). The Ebit, in contrast, is likely closer of the reality.

- Returns on invested capital (Roic): the ratio of the Ebit, previously exposed, and the total capital invested, in the case of third party capital (debt) and equity.

According to Olin (2011), the MF idea is to find stocks that are “cheap” and “good”. Stocks are cheap when EV/Ebit is low. The interpretation of this is that the amount invested will give a return more quickly taking into account the profitability based on the company’s Ebit. Shares are “good” when the Roic is high, demonstrating that the capital invested to finance its activities is being used well, in order to produce a certain amount, which represents a return for both equity and third parties.

Figure 3.1, provides an example of how assets were ranked each year. It is observed that the column “Ranking MF” was built from the sum of the other two columns, “Ranking EV/Ebit” and “Ranking Roic”. These, in turn, were formed from the ranking of the columns “EV/Ebit” (the smaller, the better positioned in the EV/Ebit ranking) and “Roic” (the higher, the better positioned in the Roic ranking).

(Figure 3.1)

CONSTRUCTION OF THE RANKING MF

Name	EV/Ebit 12.31.1999	Roic Dec. 99	Ranking EV/Ebit	Ranking Roic	Ranking MF	Closure 04.03.2000
Eternit	1.36	36.30	2.000	1.000	3.000	BRL 10.56
Bunge Brasil	2.00	22.85	4.000	4.000	8.000	BRL 0.85
Oxiteno	1.65	20.44	3.000	6.000	9.000	BRL 10.00
Fertibras	2.76	20.18	10.000	7.000	17.000	BRL 6.05
Biobras	2.00	15.36	5.000	12.000	17.000	BRL 3.68
Magnesita	1.06	13.86	1.000	16.000	17.000	BRL 0.00
Pirelli Pneus	3.82	27.25	16.000	2.000	18.000	BRL 5.30
Petroflex	2.74	16.02	9.000	10.000	19.000	BRL 2.70
Bunge Fertiliz.	3.10	19.23	12.000	8.000	20.000	BRL 0.04

Source: Elaborated by the authors.

From the formation of the ranking, three portfolios were built. One contained the first five assets of the “Ranking MF”, the other one contained the first ten assets and, the last one contained the first 30 assets. Each asset had the same weight in the portfolio, initially, so that the total return of the portfolio was the arithmetic average of the return of all assets that comprise it in each period considered, therefore, there were no readjustments with respect to the variability of each asset over the period.

Greenblatt (2007) suggests buying the first 30 assets, that is, the best MF shares in the ranking. Zeidler (2014) built portfolios with five, ten and 15 best and worst positions. The present work used the five, ten and 30 first companies for analysis. Financial companies, including insurance companies, were excluded due to differences in the accounting of balance sheets, mainly with regard to debt levels (Greenblatt, 2007).

The annual return for levels of comparison and subsequent descriptive analysis was measured using the geometric mean. Algebraically, the expression is as follows:

$$\bar{X}_g = \sqrt[n]{\prod_{i=1}^n x_i}$$

in which:

n = number of periods considered;

X = return of each period.

The return on the first period of a portfolio was multiplied by the return of the second period; this, in turn, was multiplied by the return of the third period and so on, always respecting the number of assets, in order to obtain the total profitability of the period for each type of portfolio (five, ten or 30 assets), in an effort to simulate investments made over the years (backtest). Then, the geometric average of this return was obtained, as represented above, which allows us to visualize the compound annual growth rate (CAGR), that is, the annual rate with which this investment obtained a return, as in Olin (2011).

The T-Test was applied, in order to derive the difference between the means. The test sought to present how statistically significant the results are. In a practical way, how much the returns of the MF portfolios were higher than the returns of Ibovespa, and this at a significance level of 5% ($\alpha = 0.05$). For comparison purposes, the one-tailed p-value that the tests provided was used.

Therefore:

$$H0: \mu_1 \geq \mu_2$$

$$H1: \mu_1 < \mu_2$$

in which:

μ_1 = average annual return Ibovespa;

μ_2 = average annual return on MF portfolios.

Algebraically:

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

in which:

\bar{X}_1 = sample mean of the annual returns of Ibovespa;

\bar{X}_2 = sample mean of the annual returns of the MF portfolio;

S_1^2 = sample variance of the annual returns of Ibovespa;

S_2^2 = sample variance of the annual returns of the MF portfolio;

n_1 = numbers of items of the annual returns of Ibovespa;

n_2 = numbers of items of the annual returns of the MF portfolio.

In order to improve the descriptive analysis of the results obtained, other parameters were also made available, as presented below:

- *Standard deviation* (σ): Standard deviation is an important variable, both for statistical treatment and for the calculation of other indicators that were later used for descriptive analysis. It is worth mentioning that this measurement is commonly associated with risk, as it indicates greater or lesser variability in asset prices. The solution is to form a portfolio that seeks to obtain the best combination of assets of different variability, thus, standard deviations (Markowitz, 1952), although the real effectiveness of such measures of variability in risk qualification has already been questioned, as previously presented, and more specifically in Buffet (1984).

- *Beat*: Indicator showing, in percentage terms, how many times the MF portfolio exceeded the Ibovespa index over the sample period considered (20 years).
- *Sharpe ratio*: Measure commonly used for comparisons between portfolios and, as a result, to assess the ability of managers to balance the risk-return ratio, with risk understood as volatility of returns. The metric allows analyzing how much a return exceeds, in this study, the Brazilian risk-free asset (Selic), and whether this difference is compensated by the risk. Risk is understood as volatility, as already exposed (standard deviation). Sharpe (1966) proposed this metric, motivated by the impossibility of identifying assets priced incorrectly so that it is not possible to obtain returns above the market average. To this end, the author is based on the theory of Random Walk, and adds: “In a perfect capital market, any properly diversified portfolio will be efficient; the mutual fund manager must select from among alternative diversified portfolios the one with the appropriate degree of risk.” (Sharpe, 1966, p. 46).

Mathematically:

$$S = \left(\frac{R_c - R_f}{\sigma_c} \right)$$

in which:

R_c = average annual returns of the MF portfolio;

R_f = risk free asset (Selic);

σ_c = standard deviation of annual returns of the MF portfolio.

- *Sortino Ratio (T)*: This indicator, also used in Davyclov, Tikkanen and Äijö (2016), differs from the Sharpe indicator by its denominator. Using standard deviation to measure risk penalizes positive returns, which should not be treated in the same way, since, in practice, obtaining returns above a chosen benchmark should not be considered a risk. Therefore, it is considered only the standard deviation of the periods in which the return did not reach the benchmark, which in the present work was the risk-free Brazilian asset, Selic. (Estrada, 2006).

Mathematically:

$$T = \left(\frac{R_c - R_l}{\sigma_{neg}} \right)$$

in which:

R_c = average annual returns of the MF portfolio;

R_l = risk – free asset (Selic);

σ_{neg} = standard deviation of annual returns of the MF portfolio below risk – free asset.

Then:

$$\sigma_{neg} = \sqrt{\frac{1}{n} \sum_{R_c < R_l} (R_c - R_l)^2}$$

4. RESULTS AND DISCUSSION

At first, the data obtained with the application of the MF methodology are presented, as detailed previously. Subsequently, a descriptive analysis will be offered for each relevant piece of information.

4.1 Result presentation

In order to facilitate understanding and comparison, Figure 4.1.1 below presents all the values resulting from the application of the method and the details presented in the methodological procedures. Therefore, it includes the application of MF for data from the last 20 years, with four portfolios formed per year, taking into account investments valid for 12 months.

(Figure 4.1.1)

MAGIC FORMULA 12 MONTHS

	All assets			Bellow 1 bi (market cap)			Above 1 bi (market cap)			Ibov
Portfolio	5	10	30	5	10	30	5	10	30	Index
CAGR	23.39%	24.68%	25.09%	24.38%	28.97%	27.36%	18.81%	18.10%	15.58%	11.25%
Average	30.07%	31.12%	29.77%	33.85%	37.65%	34.64%	22.52%	21.29%	18.13%	14.71%

(continue)

(Figure 4.1.1 (conclusion))
MAGIC FORMULA 12 MONTHS

Portfolio	All assets			Bellow 1 bi (market cap)			Above 1 bi (market cap)			Ibov
	5	10	30	5	10	30	5	10	30	Index
σ	44.71%	43.31%	35.47%	51.30%	49.81%	46.40%	30.65%	28.05%	24.52%	28.45%
<i>p-value</i>	0.0064	0.0033	0.0022	0.0026	0.0003	0.0009	0.0530	0.0769	0.2149	-
Beat (%)	70.13%	70.13%	77.92%	64.94%	76.62%	74.03%	64.94%	63.64%	59.74%	-
Sharpe	0.362	0.398	0.448	0.389	0.477	0.448	0.282	0.264	0.174	0.030
Sortino	0.781	0.904	0.971	0.773	1.112	1.119	0.468	0.418	0.228	0.033

Source: Elaborated by the authors.

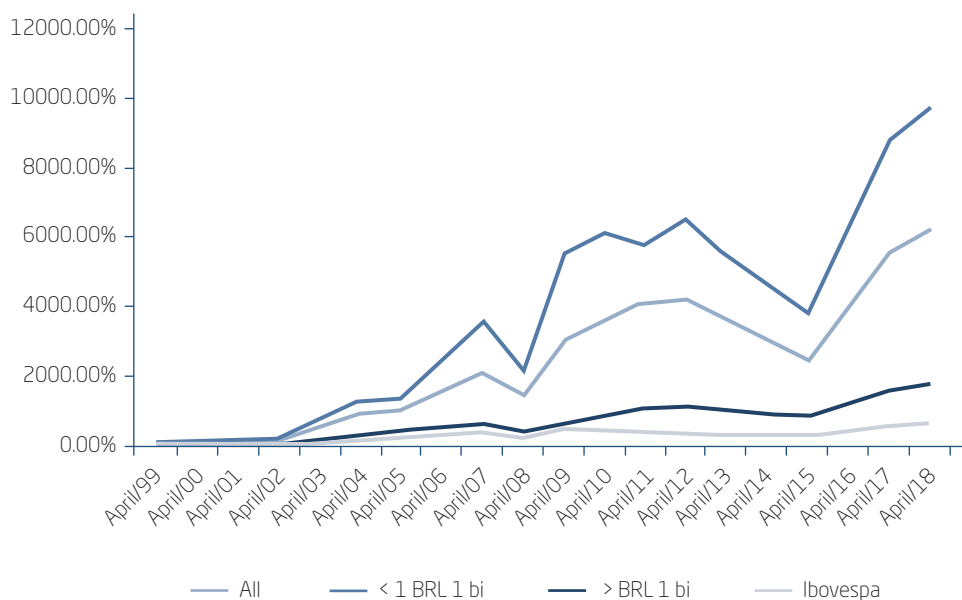
As in Zeidler (2014), all portfolios showed CAGR higher than Ibovespa. However, portfolios containing five, ten and 30 best stocks of the MF portfolio with a market value above BRL 1 billion do not have a 5% significance level to reject the null hypothesis.

The portfolio containing the ten and 30 best stocks of the MF portfolio with a market value below BRL 1 billion was the one with the highest CAGR, that is, the geometric mean, as well as the highest arithmetic mean, and is at a significance level of 5%, with p-value of 0.03% and 0.09%, respectively. In addition, both obtained a Sharpe and Sortino indexes substantially higher than the Ibov index, indicating a higher return and less risk, something contradictory in the conception of EMH, however, dispensable for some investors (Greenblatt, 2007). The beat indicator indicates that in 77 times (purchases), portfolios outperformed the market 59 and 57 times, that is, 76.6% and 74%, respectively.

The portfolio with the lowest return was composed of the 30 best stocks of the MF portfolio with a market value above BRL 1 billion. It exceeded the Ibov, although it did not obtain the required statistical significance (5%). The Sharpe and Sortino indices still had a large advantage over the Ibov, although if a level of significance of 10% were considered, portfolios containing the five and ten best stocks would have their averages statistically significant.

Among all portfolios, Ibovespa had the lowest CAGR; lower arithmetic mean together with greater deviation coefficient, thus, greater variability as a function of the mean; substantially lower Sharpe index, indicating greater risk; an equally inferior Sortino index, indicating even greater risk, considering the variation below the risk-free asset.

(Figure 4.1.2)
REINVESTED RETURNS



Source: Elaborated by the authors.

Figure 4.1.2 illustrates the returns for each of the portfolios if these assets were reinvested every 12 months, functioning as compound interest. We opted to use the MF portfolios with the first 30 shares, for demonstration.

The superiority obtained in the long term is remarkable, mainly in relation to Ibovespa, in such a way that considering the risk by the way it has always been considered, that is, by the volatility, becomes unnecessary; after all, in the long term, we obtain superior profitability, thus ignoring the path taken (Greenblatt, 2007). Even so, other studies, already published, portrayed more precisely that such returns still exist even if they are risk-adjusted, that is, measures of statistical dispersion.

The best way, therefore, to explain such possibilities of returns, in the long run, would be to admit the emotional elements that in the short run dominate investors' expectations, but which in the long run are perceived by the market, thus, functioning as a regression to the average, what was even more accurately portrayed in other studies already mentioned, but that would escape the focus of the present work. Thus, this volatility does not matter, as the price paid has been low, a fundamental argument of MF (Greenblatt, 2007).

(Figure 4.1.3)
COMPARISON BETWEEN THE BEST AND WORST STOCKS

Nº de ativos da carteira	All					< 1 bi					> 1 bi					IBOV
	5	10	30	5	10	30	5	10	30	5	10	30	5	10	30	
Average	15.98%	20.06%	16.27%	27.23%	22.55%	24.07%	8.13%	7.39%	13.46%	14.71%						
CAGR	7.46%	11.22%	8.81%	13.50%	13.40%	15.57%	1.84%	1.45%	9.70%	11.25%						
Average	30.07%	31.12%	29.77%	33.85%	37.65%	34.64%	22.52%	21.29%	18.13%							
CAGR	23.39%	24.68%	25.09%	24.38%	28.97%	27.36%	18.81%	18.10%	15.58%							
Average	39.15%	39.85%	32.62%	47.59%	42.48%	49.43%	11.33%	21.78%	26.86%	27.51%						
CAGR	10.78%	11.45%	7.75%	10.95%	11.00%	12.01%	1.09%	5.46%	9.59%	9.89%						
Average	59.93%	63.11%	61.26%	73.99%	73.39%	80.05%	39.78%	44.00%	37.58%							
CAGR	20.27%	21.23%	21.09%	20.37%	22.49%	25.30%	14.76%	16.56%	14.36%							
Average	54.00%	133.74%	73.37%	209.31%	138.91%	99.18%	26.91%	38.15%	43.80%	45.66%						
CAGR	10.48%	15.42%	12.53%	14.80%	17.29%	18.13%	5.00%	7.91%	10.93%	9.89%						
Average	77.55%	93.75%	95.97%	110.80%	106.39%	118.84%	74.66%	78.68%	62.03%							
CAGR	13.27%	15.54%	17.68%	16.76%	19.06%	22.82%	13.91%	16.43%	14.54%							
Average	88.72%	60.78%	83.73%	79.40%	89.43%	116.24%	29.63%	44.84%	63.41%							
CAGR	12.48%	8.03%	11.75%	7.25%	11.69%	15.00%	4.57%	6.89%	11.83%	9.92%						
Average	141.41%	118.40%	137.98%	102.92%	125.96%	159.32%	156.63%	134.44%	90.30%							
CAGR	17.12%	15.92%	18.05%	14.25%	16.50%	19.49%	17.65%	17.21%	14.41%							

(continue)

Figure 4.1.3 (conclusion)

COMPARISON BETWEEN THE BEST AND WORST STOCKS

	All						< 1 bi			> 1 bi			IBOV
	5	10	30	5	10	30	5	10	30	5	10	30	
Nº de ativos da carteira	127.70%	91.72%	94.16%	108.98%	113.68%	143.91%	54.10%	71.36%	90.80%	90.62%			
Average	127.70%	91.72%	94.16%	108.98%	113.68%	143.91%	54.10%	71.36%	90.80%	90.62%			
Worst	CAGR	13.17%	10.25%	9.10%	8.96%	10.87%	6.37%	7.90%	11.26%	10.47%			
5 years	Average	134.85%	143.32%	179.87%	137.51%	167.58%	232.76%	166.99%	109.74%				
Best	CAGR	13.52%	14.24%	16.90%	14.08%	15.99%	20.29%	14.95%	13.17%				

Source: Elaborated by the authors.

It is possible to notice in Figure 4.1.3 one more way to confirm the superior pattern of “value” stock returns, whose percentage is higher for all types of portfolios. Thus, the best-positioned shares in the MF Ranking (best), therefore, the “good” and “cheap” shares, obtained higher returns in relation to the last ranked shares in the MF Ranking (worst), which have larger multiples. “Value” stocks, for some reason, are ignored in the short term, creating advantages for investors who purchase them (Shefrin, 2002), and waits for indications of market inefficiency.

The results obtained in the MF portfolios not only obtained expressive superiority in terms of returns, but also in comparison to the risk accepted. Other works: De Bondt and Thaler (1985), Basu (1977), Davyclov et al. (2016), Lakonishok et al. (1994), Piotroski (2000), Zeidler (2014), and Fama and French (1993), among others, also showed higher risk-adjusted returns. Thus, the application of the proposed method indicates that it is not possible to reject the alternative hypothesis, in other words, the data suggest the possibility of obtaining returns above the market average, as proposed by the aforementioned studies.

A possible interpretation is given by the representativeness bias, as in the study by Barberis et al. (1998) and De Bondt and Thaler (1985). Thus, in the face of the new information published, allegedly, there is reaction on the part of the economic agents, who divert the decision from total rationality. In other words, behavioral biases induce these investors to overreact to salient events, being emphatic about some pieces of information and less about others. By exaggerating, they create space for the purchase or sale of securities at prices that do not correspond to the real position of the company behind this security. Higher returns are possible for those who wait for the created discrepancy to return to its mean, that is, to its intrinsic value: “[...] how can the 10% to 11% per year in extra returns on value stocks over glamour stocks have persisted for so long?” (Lakonishok et al. 1994, p. 1574). Such a rhetorical question induces to the hypothesis that the market is inefficient, at least in parts.

5. CONCLUDING REMARKS

In short, the assumptions suggested by behavioral finance consider that the results of analyzes made by rational agents may suffer psychological biases, and this is due to the very human characteristic of having emotions limiting the mind to act only in a rational way. It follows that the unpredictability of factors that affect the income of companies in the future, influencing



investor expectations, and the psychological action that has an effect on the rationalization of these investors, create distortions of the real price of the asset, creating space for obtaining advantages.

The methodology in the present study sought to evidence whether such advantages exist, corroborating the syllogism of the behavioral finance theory, although not in an unprecedented way, since works of this nature are widely known.

It is worth mentioning that, according to Thaler (2019), there is still no consensus on the interpretation of the causes of the superior returns found here, so that the investigations must continue, and thus, there is no intention to create a model that makes predictions, let alone that they could be correct. However, Fama (1998) concludes that the fact that there are exaggerated and underestimated reactions is an indication of efficiency: “[...] anomalies are chance results, apparent overreaction to information is about as common as underreaction [...]”.

Considering, however, that human behavior is changeable and unstable, the patterns of these results are unlikely to occur, or at least to occur in a precise way, which makes it impossible, so far, to create an acceptable model. An alternative would be to look for evidence from radical behaviorism, that is, the existence of the Operant Conditioning mechanisms (Skinner, 1953 [2003]).

Thus, it could be evidenced that changes in the environment produce stimuli that generate responses on the part of agents, and thus, through positive and negative reinforcements, the existence of a reaction mechanism by individuals that can reveal patterns in behavior. More specifically, the stimuli that investors receive from the market, that is, price variations, generate a response from them. This response can be reinforced or punished by upward or downward trends, financial cycles, positive or negative results of companies, thus, shaping a behavior. It is worth mentioning that the changeability of the environment is taken into account in the theory of radical behaviorism, so that the adaptability of individuals is considered non-static, but constantly changing. Thus, a parallel could be drawn between the conclusion of Fama (1998) and Thaler (2019).

It should be noted that the results discussed here are limited to the sample considered, and the period studied and should not be extrapolated to other situations. The concepts discussed and tested in this text, on the other hand, require additional research and tests in order to consolidate the understanding about the themes, thus contributing to continuously increase the academic and scientific knowledge of the community, as well as offering subsidies to companies and people who participate in the financial markets, making decisions.



FINANÇAS COMPORTAMENTAIS: EVIDÊNCIAS EMPÍRICAS UTILIZANDO *MAGIC FORMULA* NO MERCADO DE AÇÕES BRASILEIRO

RESUMO

Objetivo: Explicar as causas das ineficiências na precificação de ativos, na bolsa de valores brasileira, por meio da hipótese das finanças comportamentais.

Originalidade/valor: Pesquisas feitas no mercado de ações ao longo das últimas décadas sugerem que há evidências de obtenção de retornos superiores à média de mercado, por meio da compra de ativos subvalorizados, isto é, quando estes possuem uma baixa relação entre o preço e os fundamentos da empresa. No entanto, existe uma notável discrepância quanto à interpretação das causas entre os acadêmicos. Foi apresentada hipótese dos mercados eficientes, a qual possui suas bases na premissa da estrita racionalidade dos agentes econômicos. Também se discutiu a teoria das finanças comportamentais que apresenta pressupostos diferentes.

Design/metodologia/abordagem: Utilizando as cotações históricas das ações negociadas na B3, extraídas da base de dados Economática®, o presente trabalho adotou a metodologia *Magic Formula* para investigar o efeito comportamental, por meio das ineficiências encontradas na precificação desses ativos.

Resultados: Os resultados sugerem que o mercado de ações brasileiro, em conformidade com trabalhos de mesma natureza realizados em mercados de outros países, possui ineficiências na precificação dos ativos, de forma a ser possível obter vantagens por parte dos agentes econômicos. A interpretação para as causas de tais ineficiências se fundamenta nas premissas das finanças comportamentais e aponta para existência de uma limitação da racionalização desses agentes.

PALAVRAS-CHAVE

Finanças comportamentais. *Magic Formula*. Precificação. Sobrerreação. Hipótese dos mercados eficientes.



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