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Technical Indicators for Rational Investing in the Technology Companies: The Evidence of FAANG Stocks

(Petunjuk Teknikal untuk Pelaburan Rasional di Syarikat Teknologi: Bukti Saham FAANG)

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ABSTRACT

This paper aims to contribute to technical-scientific knowledge about the tools needed to support the decision making in investments in the capital market. We focus our analysis on the following technology companies' performance: Facebook, Apple, Amazon, Netflix and Google (FAANG). The simulation covers 18,389 observations, applying strategies based on the Ichimoku dynamics, technical analysis indicators, MACD and RSI, and the purchase and maintenance strategy (B&H), that gives evidence that the dynamics of the past is the best predictor for the future. We also found theoretical and empirical evidence of the predictive capacity of these investment strategies, and their performance was evaluated by the return provided, through different negotiation methodologies tested. The Ichimoku system trading dynamics offers the best profitability and the lowest concerning the risk, in the short and medium term, evaluated by the return and number of trades with positive returns.

Keywords: Ichimoku; Buy and Hold; MACD; Chikou Span; RSI

ABSTRAK

Kajian ini bertujuan untuk menyumbang dalam aspek pengetahuan teknikal-saintifik berkaitan pembuatan keputusan dalam pelaburan di pasaran modal. Analisis kajian memfokuskan kepada prestasi syarikat teknologi Facebook, Apple, Amazon, Netflix dan Google (FAANG). Simulasi dilakukan terhadap 18,389 pemerhatian yang menerapkan strategi berdasarkan dinamika Ichimoku, petunjuk analisis teknikal, MACD dan RSI, serta strategi pembelian dan penyelenggaraan (B&H) memungkinkan pencarian bukti bahawa perubahan masa lalu adalah peramal terbaik dari masa depan. Kami menemui bukti teori dan empirikal mengenai kemampuan ramalan strategi-strategi pelaburan ini yang mana prestasi mereka dinilai berdasarkan pulangan yang diberikan. Penemuan kajian menunjukkan bahawa sistem perdagangan dinamik Ichimoku dapat memberikan keuntungan terbaik serta tahap risiko terendah bagi jangka masa pendek dan sederhana yang dinilai berdasarkan pulangan dan jumlah perdagangan yang memberikan pulangan positif.

Kata kunci: Ichimoku, Buy and Hold; MACD; Chikou Span; RSI

INTRODUCTION

The behavioural study of prices in the financial markets has provided different interpretations on the methodologies applied in forecasting future movements. It is a common sense among financial market stakeholders that stock prices move in trends and they are the outcomes of the multi-variable effect of economic, monetary, political and psychological factors, which makes the accuracy of this prediction difficult, if not impossible. Usually, individual investors have lesser knowledge, training and data, when compared to institutional investors, such as that available data may affect business behaviour. They tend to behave as trend followers.

In general, the stock market is rational, which means it is motivated by supply and demand, which is determined by the investors' assessment and perception of the future price movements. In financial literature, another consensus idea is that the main objective of investors is to maximize wealth and minimize loss risks. In this sense, investors apply methodologies that allow to predict the possible path of prices in order to increase profits. This is a long and never ending discussion, which has no solution in sight. Through the last few decades there has been an evolution of the methodologies and strategies for market prediction, however, the trade-off that remains is one, between fundamental analysis and technical analysis, and two, distinct tools which have divided investors and scholar's visions and opinions regarding its usefulness and effectiveness.

The fundamental analysis was developed after the Graham and Dodd's diligent financial assessment (1934). These authors are known as the buy-and-hold (B&H) trading strategy mentors. Its main objective is to evaluate the company's financial health and to project future outcomes by studying economic behaviour in both, micro and macroeconomic aspects. It briefly calculates the intrinsic value of an asset and compares it with the market price, furthermore it points to a target price, suggesting what position to take concerning this asset.

On the other hand, technical analysis essentially based on graphical analysis and on mathematical formulas, produces "indicators" that support decision making in negotiation. Research mainly on technical analysis has grown and therefore, there is a progressive acceptance of their capacity to generate superior profits. Within the scope of this context, the present study simulates and compares the performance of the technical indicators, the Moving Average Convergence Divergence (MACD) and the Relative Strength Index (RSI), and the "Ichimoku" trading system, in technology companies namely, Facebook, Amazon, Apple, Netflix and Google, known by the acronym of FAANG stocks.

The study structured in five sections begins with the introduction and proceeds with the second section where we carry out a literature review on the thematic and the methodologies applied. In the third section, the research hypotheses are formulated, and the sample and methodology applied are described, the fourth section is reserved for the presentation and discussion of the outcomes of the study. Finally, the fifth section, contains the conclusion of the research.

LITERATURE REVIEW

The Technical Analysis has its genesis in the graphical analysis and in Dow's theory. The first graphical analysis originated in Japan in the 1700s where it was used in the anticipation of the price movement analysis of the rice exchange and has evolved into the Candlestick charting technique as it is still known today. Charles Dow was one of the founders of the Dow Jones and Company in 1882, indexed to the Dow Jones Industrial Average in 1896. Dow became known for the way he defended and explained the behaviour of stock prices on the stock exchange market. his view was disclosed through the Wall Street Journal (Brock, Lakonishok & LeBaron 1992; Zhou & Zhou 2009; Ketan 2012).

Authors such as Taylor and Allen (1992), Anghel (2015) and Ahmar (2017), define the technical analysis as a set of indicators that help to predict the financial market's movements, through the use of historical data that, after due analysis and processing, predict the market's movements, essentially through the aid of graphic analysis that allow following the trend and anticipating movements, hence leading to increased profit. Park and Irwin (2007) classify technical analysis as a set of techniques and studies based on the historical financial price and volume movements that apply graphical tools and mathematical techniques to forecast and expose patterns of price behaviour, that try to forecast financial market movements of the most diverse products, be it stocks, forex, indexes, commodities, derivatives or options.

The technical analysis was highlighted in the academic field has arouse the interest of the investors, hence since the 1970's, with the evolution of technology data allied to a growing computerized trading, it allowed the diversification of methodologies and rules applied in the research, (Park & Irwin 2007; Metghalchi, Chen & Hayes 2015). Until the 1980s research on technical analysis relied on filter rules, momentum oscillators, stop-loss orders, and moving averages (Park & Irwin 2007). Research on the filter rules were carried out by authors such as Fama and Blume (1966) and Sweeney (1986), on what moving averages and momentum oscillators are concerned, however in general the great majority of the studies concluded that these methodologies were unable to overlap the B&H strategy.

Fama (1970), argues that investors cannot obtain abnormal profits by investing in capital market transactions, therefore it is not possible to achieve higher than average returns in the market. Authors such as Brock et al. (1992), Zhou and Zhou (2009), argue that investors adopt technical analysis as a favourite tool when negotiating, however, it is not yet as solid and relevant as the fundamental analysis in the academic world.

According to Metghalchi et al. (2015), in the late 1980s and early 1990s, interest in technical analysis was revived as an outcome of the findings of studies such as Lukac, Brorsen, and Irwin (1988), Brock et al. (1992), which challenged HME, these conclusions triggered the start of academic work based on technical analysis. The technical analysis has been the source of numerous studies, over time, the research of several authors share a common objective; the anticipation of the price movements, hence they combine strategies and rules such as nonlinear studies (Gençay 1998) and model based bootstrap studies, (Brock et al. 1992; Teplova, Mikova & Nazarov 2017), genetic programming in order to create trading systems, (Ticknor 2013; Bisoi & Dash 2014). Among these trading systems, we may find the technical indicators and the *Ichimoku* system, approached by our study.

Wang et al. (2014) advocates that there are currently six mobile averages indicators commonly used in the study of the technical analysis, namely: the simple moving average (SMA), weighted moving average (WMA), adaptive moving average (AMA) (TPMA), triangular moving average (TMA) and the exponential moving average (EMA), the latter being the basis of the MACD indicator.

MOVING AVERAGE CONVERGENCE DIVERGENCE

The Moving Average Convergence Divergence (MACD) indicator, is an indicator of trend and collective momentum of technical analysis, created by Gerald Appel in the mid-1970s. Itis one of the most popular indicators in financial market analysis (Eric, Andjelic & Redzepagic 2009). The MACD is considered a "trend following indicator", is an indicator that sometimes sacrifices the speed of anticipation by rewarding greater security and privileges the reduction of losses. The main purpose of this indicator is to highlight the most

important moments that the convergence and divergence of moving averages expose, which means it identifies market change points, between bullish and bearish, and identifying the best trading timings, whether trading in short or long positions, (Ülkü & Prodan 2013; Wiles & Enke 2015; Gold 2015). Ülkü and Prodan (2013) argue that although this indicator is popular among traders, it has been forgotten by academic literature.

Chong, Ng & Liew (2014), studied the profitability presented by the MACD for the FTSE30 index, the authors concluded on the predictive capacity of this indicator and its ability to overcome the B&H strategy. Da Costa et. al. (2015) tested the predictive capacity of the MACD for the Brazilian market, concluding that for the period between 2000 and 2014, it permitted to achieve returns superior to the B&H strategy. Gold (2015), studied the predictive capacity of the MACD for the DJIA index between 2013 and 2014. The author obtained conclusions coinciding with the predictive capacity of the MACD indicator, thus found evidence that the MACD indicator when combined with indicators of volumes, presented higher return and lower risk.

Eiamkanitchat, Moontuy and Ramingwong (2017) researched for the Thai market on the application of technical analysis and fundamental analysis as complementary tools through the application of the MACD, RSI, EMA and the Stochastic Oscillator (OS) indicators between the 1st of January 2015 and the 2nd of February 2015. The authors found evidence that the profitability of the indicators allowed to surpass the profitability of the market 12.31% in average.

Macedo, Godinho and Alves (2017), studied the optimization of a different portfolio investment from different countries, such as USA, Portugal, Argentina, South Africa, Greece, Belgium, UK, among others, between 2000 and 2015, by applying a set of technical analysis strategies, including MACD and RSI, concluding that these indicators should be B&H strategy, with RSI showing the best performance. With regard to "anticipation" indicators, the risks are higher because they aim to capture signs of market change as early as possible in order to maximize gains, such as the Relative Strength Index.

RELATIVE STRENGTH INDEX

The Relative Strength Index, (RSI), is an indicator of anticipation, and just like the MACD, it enjoys popularity among traders. This indicator, contrary to what the name may indicate, does not compare the strength or performance between two bonds, but rather the profits from the recent loss of the bond. It is a recurring indicator used in the forecast of market price movements, and the aim of research and simulation in several studies.

Rosillo, Fuente and Brugos (2013) analysed the predictive capabilities of the MACD and RSI for the Spanish stock exchange, IBEX 35, between 1986 and 2009, concluding that the RSI was the indicator with the best performance for the companies with the highest stock market capitalization. The authors concluded that the indicator to be used should be dependent on the securities to be invested and the intended objectives, since there was no indicator to show superiority in all situations.

Cohen and Cabiri (2015) studied the technical analysis indicators, namely the RSI and MACD for the indices, Dow Jones industrial index, London stock exchange, FTSE100, Japan stock market, Nikkei 225 and the Israel stock market, TelAviv index. The authors concluded for the Dow Jones, Nikkei 225 and FTSE100, that the RSI was the indicator with the best returns, surpassing in 5/6 of the period the B&H strategy, and the MACD presented negative. Contrary to the findings in these markets, the authors for the Israeli market concluded that the B&H strategy outperformed the two technical indicators.

Authors such as Chong et al. (2014) studied these technical indicators for the London stock exchange, the Canadian and Italian stock exchanges, while Metghalchi et al. (2015) analyzed the general stock index in Madrid, the authors corroborated the conclusions previous reports on the superior predictive capacity of the RSI indicator, when compared to the B&H and MACD strategy. Although the conclusions are not unanimous about the RSI being the indicator that provides better returns, all authors are unanimous in their conclusions about the excellent predictive capacity of the RSI, (Chong et al. 2014; Metghalchi et al. 2015; Macedo et al. 2017).

ICHIMOKU

Contrary to the technical indicators previously mentioned, there are few published studies that concern about *Ichimoku* (Alhashel, Almudhaf and Hansz, 2018). *Ichomoku is* considered as a trading system or method that applies technical graphical analysis. It is originally developed by the Japanese journalist Goichi Hosada, in the 1930s.

Elliott (2007) explained that this trading system began to be practiced in the West merely at the beginning of this century, the author further argued that it was in 1996 that the method was rediscovered, and it gained popularity when the book Ichimoku Kinko Studies was published, hence it became known as I*chimoku*. *Ichimoku* trading system consists of five separate indicators (lines), four of which are price averages and one of the lines is the price outdated. Elliott (2007) advocates that a decision should not be made based on an isolated interpretation of the lines, but it is essential to analyse them together.

Outside Japan, Elliott (2007), Linton (2010), Patel (2010) and Matsura (2013) have described the *Ichimoku's* technique, amongst other authors. These authors consider this trading methodology an excellent trend forecaster, by incorporating historical data, it incorporates the past and it is considered by many traders as the best predictor of the future, furthermore these authors consider that the

analysis of the *Ichimoku* lines allow to filter and to detect trading opportunities.

There are an increasing number of trades that defend the use of this technique due to its simplicity and its ease of interpretation, permitting an easy and fast combination of market analysis tools, and therefore it is indeed a trend tracking system. Alhashel et al. (2018) argued that the *Ichimoku* methodology tested the predictive control of the model in order to optimize dynamically a portfolio based on quotations forecasts. Cahyadi (2012) applied this methodology in Forex trading and found that the *Ichimoku* technique is a method available for predicting trends for the USD / JPY and EUR / USD. With favorable conclusions, we can mention the work of Almeida, Tavares and Biglieri (2018) where they studied the *Ichimoku* method performance in Facebook Options.

Deng and Sakurai (2014) studied the *Ichimoku* method performance in Forex's market and compared it to the B&H strategy, hereafter they concluded that on average the return on trading strategies based on *Ichimoku* was superior to that of the B&H strategy. Shawn, Yanyali and Savidge (2015) studied the profitability of signals generated with the *Ichimoku* method in Japan's and USA's individual stock exchange shares, the authors built long and short-term conservative and aggressive strategies, by analysing the signals generated by the method *Ichimoku*, based on simulation. The authors concluded that the *Ichimoku* graphics had predictive power and generated profitable trade signals in these two markets.

Bąk (2017) analysed the predictive capacity of the *Ichimoku* technique in the change of GDP dynamics in Poland, concluding that the *Ichimoku* system lacked predictive capacity to change the country's GDP dynamics. The authors considered that the findings were the outcomes of the assumptions adopted in the study and significantly limited the negative possibility in the verification of the hypothesis. Fafuła and Drelczuk (2015) found that *Ichimoku* methodology was ineffective, due to winning stock exchange shares in previous years, concerning the Warsaw Stock Exchange, therefore these authors justified the findings with the choice of the sample since it is an unexpressed market sample allied to the fact that it is composed by typical winning stock exchange shares.

HYPOTHESES, SAMPLE AND METHODOLOGY

As in previous studies, and with the aim of simulating the predictive capacity of the *Ichimoku's* system and technical indicators, based on the framework of the research discussions, we proceed to the operational strategies of different negotiation strategies and the enunciation of different hypotheses tested.

HYPOTHESES

The hypotheses of the research are based on the theoretical logic of the research work, and are also based on revised literatures and on the logic of testing the predictive capacity of the *Ichimoku* technical indicators and trading system. The research hypotheses formulated are the outcomes of the articulation of the several trading strategies simulated. For the trading strategies to be successful, it is expected that the annual return that they provide will exceed the annual return of the B&H strategy, thus leading to the formulation of hypothesis 1 and 2.

H_1 The annual return provided by the different trading strategies, surpasses the annual return of the B&H strategy.

H_2 The annual returns provided by the strategies exceed the return of the B&H strategy by at least 50% of the years.

Another measure applied to evaluate the success of trading strategies is the annualized rate of return or yield, calculated through the geometric mean. This is a fundamental measure to evaluate the success of the system, the rate of return measured by the average return of the period under study, to eliminate maturity investment problems and it also furnishes a clearer demonstration of the economic reality, allowing several comparisons (Fang, Jacobsen & Qin 2014).

H_3 The yields provided by the various strategies applied in the negotiations, surpass the yield of the B&H strategy.

Davey (2014) and Gold (2015) advocate that among the various performance measures of trading systems is the percentage of the number of profitable trades. According to these authors, profitable negotiations must exceed the total number of negotiations carried out by at least 50%. The authors consider that only then, the method used can overcome the so-called "monkey test", a test that considers that a random selection of entry and exit points, such as those selected by a monkey, would produce only half of the selections. This leads us to the formulation of the second hypothesis.

H_4 More than 50% of the total number of trades carried out is profitable.

The authors consider that only then can the method used overcome the so-called "monkey test", a test that considers that a random selection of entry and exit points, such as those selected by a monkey, would produce only half of the selections. Which lead us to the formulation of the second hypothesis for each one of the strategies applied. Authors like Brock et al. (1992) and Gold (2015), compare the portfolio rate of return with the Benchmark's rate of return, in the study it is the stock market indices NASDAQ. The authors consider that a portfolio of stocks must surpass the return of the Benchmark which led to the formulation of $H_{5.}$

H_5 Yield provided by asset trading strategies outperforms the annualized return provided by the Benchmark negotiations.

SAMPLE

In the second phase, after the formulation of the hypotheses, the sample is presented and described, justifying our choice and referring to the sources of the data used and the process of data processing. Our sample falls upon the five largest technology companies, Facebook (FB), Amazon (AMZN), Apple (AAPL), Netflix (NFLX) and Google (GOOGL) currently Alphabet, known on Wall Street by the acronym FAANG, and the stock exchange NASDAQ index is the Benchmark. FAANG have a huge stock market capitalization and if we combine these titans of technology, on the date of the study they are worth more than $ 3.26 trillion. If they were a country, they would represent the fifth largest economy in the world, placed between the United Kingdom and Germany, as shown in table 1.

TABLE 1. GDP of the 10 Largest World Economies

No.	PIB COUNTRY	VALUE PIB (Trillions USD)
1	Eua	20.4
2	China	14
3	Japan	5.1
4	Germany	4.2
5	United Kingdom	2.94
6	France	2.93
7	India	2.85
8	Italy	2.18
9	Brazil	2.14
10	Canada	1.8

Source: Elaboration based on data from the International Monetary Fund, reported on 1st May 2018

In the study, daily closing prices were used between the year 2000 and 2018 for the index and all the companies in the sample were taken from Yahoo Finance. The time under study differs in several market shares, due to the different dates of stock exchange trading. These dates are referenced in table 2, as well as the number of observations for each market share. Table 2 also presents some recurring financial indicators of the fundamentalist analysis which influenced our choice, such as stock market capitalization, EP and P / E ratios, and it is also a differentiating factor in previous studies, as well as the inclusion of the *Ichimoku* system in companies that show strong growth.

METHODOLOGY

To test the success of the trading strategies, it is inevitable that we proceed to estimate the different trading indicators and methods, in order to conclude what kind of position to adopt when there are trading signals, through the graphical visualization of the indicators. We present the research methodology used in the construction of models and negotiation strategies to test the hypotheses of the object under study, in order to achieve the research objectives.

MOVING AVERAGE CONVERGENCE DIVERGENCE

The MACD is based on the calculation of simple moving averages (MMS), these averages are calculated by the following:

$$\text{MMS} = \frac{\sum_{t=1}^{n} \text{Price t}}{\text{n}} \quad (1)$$

The MACD consists of three elements, the MACD line, the signal line and the histogram. This indicator evaluates the divergence of moving averages by measuring the difference between two exponential moving motions (EMA), one long-term or slow (26 days), and another short-term or fast (12 days).

MACD is calculated by applying two steps, the first is the transformation of the number of days chosen (n) into a percentage, thus finding the multiplier, using the following:

$$\text{Multiplier ("%")} = \frac{2}{n+1} \quad (2)$$

After calculating this percentage, the following shall apply to the quotation:

$$EMA = \left(P_t * \text{"\%"}\right) + \left(EMA_{t-1} * \left(100\% - \text{"\%"}\right)\right) \quad (3)$$

The 12-day MME subtraction to the EMA at 26 days, forms the MACD line, based on these EMA's the EMA is calculated at 9 days (EMA 9), known as the indicator signal line, or "Trigger" (Gold 2015).

MACD_t = 12 day EAM_t of closing price – 26 day EMA_t of closing price (4)

Trigger = 9day EMAt of MACD (5)

Trading signals are generated when the MACD line crosses the signal line, upwards indicates entry into the negotiation, when it is downwards it will signal output. The most common strategy is by verifying the location of this line before the zero line during sustained periods of time, trading signals are enhanced when there are crossings with the zero line or between the fastest and

TABLE 2. Data on FAANG's

	FB	AAPL	AMZN	NFLX	GOOGL
Market Cap (B.USD)	583.45	900.609	812.71	166.859	800.929
EPS	6.04	10.36	7.93	2.19	23.56
P/E	34.73	18.48	228.66	164.86	50.29
B	1.1616	1.0945	1.1539	1.4454	1.1637
Study Start	18/05/2012	03/01/2000	03/01/2000	23/05/2002	19/08/2004
End Date Study	25/06/2018	25/06/2018	25/06/2018	25/06/2018	25/06/2018
Nº observations	1.538	4.653	4.653	4.055	3.490
Initial quote	38,23	3,997	89,37	1,20	50,22
Final quote	196,35	182,17	1.663,15	384,49	1.169,29
Return rate (Cf-Ci)/Ci	413,60%	4.457,67%	1.760,97%	31.940%	2.228,34%
Return rate2017	51%	45,70%	55,17%	50,57%	30,37%

Source: Author's elaboration based on data from the Yahoo Finance

TABLE 3. Ichimoku strategies

Trading Strategy	Trading Signal	Trading Condition
Chikou Span Vs Price	Buy signal	$\text{Chikou-Span}_{(T)} > P_{(T-25)}$
	Sell signal	$\text{Chikou-Span}_{(T)} < P_{(T-25)}$
The 5 lines Ichimoku and cloud	Buy signal	$P_{(T)} > \text{Tenkan-sen}_{(T)} > \text{Kijun-sen}_{(T)}$ and $P_{(T)} > \text{Senkou-Span A}_{(T)} > \text{Senkou-Span B}_{(T)}$ and $\text{Chikou span}_{(T)} > P_{(T-25)}$
	Sell signal	$P_{(T)} < \text{Tenkan-sen}_{(T)} < \text{Kijun-sen}_{(T)}$ and $P_{(T)} < \text{Senkou-Span A}_{(T)} < \text{Senkou-Span B}_{(T)}$ and $\text{Chikou span}_{(T)} < P_{(T-25)}$

Source: Author's elaboration

slowest line of MACD, allowing the identification of short-term momentum. According to Anghel (2015), this method of negotiation was developed in order to combat the deficiency of most of the impulse indicators that are delayed when faced with market events. The first trading strategy, one of the most recurrent among investors, defines the time of entry and exit of the market using the MACD and EMA lines (9). Whenever the MACD line crosses the EMA line (9) upwards, we are faced with a buying signal, whenever the crossing is done in the opposite direction we are faced with a short position signal (Cohen & Cabiri 2015). It is also considered by the MACD, if the stock exchange shares were overvalued or undervalued. When stocks are overvalued the MACD lines move well above the centreline, this is the zero line, indicating a very optimistic historical trend, when the opposite is true the shares are undervalued. Given such a scenario, the investor should adopt a counter-trend trading strategy, anticipating a possible inverse (Anghel 2015).

RELATIVE STRENGTH INDEX

The use of RSI is primarily intended to detect the points of mutation of direction in the negotiation as soon as possible. Wilder (1978) formulated the RSI indicator defining a periodicity of 14 days for its calculation, this definition is still the most recurrent in research, however other periods may be used, and this choice makes the indicator more volatile when the number of days are used. The formula for calculating the RSI is as follows:

$$\text{RSI} = 100 - 100 * \left(\frac{1}{1 + \text{RS}} \right) \qquad (6)$$

where:

$$\text{RS} = \frac{\text{MME Up}}{\text{MME Down}} \qquad (7)$$

Upwards represents the average of daily rate hikes in the last n days.

Downwards represents the average of the daily descent values that occurred in the same period n.

By calculation formula, it is verified that this indicator oscillates between 0 and 100, however and like other authors it was considered the value of 30 for minimum and 70 for maximum. It is considered a buying

signal, whenever the RSI lowered below 30 and it returns to exceed this value, and it is considered a selling signal, whenever the RSI exceeds the value of 70 and it returns to cross when descending this value.

ICHIMOKU

The *Ichimoku* system lines are calculated in a similar way to the moving averages of the technical analysis, however there is an enormous difference, instead of using closing prices as the averages, the "Ichimoku" indicator uses daily maximum and minimum quotes for line calculations. The *Tenkan-Sen* line also known as the conversion line, based on the maximum and minimum price of the previous nine periods, including the current period, is calculated as follows:

$$Tenkan\,Sen(T) = \frac{\max(P(t)\Big|_{t=T-8}^{t=T}) + \min(P(t)\Big|_{t=T-8}^{t=T})}{2} \quad (8)$$

Where Pt is the quotation of the asset at moment t.

The *kijun Sen* line or base line, very similar to *tenkan*, is constructed based on the maximum and minimum prices of twenty-six periods:

$$Kijun\,Sen(T) = \frac{\max(P(t)\Big|_{t=T-25}^{t=T}) + \min(P(t)\Big|_{t=T-25}^{t=T})}{2} \quad (9)$$

These two lines are the fastest and shortest means of the "Ichimoku" system, the gap created between these two lines is the secondary cloud. The *Chikou-Span* line or lagging span period determines the strength of the buy or sell signal, this line compares past price levels with the current price, and it is represented by the price displaced twenty-six periods back and it is calculated as follows:

$$\text{Chikou Span}(T-25) = P_{close}(T) \quad (10)$$

The *senkou* span A line, or leading span A, is the average between the *tenkan-sen* line and the *kijun-sen* line of twenty-six periods, the *senkou* span B line, or leading span B, in turn is the moving average of the maximum and minimum price of fifty-two periods, and the gap between it and the line *senkou* span A, form the cloud or *kumo*, and represent the incorporation of the future in the prediction of the present, and they are calculated as follows:

$$Senkou\,Span\,A(T) = \frac{\text{Tekan}\,Sen_{26p} + \text{Kijun}\,Sen_{26p}}{2} \quad (11)$$

$$\text{Senkou Span B}(T) = \frac{\max(P(t)\Big|_{t=T-51}^{t=T}) + \min(P(t)\Big|_{t=T-51}^{t=T})}{2} \quad (12)$$

To test the "Ichimoku" methodology, two portfolio management strategies are defined and tested: the first tests the *Chikou-Span* line, that is, the predictive capacity through the analysis of the past, the second strategy is the simultaneous analysis of the five lines of the "Ichimoku" system, as we can observe in Table 3.

ASSUMPTIONS IMPLEMENTATION OF STRATEGIES

In carrying out the research, in order to maintain the coherence and ease of implementation of strategies, the following assumptions are considered:

1.8 Daily closing rates were used in all negotiations;
2. The investor opened and closed positions on the first and last day of each year, with returns calculated annually;
3. In the methodologies adopted, the investor conducted the negotiations whenever the indicators showed buy or sell signals, and the positions were closed on June 25th, 2018;
4. Short selling transactions were not considered;
5. The amount obtained in dividends was not considered for calculating yields;
6. The transaction fees and taxes were not taken into account.

The arithmetical return, Rt, for a single period, where Pt denotes the price of an asset at time t, is obtained as follows:

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} = \frac{P_t}{P_{t-1}} - 1 \quad (13)$$

For multiple periods we have:

$$R_t\left[\prod_{i=0}^{K-1}\left(1+R_{t-j}\right)\right] - 1 = \frac{P_t}{P_{t-K}} - 1 \quad (14)$$

The logarithmic return for a period, rt, is given by:

$$r_t = \log(1+R_t) = \log\left(\frac{P_t}{P_t - 1}\right) = \log(P_t) - \log(P_{t-1}) \quad (15)$$

For multiple periods we have:

$$r_t[K] = \log(1+R_t[K]) \quad (16)$$

PRESENTATION AND DISCUSSION OF THE OUTCOMES

After applying the above-described methodologies, negotiations based on the signals produced by the indicators are simulated. The returns provided by each strategy are calculated individually, and the outcomes obtained are presented and discussed according to the hypotheses formulated. Figure 1 presents the returns obtained from the negotiation of the several strategies for the NASDAQ index.

From the NASDAQ index with respect to H_1 and H_2, we find that the negotiations based on the "Ichimoku" method outweigh the return provided by the B&H strategy. The strategy is based on the *chikou* line and it exceeds in 16/19 periods, that is, in 84.21% of the years under study and the strategy based on the 5 lines *Ichimoku* surpasses in 78.94%, that is, 15/19 of the B&H strategy periods. In relation to the MACD indicator, it exceeds the return of the B&H strategy in 15/19 periods, presenting in 3/19 periods negative yields. The RSI shows higher returns than the B&H strategy in 17/19 periods. The outcomes found for the technical indicators coincide with the ones found by Cohen and Cabiri (2015) for the FTSE 100, verifying that H_1 and H_2 are not rejected.

Table 4 summarizes the performance measures of the different strategies, confirming that all indicators exceeded the monkey test, with the number of profitable trades being over 50% of the total number of trades performed, thereby validating H_4. The strategy based on the five lines of the *Ichimoku* system, presents 90% of negotiations with positive return. Similarly, the *chikou* span line produced the largest number of trades, and the highest profitability, its yield is 28.86% for the 18 years in the study, against 2.75% presented by the B&H strategy, finding that H_3 and H_5 are not rejected.

The crossing of the Chikou Span Vs Price (Ch vs P) lines is the strategy that presents the best profitability. Regarding FB, by analysing Figure 2, the strategy based on the analysis of the *chikou* line, exceeds the B&H strategy in all the years, the five *Ichimoku* lines surpass the B&H strategy in 6/7. Technical indicators also outperform the B&H strategy, the MACD indicator exceeds 3/7 and the RSI indicator exceeds 5/7. The outcomes found are coincident with those found by Macedo et al. (2017).

When analysing the outcomes described in table 5, we find evidence that the strategies based on the indicators do not reject H_4, presenting a percentage of profitable trades of more than 50% of the negotiations

TABLE 4. Performance measures of strategies for the NASDAQ index

		Ch vs P	5 lines instead	MACD	RSI	B&H
NASDAQ	Σ Perfomances	532.15%	375.81%	282.77%	300.93%	121.62%
	Annual Average	28.01%	19.78%	14.88%	15.84%	6.40%
	Yeld	28.86%	19.73%	14.07%	14.57%	2.75%
	Total Of Trades	207	75	152	127	19
	Percent Profitable Trades	83.09%	90.00%	85.53%	77.96%	78.00%

Source: Author's elaboration

TABLE 5. Performance measures of strategies for FB

		Ch vs P	5 lines instead	MACD	RSI	B&H
FB	Σ Perfomances	428.58%	197.59%	186.30%	271.48%	215.58%
	Yeld	66.08%	31.06%	31.20%	43.02%	30.27%
	Total Of Trades	124	33	64	78	7
	Percent Profitable Trades	75.87%	90.91%	62.50%	83.33%	85.71%

Source: Author's elaboration

TABLE 6. Performance Measures of the strategies for AMZN

		Ch vs P	5 lines instead	MACD	RSI	B&H
AAPL	Σ Performances	1 182.97%	1 428.99%	653.17%	790.18%	737.95%
	Annual Average	62.26%	75.21%	34.38%	41.59%	38.84%
	Yeld	63.84%	64.22%	25.30%	37.75%	22.10%
	Total Of Trades	208	37	167	134	19
	Percent Profitable Trades	69.23%	94.59%	49.70%	58.20%	78.00%

Source: Author's elaboration

carried out by the strategies, whereas the analysis of the five *Ichimoku* lines, present the highest percentage of 90.91% in 33 trades and the strategy based on the *chikou* line produced more trades, 124.

When testing H_3, we corroborate that all strategies exceed the return demonstrated by the B&H strategy, and the inclusion of the past in the prediction of the future, through the *chikou* line, is the strategy with the highest return, that is, 66.08% per year against 30.27% of the B&H. We find evidence that the trading strategies applied to the FB asset outweigh the Benchmark yields, not rejecting H_5. For Apple's assets, and through Figure 3 analysis, we can see that the *chikou* line has not exceeded the profitability of the B&H strategy only in 4 years, with no negative returns, since the five-line strategy *Ichimoku* evidences a return that surpasses the B&H strategy in 10/19, or 52.6% of the years under study.

Table 6 describes the performance measures of negotiation strategies showing the acceptance of H4 for all of them. For the yields, tested in H_3 and H_5, we verify that it is the *Ichimoku's* method, which presents the highest yield, 64.22% versus 22.10% of B&H. All strategies show yields that allow non-rejection of H_3 and H5.

Figure 4 demonstrates the outcomes for the Amazon, coinciding with the previous ones for the *chikou* line, which has the highest percentage of surpassing returns on the B&H strategy, having surpassed in 68.43% of the years under study, that is, on 13/19, showing the same return in 2018 and a lower return in 5/19 or 26.31% of the years under study. The *Ichimoku* method, through the five lines, surpasses in 12/19 the return of B&H, evidencing zero returns in the years in which the B&H strategy presents negative returns.

The MACD indicator shows a lower return than the B&H strategy in 10/19, 52.6% of the years under study, in turn the RSI cannot surpass the B&H strategy profitability in 68.42%, that is, 13 / 19 of the years under study, as for the Amazon shares, technical indicators cannot overcome the success of the B&H strategy. For Amazon, the outcomes of the technical indicators coincide with those found by Cohen and Cabiri (2015) for the Israeli market

Table 7 indicates the performance measures of the applied strategies. We can see that only the RSI indicator cannot surpass the annualized return of the B&H strategy, presenting an annualized profitability of 26.15%, against 36.01% of B&H. For Amazon, the strategies focus on the "Ichimoku" method show higher annualized profitability, 67.86% for the *chikou* line, 50.07% for the five lines of the *Ichimoku* system, and MACD for 37.72% versus 36.01 % of B&H. Regarding H2, we verified that all the

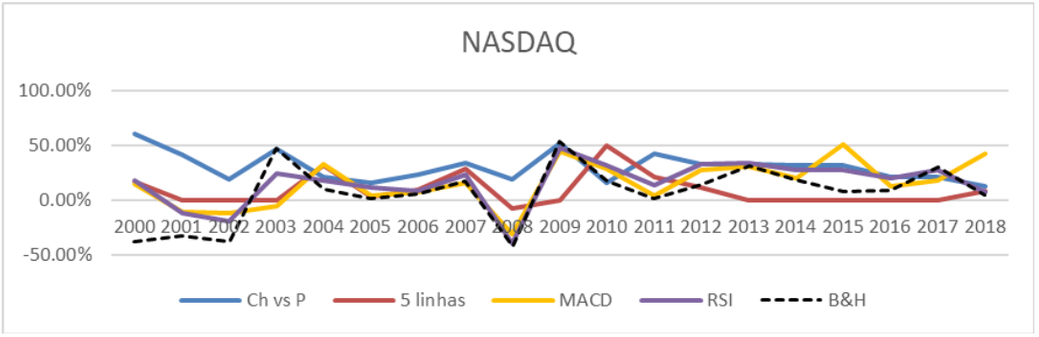

FIGURE 1. Annual yields obtained for NASDAQ
Source: Author's elaboration

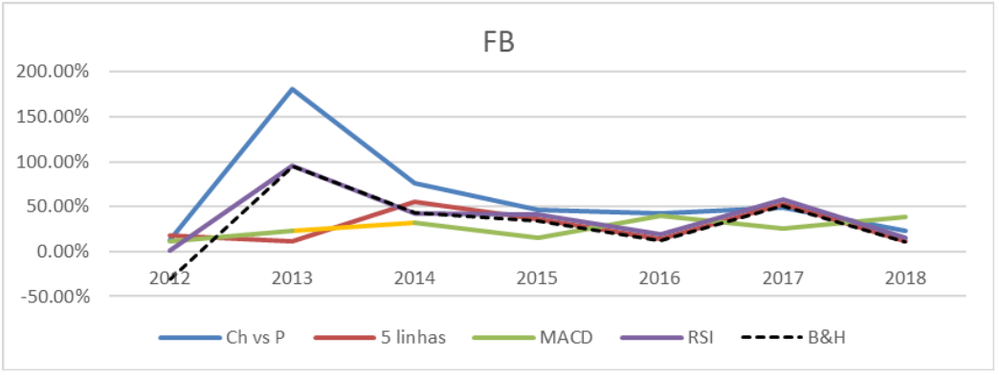

FIGURE 2. Annual yields obtained for FB
Source: Author's elaboration

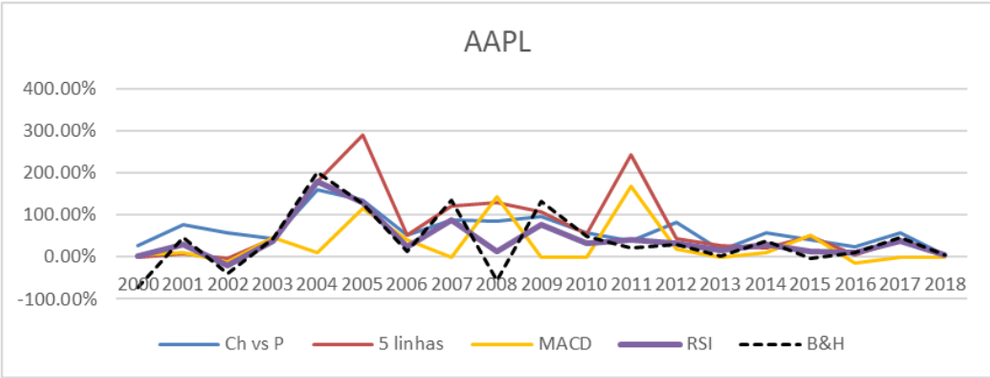

FIGURE 3. Annual yields obtained for AAPL
Source: Author's elaboration

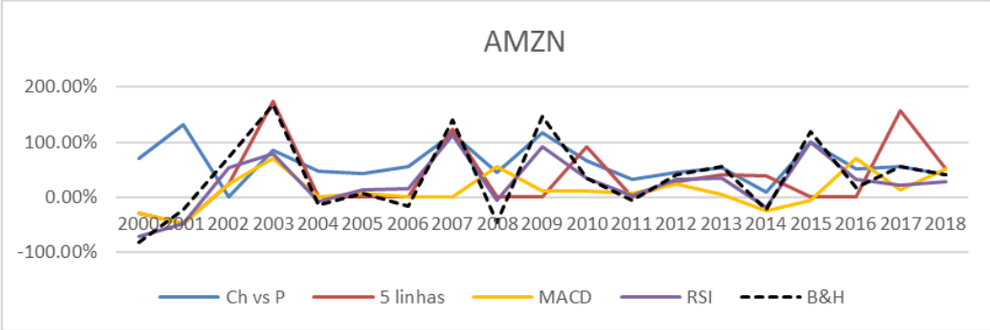

FIGURE 4. Annual yields obtained for AMZN
Source: Author's elaboration

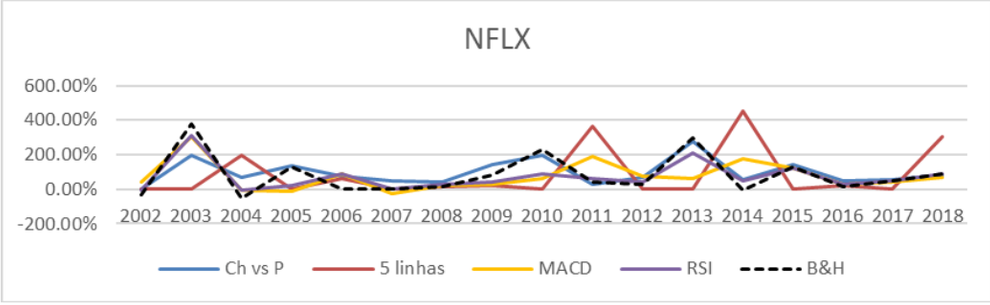

FIGURE 5. Annual NFLX Return Ratio
Source: Author's elaboration

strategies surpass the 50% of the operations with positive returns.

For Netflix, the strategy based on the *chikou* line presents 13/17 returns, hence above the B&H strategy, the analysis of the five lines in turn can only surpass in 8/17, or 47.6% the return of B&H, as indicated in Table 8. With respect to the MACD, this indicator surpasses the B&H strategy by 8/17 and the RSI exceeds the B&H strategy by 58.9%. Table 8 shows the performance measures obtained for Netflix assets.

Regarding annualized profitability, the strategy based on the *chikou* line presents a return of 99.22%. The trading strategy based on the 5 lines of the *Ichimoku system* presents an annualized return of 68.86%, and it is also verified that the only strategy that does not surpass the return on B&H strategy is based on the MACD indicator, but with a very close but lower return of 0.73%, this strategy does not present positive returns in more than 50% of the trades. In graph 6 negotiations on Google's assets are summarized. We highlight that

TABLE 7. Performance Measures of the strategies for AMZN

		Ch vs P	5 lines instead	MACD	RSI	B&H
AMZ	Σ Perfomances	1 289.31%	951.24%	716.76%	496.88%	684.26%
	Annual Average	67.86%	50.07%	37.72%	26.15%	36.01%
	Yeld	61.66%	24.47%	8.86%	15.98%	17.36%
	Total of Trades	199	20	186	157	19
	Percent Profitable Trades	82.41%	100.00%	59.14%	68.79%	63.16%

Source: Author's elaboration

TABLE 8. Performance Measures of NFLX Strategies

		Ch vs P	5 lines instead	MACD	RSI	B&H
NFLX	Σ Perfomances	1 733.38%	1 304.88%	1 073.39%	1 228.99%	1 386.19%
	Annual Average	101.96%	76.76%	63.14%	72.29%	81.54%
	Yeld	99.22%	68.86%	54.10%	63.33%	54.83%
	Total Of Trades	146	16	174	123	17
	Percent Profitable Trades	58.08%	93.75%	49.43%	63.41%	76.47%

Source: Author's elaboration

TABLE 9. Performance measures of GOOGL strategies

		Ch vs P	5 lines instead	MACD	RSI	B&H
GOOGL	Σ Perfomances	703.23%	565.93%	351.26%	430.58%	430.45%
	Annual Average	46.88%	37.73%	23.42%	28.71%	28.70%
	Yeld	46.58%	37.44%	22.81%	28.64%	24.82%
	Total Of Trades	165	26	138	112	15
	Percent Profitable Trades	64.85%	84.62%	49.28%	64.29%	80.00%

Source: Author's elaboration

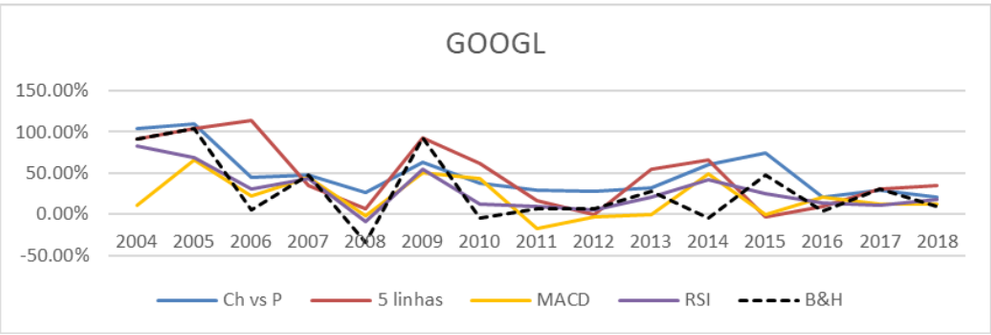

FIGURE 6. Annual returns obtained for GOOGL
Source: Author's elaboration

the outcomes found for Google are coincident with the outcomes found for previous companies, and the strategy based on the *chikou* line overcomes in 13/15 years the return of the B&H strategy, it is the highest percentage of overcoming. The strategy based on the 5 lines of the Ichimoku system surpasses in 8/15 years equalling the B&H strategy in 3/15 years.

The MACD can only surpass the return of the B&H strategy in 6/15 years, that is, in 40% of the study time, the RSI indicator shows returns higher than the B&H strategy in 8/15 years. It is also verified that just like the previous companies, in the years in which the strategy B&H presents negative returns, all the strategies even when their returns are negative, they are still superior to the B&H strategy.

Table 9 shows the outcomes found for Google, where the strategy that evidences the highest return is based on the *chikou* line, in agreement with the previous results, and the MACD indicator is the only strategy that cannot overcome B&H's return, and presents a percentage of 49.28% of trades with positive returns, thus the assumption of H2 is not verified.

CONCLUSIONS

Some of the outcomes found are encouraging, in regards of the viability of the *Ichimoku* trading system and technical analysis indicatorsto obtain a higher return on investments. Assuming the fact that trading is not only the ability to develop negotiation rules or skill analysis, but also the ability to observe these rules, leads us to conclude from the outcomes found that, when applied as skill it increases the level of the investor's return. The performance of the negotiation strategies tested was measured by the general efficiency of their return and by the success of the signals of entry and exit in the negotiations of the various strategies applied, evidencing an increase of the return as well as the achieved trades, thus allowing to verify that the signals produced are effective indicators of a return's increase.

Concerning the efficiency of the *Ichimoku* system indicators, we conclude that in general, for the sample, they have managed to exceed the annual returns of the B&H strategy, whereas the trades based on the signals produced correspond to more than 50% with positive returns. The outcomes show that the MACD in most companies cannot surpass the B&H strategy These outcomes coincide with Cohen and Cabiri (2015), and Macedo et al. (2017) research, nevertheless, evidences found are favourable to its predictive capacity, coinciding with the conclusions of Chong and Ng (2014), and Da Costa et al (2015).

As for the RSI, it is able to overcome the outcomes provided by the B&H strategy, which is in line with the outcomes of authors such as Macedo et al. (2017). Regarding the evidence of a greater capacity to present higher yields by the RSI, when compared to the MACD, the outcome is in line with Rosillo et al. (2013), Nor and Wickremasinghe (2014), and Cohen and Cabiri (2015).

We conclude that the *Ichimoku* system is more effective than the two indicators of the technical analysis, providing higher returns, with a higher number of trades with profits, which means that the ichimuku dynamics also presents less risks, coinciding with the conclusions of Bąk (2017) and Almeida et al. (2018). We furthermore conclude that the trading strategy based on the *chikou* line of the *Ichimoku* system is the most profitable one. The outcomes show that it is the 5 *Ichimoku* lines strategy that presents the highest percentage of negotiations with a positive profit, with an average of close to 90% of the trades carried out, and it is also the one that produces less signals and negotiation.

The study shows that although the technical indicators exceed the B&H strategy annually, when considered the entire time of the study, it is superior to all the strategies applied, as shown in table 2, which is coincident in the sample with the market efficiency hypothesis. This study opens the way to further research on the different methods of investing in the market, and it would be interesting to test the indicators in joint analysis.

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