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Efficient Market Hypothesis: Diving into the Cryptocurrency World

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Introduction

For a long time, in the past, economists considered the stock market a non-interesting topic for serious studies. As a matter of fact, the majority of pre-1960 research about stock prices serial correlation was the concern of statisticians.

The origins of preliminary studies stem form a scenario where security prices follow a random walk, implying a non-influence among them, regardless of the time horizon. Their independence results in an impossibility to forecast successive movements or future patterns price series. Since the flow of information is unpredictable and information is immediately reflected in stock prices, the next price change will reflect only tomorrow's news and it will be totally independent on today price movements. In 1965 Eugene Fama formulated for the first time the Efficient Market Hypothesis. Depending on which set of information is reflected in prices, the market will possibly comply with the weak, semi-strong or strong form of efficiency. A big number of researchers tested the Efficient MarketHypothesis, and some controversial evidence began to come into the scene in the 1970s and 1980s. The excess volatility of prices, investors behavior, dividend puzzle and equity premium are key areas where empirical facts are in contrast with previous assumptions. Market anomalies looked like an obstacle to the latter hypothesis, so that reconciling the two became a priority. Indeed, since the beginning of 1980s, the behavioral science started to be incorporated into finance. Behavioral finance documents a cognitive bias, a misperception of reality in the investors' mind which is massively important in the process of decision making to analyze the beliefs and motivations behind the actions of individuals.

However, despite the irregularities, a real-world portfolio manager does not beat the market on average. Indeed, a successful performance during the current year does not infer something of the performance of next year.

After a deep explanation and understanding of the EMH and its anomalies, is interesting to examine such issues in the context of the cryptocurrency market. Andrew Urquhart in 2016, found out that Bitcoin market in US was not weakly efficient over the full time period, but was moving towards a weak form of market efficiency in the last subsample. The University of Agder replicated the study of Urquhart using more recent datas and comparing to US, the Venezuelan market. Eventually the results about US confirmed that the Bitcoin market actually goes towards a weak form of EMH. Venezuela, on its side, showed the total absence of the weak form of market efficiency. Eventually, empirical results present no evidence of anomalies in the Bitcoin Market. Nonetheless, Bitcoin prices provide some anomalous evidences in July

and August, being abnormally lower compared to the rest of the year. As a matter of fact, the relative inefficiency of Bitcoin market might be a good basis for the Month of the Year Effect existence.

The remainder of the paper is organized as follows: Section 1 defines the origins and evolutions of efficient market hypothesis. Section 2 develops the anomalies of the efficient market hypothesis. Section 3 tries to reconcile theory and empirical evidences . Section 4 reports the empirical evidence of Efficient Market Hypothesis in the Cryptocurrency market. Finally, Section 6 concludes.

The Origins and Evolutions of the Efficient Market Hypothesis

Harry Roberts: The First Relevant Research Project about the EMH

For a long time, in the past, economists considered the stock market a non-interesting topic for serious studies. As a matter of fact, the majority of pre-1960 research about stock prices were the concern of statisticians. The main issue to be investigated was whether security prices were serially correlated.

A scenario where security prices follow a random walk, implies a non-influence among them, regardless of the time horizon. Their independence results in an impossibility to forecast successive movements or future patterns.

Harry Roberts[1] conducted one of the first relevant research projects: *Stock Market 'Patterns' and Financial Analysis*[2]. According to Roberts, the stock market was not comparable to a "mechanically imperfect roulette wheel". Indeed, those imperfections would be noticed and exploited by market participants, up to the point of their suppression. The results of some random numbers were plotted to verify if there were any predictable price patterns known to technical analysts.

Figure 1 provides an example of Roberts' plot:

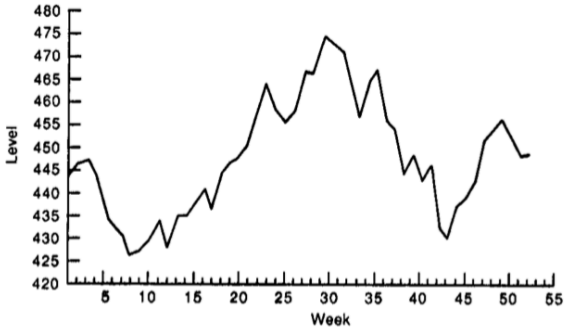

Figure 1. Simulated stock price path

Technical analysts may evaluate the simulated stock price pattern of the graph above, as something familiar to an indicator of a recursive trend reversal. Valuable stock price patterns, which even work on decidedly random series, means that technical analysis may suggest trading rules strategies, hence revealing a contradiction to the presumed uncorrelation.

[1] a statistician of the University of Chicago
[2] published in the *Journal of Finance* in 1959

Furthermore, Roberts considered a hypothetical example of a stock price path in Figure 2.

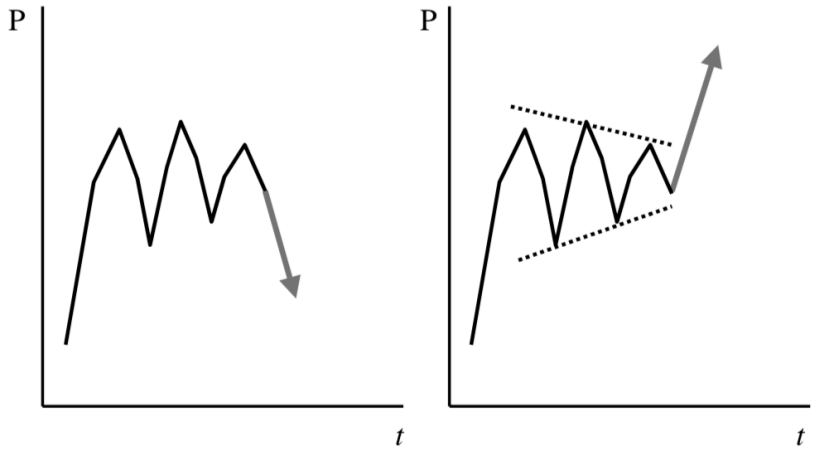

Figure 2. Hypothetical example of technical patterns formation

Depending on how the price will move "on the next day", two different patterns will be drawn. If tomorrow the price of this stock goes down, in technical analysis, is the case of a head and shoulders trend reversal pattern. The latter describes a specific chart formation that predicts a bullish-to-bearish trend reversal and that an upward trend is nearing its end. If, however, tomorrow the price goes up, the resulting graph will be closer to a pennant pattern, which, in technical analysis, is a signal of a renewal trend.

In conclusion, the technical patterns are impossible to be predicted. They are easy to see only looking backward, when is too late to act and speculate on them.

Harry Roberts 'paper, eventually revealed to be a prophetic guide for future studies about the stock market.

Nevertheless, in 1967 he proceeded to differentiate the degree of market efficiency in three forms, depending on the information set reflected in prices:

1. The *Weak Form of Efficient Market Hypothesis* claims that any information contained in the historical sequence of prices are fully reflected in today's prices. This implies that investors are not provided with any investment strategy resulting in abnormal profits, based on the analysis of past price patterns. [3]
2. The *Semi-Strong Form of Efficient Market Hypothesis* states that prices do reflect historical price information together with all publicly available information related to the securities of a company. Consequently, investors are not provided with any investment strategy based on the analysis of balance sheets, income statements,

[3] This is strongly connected with the concept of "Random Walk Hypothesis"

announcements of dividend mutations or stock deviations, resulting in abnormal economic profits yield.

3. The *Strong Form of Efficient Market Hypothesis* argues that any information, public and private about a company known by market participants, is reflected in market prices. In fact, investors, even those having privileged information, do not have a secure and superior abnormally profitable strategy.

Eugene Fama: the First Formulation of the EMH

Nowadays, everyone has the possibility to replicate Roberts' studies through common spreadsheet programs.

The establishment of the Center for Research in Securities Prices (CRSP[4]) in the University of Chicago, contributed and encouraged the stock market research, by providing one of the largest amount of stocks data traded on the New York Stock Exchange since 1926.

CRSP data had a small, negligible amount, of errors and was easily-accessible to anyone involved in the economic research.

In 1965 Eugene Fama formulated for the first time the efficient market hypothesis in his paper "Random Walks in Stock Market Prices". He analyzed possible serial correlations of 30 stock prices comprising the Dow Jones Industrial Average index[5] ("The Behavior of Stock Market Prices") and he eventually concluded that daily changes presented a small positive correlation and they were approaching zero for practical purposes. The stock market appears to reflect and incorporate all the information contained in past prices, into the current prices. The efficient market was defined as a market with a large number of rational profit maximizer competitors, who try to predict future prices of individual securities and with free access to information.

The above description is similar to the one of perfectly competitive market. The latter is characterized by costless trading, free access to financial markets, freely available information, the presence of many traders having no impact on the price of goods and services and every seller earning a normal profit.

[4] founded by James H. Lorie in 1960

[5] The Dow Jones Industrial Avarage Index is the second oldest stock market index, which measures the stock performance of 30 large companies listed on stock exchanges in the United States.

A normal profit, is an amount of money sufficient to stay in business, but insufficient to attract competitors. In the stock market context, it translates into the instantaneous reflection of any new market information in actual prices. In case those conditions will not be met, exploitable opportunities for abnormal returns will arise.

Eugene Fama's (1970) followed with an influential survey article, "Efficient Capital Market", in which the EMH was better explained. Security markets efficiently reflect the existing information related to each individual stock as well as the market as a whole and in case some updates arise, the news will be immediately incorporated in the security prices.

The main consequence is that no technical analysis, focusing on past stock prices to predict future prices, and no fundamental analysis, which is the analysis of financial information to help investors selecting "undervalued" stocks instead of a randomly selected portfolio, conducts to earn higher returns. Indeed, the efficient market hypothesis is strongly related to the concept of "random walk," so that price series are characterized by subsequent random price changes compared to the previous ones. Since the flow of information is unpredictable and information is immediately reflected in stock prices, the next price change will reflect only tomorrow's news, being totally independent on today price movements. Hence, the final outcome is a rate of return potentially equal among uninformed investors owning a diversified portfolio and a bunch of securities collected by some experts.

Nonetheless, the same paper examines the criticism attached to the efficient market hypothesis about the predictability of stock prices and its relationship with efficiency.

Efficient Market Hypothesis and the Analysis of its Deviations

After the first formulation of the Efficient Market Hypothesis, in 1960s, multiple approaches were used to test the different serial correlation of security prices and whether among various trading strategies there was any investment value.

Coherently with the Efficient Market Hypothesis, the results were mostly negative. However, visible asymmetries in return distributions are considered an interesting area to be explored. In S&P 500 index since 1947, nine out of the ten biggest one-day movements, would be declines and in October 1987, the market crash caused a negative return bounded to 20 standard deviations away from the mean.

The conclusion was that stock returns are not normally distributed; they rather follow some sort of distribution which is still not categorized. Although the closer approximations are the stable Paretian distribution and Student *t*-distribution, the researchers who lack better assumptions, still assume normal distributions in relation to statistical inferences studies.

The Event Study Methodology

Researchers, following the "event study" methodology, took a sample of similar events happened in a selected amount of companies over a given time-horizon, and determined how, on average, this kind of event affected stock prices. Assuming the sample is made up of favorable events, we would expect the stock price to go up. The exact time of the price movement depends on whether the event is well-predicted by the market, and if the latter is efficient. In case of an unanticipated event and with the assumption of an efficient market, the stock price would adjust upward immediately.[6] On the contrary, an unanticipated event with the assumption of an inefficient market, would cause the stock price to adjust upward taking some time, consequently to the event.[7]

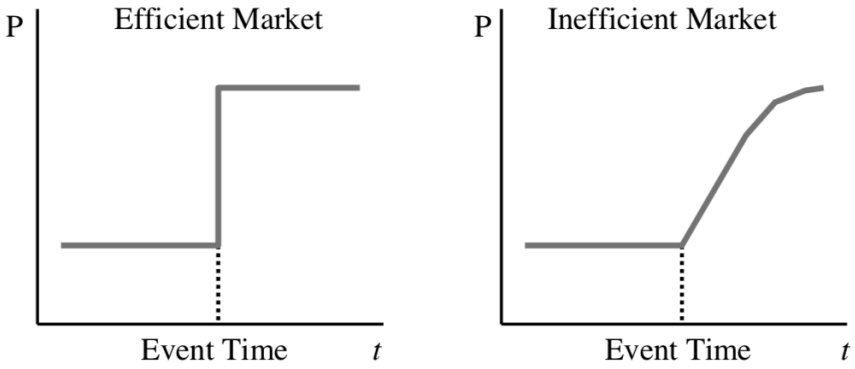

Figure 3. Market reaction to an unanticipated favorable event

On the other hand, when the event is anticipated and with the assumption of an efficient market, the stock price would go upward for some time before the event and stabilize on the

[6] See Figure 3a
[7] See Figure 3b

event date.[8] While, an anticipated event joint with the assumption of an inefficient market, would incentive the stock price to drift upward for some time before the event and keeps going after its occurrence.[9]

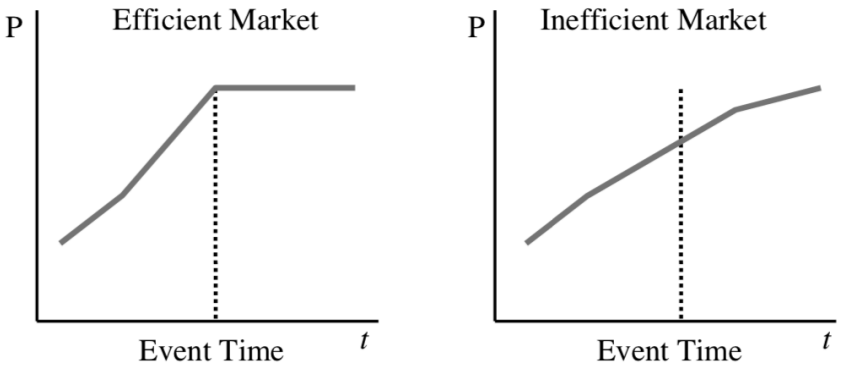

Figure 4. Market reaction to an anticipated favorable event

Eugene Fama, Lawrence Fisher, Michael Jensen, and Richard Roll executed the first event study, the so-called "FFJR study."

FFJR mainly examined the behavior of stock market in response to the announcement of stock splits such as inexplicable good news for investors.

Figure 5 shows on average, how stock prices around the date of the split behave.

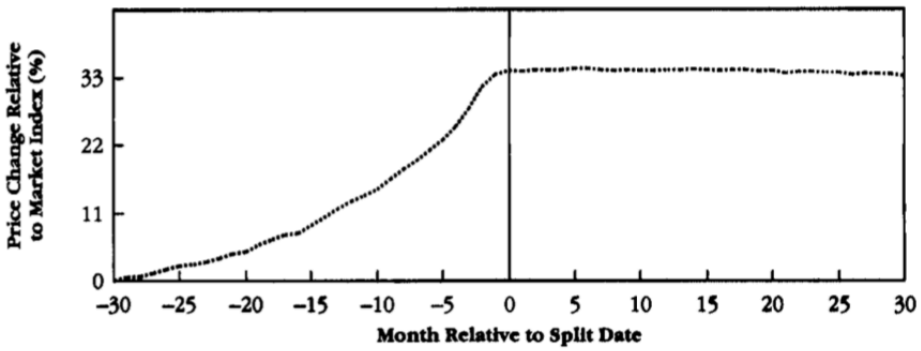

Figure 5. Averaged stock price performance around the split date

According to FFJR findings, 72% of firms in their sample consequently to the stock splits, claimed an increase in future dividends. In particular, the market anticipates about two years before the stock split occurs and all the consequences related to it come out.

[8] See Figure 4a
[9] See Figure 4b

The above methodology was better refined by other researchers over time, in accordance to anomalous and bizarre circumstances. In "An Analysis of the Stock Price Reaction to Sudden Executive Deaths", a 1985 article by Johnson, Magee, Nagarajan, and Newman, showed an association between unexpected CEO deaths with a decrease in stock price. On the other side, the stock price might increase if the CEO was the company founder as well, appealing to the idea that creating a business is different from the ability to run one. [10]

Can the investment performance be affected by professional investors? By 1975, the prevailing conclusions of statistical studies, still stated the efficiency of markets. The event studies showed a quick reaction of prices to new information embracing the weak form of market efficiency, so that technical analysis did not add any value. Furthermore, all the experiments related to professional investors' performances, are supporting the strong form of market efficiency.

[10] Ownership does not imply the control of a company, which is reserved to the directors.

Evidence of some anomalies

An Alternative to EMH

A big number of researchers tested the efficient market hypothesis, and some controversial evidence, clearly inconsistent with the weak-form market efficiency, began to come into the scene in the 1970s and 1980s.
An efficient market is efficient in relation to a set of information if it is 'fully reflected' in the price (Fama, 1970). However, the term 'fully' is a precise and strict requirement, implying that no real market might be efficient, so that the EMH is probably false.
Nevertheless, economics as a social science, accepts the EMH for one of the strongest hypotheses and until it will not be replaced by a better alternative, criticism is not taken into consideration.

The January Effect

In 1976, Rozeff and Kinney studied the stock market seasonality and found an important evidence: "The January Effect". Over the twelve months of the year, January has the highest stock returns.
The January Effect is a perceived seasonal tendency in stock prices to rise during the first month of the year. Analysts theorized this effect being due to an increase in buying, as a reaction to the December drop in price. In December investors sell winners in order to seek a year-end capital gains tax. Alternatively, investors may use year-end cash bonuses to buy investments for the following month

The Monday Effect

In 1981, Gibbons and Hess described "The Monday Effect". Stock prices decrease on Mondays, even if always less over time[11].

[11] See Figure 6

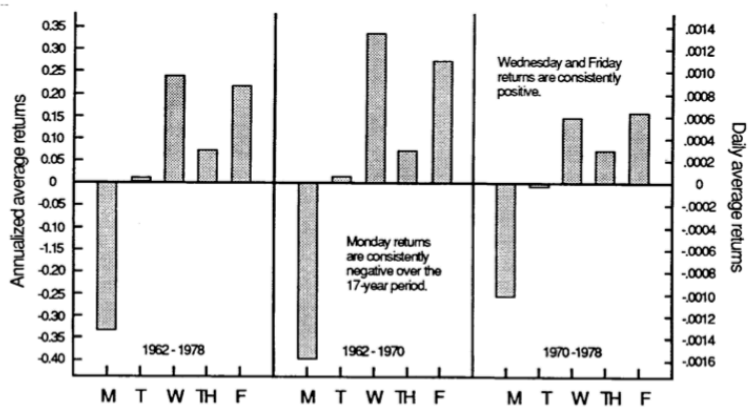

Figure 6. The Monday effect

- In the first nine-year period (1962-1970), the S&P 500, on Mondays had an average return of -0.16%.
- In the second nine-year period (1970-1978), the S&P 500, on Mondays had an average return of -0.10%.

According to data suggestion, as "the Monday effect" became popular to market participants, those, exploited the knowledge of private information causing a reduction in the gains over time.

Investment Advices: Are they Reliable?

The *Journal of Financial Economics* dealt with different market anomalies in June 1978, which looked like an obstacle to the efficient market hypothesis to be overcome by academic economists. In 1980, Sanford Grossman and Joseph Stiglitz published their article "On the Impossibility of Informationally Efficient Markets" in the *American Economic Review*. The Grossman-Stiglitz Paradox emerged: according to the efficient market hypothesis, if all the relevant information was reflected in stock prices, market participants would not be encouraged to acquire the information stemming behind the price, since considered as worthless.

A great majority of researches converged to the conclusion that a profitable selection rule is supported by publicly available information. Indeed, stocks with low price-earnings ratio and high dividend yield outperformed the market, while those stocks with a small capitalization and a higher risk, present a return premium overwhelmed, accounting for the additional risk taken.

Benjamin Graham in his book *The Intelligent Investor,* describes a stock selection criteria, tested by Henry Oppenheimer in 1981. Benjamin published different editions of his book and in each of those, presented a different investment advice to be tested.
Eventually, the claims of Graham, were considered particularly relevant in today's investments: avoiding big risks, so investing safely and by evaluating companies with surgical precision are the keys to success.

Earning Announcements: Underreaction or Overreaction of the Market?

In 1981, Robert Shiller in his article "Do Stock Prices Move Too Much to Be Justified by Subsequent Changes in Dividends?" studied the "excess volatility" of stock prices.
One year later, Rendelman, Jones, and Latané published "Empirical Anomalies Based on Unexpected Earnings and the Importance of the Risk Adjustments". They took a sample divided into ten categories, depending on how positive or negative the earnings surprises were and analyzed their effect on stock prices. [12]

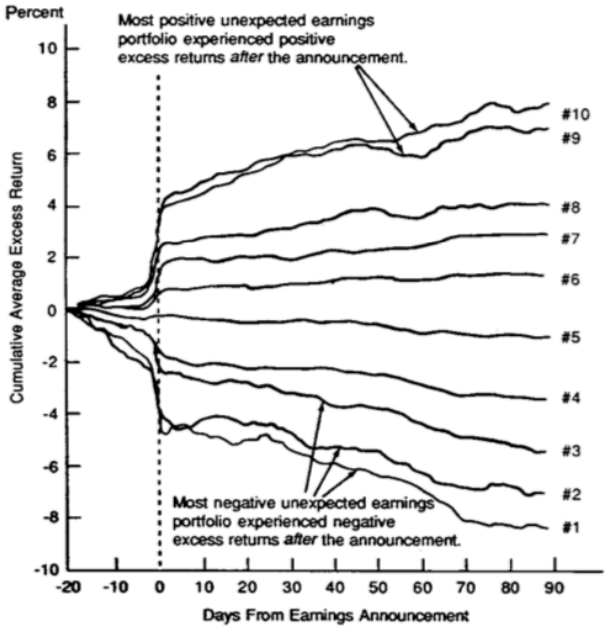

Figure 7. Stock price paths around earnings announcement by decile

Earnings surprises, both positive and negative, cause a quick reaction in the market and prices move in the direction of earnings surprises following the announcement.

[12] Figure 7 represents the averaged price paths for stocks in each decile.

The market is supposed to underreact to earnings announcements and coherently with the strategy of "earnings momentum", buying stocks just after a positive earnings surprise would be profitable. Nevertheless, in 1985, Werner De Bondt and Richard Thaler in "Does the Stock Market Overreact?"[13] concluded that stock market overreactions to some specific announcements may occur. In particular, the stock market had an overreaction trend to long series of bad news.

[13] In 1985, the anomalies were enough to arise doubts about the efficient market hypothesis consistency.

Doubts about EMH: Reconciling Theory and Reality

Discussing EMH Assumptions

At this moment in time, matching the efficient market hypothesis with those assumptions incoherent with real world life became a priority.

Market efficiency cannot be tested directly, but a valid alternative is a joint hypothesis stating that, first, the market is efficient in equating asset prices with their intrinsic values, and, second, we have the knowledge of what the intrinsic values are.

The weakness is that in case of findings related to an anomaly, you do not know which part of the joint hypothesis it is referred to.

Back to Fama's definition, an efficient market is supposed to offer free availability of current information to all participants. However, transaction costs related to the information processing and some additional costs arising from the market impact of large portfolios do exist.

While an institutional investor faces hiring costs about security analysts and portfolio managers, an individual investor faces an opportunity cost in every portfolio evaluation.

What is the level of transactional costs pushing the market out of the efficiency boundaries?

According to Michael Jense 1978 paper, "Some Anomalous Evidence Regarding Market Efficiency," the market is efficient if it adjusts prices within some limits set by the trading costs. For example, if transactional costs are 1%, the market would be considered still efficient in the scenario of abnormal return of 1%. The logic behind is that, as long as inefficiency does not create an opportunity for profit net of costs, the market may not be considered inefficient.

The way security prices are reported may also have some consequences.

A very common assumption is that trades can be executed at a closing price registered in a database, like CRSP. Nonetheless, the average NYSE-AMEX stock has a quoted bid-ask spread of about 3% and sometimes transactions cannot be executed at quoted spreads, given some illiquidity factors or too large market impacts. The latter concept was recalled by Donald Keim in his 1989 paper "Trading Patterns, Bid-Ask Spreads, and Estimated Security Returns". In support of "the January effect", stock prices at the end of December, result to tend towards the bid, but close prices in early January go closer to the ask.

Furthermore, in an efficient market short selling is presumed to be unrestricted. The issue arises because in reality, according to the prospectus of 70% of mutual funds, they would never

engage in a short sale.

In 1999, Mark Finn, Russell Fuller, and John Kling published an article by "Equity Mispricing: It's Mostly on the Short Side". They showed an empirical evidence in 1983-1998, in which overvalued investments are a great majority compared to undervalued ones. Indeed, in the above framework, overvalued large-cap U.S. stocks were almost equivalent to four times the amount of underpricing observed in undervalued large-cap U.S. stocks.
Eventually, investor heterogeneity is an unavoidable problem. They may have all the same information, but given their diversity, will present different interpretations and will act differently. We should remember that liquidity needs are an important discriminant. A common example is taxes. Rational investors, presented with the same situation, may run on different paths about tax-status: tax-exemption, tax-deferral or tax-available investor.
Completing the plot, Fama's model of behavior might be adjusted and integrated with some notions of behavioral finance.

An Alternative Behavioral Model

Since the beginning of 1980s, the behavioral science started to be incorporated into finance. The aim is to explain and justify those cases in which the efficient market hypothesis is not reflected empirically in reality. For example, the *excess volatility of prices* is a key area where empirical facts are in contrast with the efficient market hypothesis.
Another case-analysis is that according to theory *every investor is assumed to be rational*, hence he might be wondering which kind of information the seller has that he does not know, and vice versa. If this was true, the amount of actual trading under the efficient market hypothesis would be extremely small due to a person needs about liquidity and rebalancing. On the other hand, behavioral finance offers a plausible explanation for an higher amount of trade than theoretical expectations.
Next is the *dividend puzzle*. In a perfect world, following Modigliani and Miller claims, dividends and capital gains should lay on the same investor's indifference curve. Unlikely in everyday life due to the U.S. structure of the tax system, investors prefer capital gains to dividends, while companies appreciate more share repurchases to dividends. Dividends are an important signal of the financial health of a company: most large companies do distribute dividends and as those are payed, the share price increases.

The *equity premium* is another key area, which in the past has been much higher than the amount potentially justified by only the risk. In response to that, some supporters of the efficient market hypothesis might say that if the dividend yield comprises the equity premium, then it will be essentially lower. Finally, there was the appearance that the *prediction of future returns could stem from historic measures* as price-earnings and price-to-book ratios, earnings surprises, dividend changes, or share repurchases.

Summarizing, despite the whole set of these irregularities, the conclusion is a real-world portfolio manager who does not beat the market on average. Furthermore, a successful performance during the current year does not infer something of the performance of next year.

Cognitive Biases of Behavioral Finance

Behavioral finance states a cognitive bias, a misperception of reality in the investors' mind. The most common cognitive biases in finance are listed below.

Mental Accounting

More than half of people consider dividend yield differently from capital yield. Dividends are perceived as an increase in disposable income, while an increase in the price of shares is not.

Biased Expectations

People predictions usually follow a too optimistic trend about the future. The statistics suggest that a security analysis with an 80% confidence, is usually realized just 40% of the time. In the second half of 18th century, errors regarding forecasts lied between 25% and 65% of actual earnings.

Reference Dependence

An investor's reference point seems to be a fundamental factor in investment decisions. The propensity of an investor about a current purchase is contingent to the price of the last stock deal

Representativeness Heuristic

In cognitive psychology language, it represents the tendency of people to judge more probable an event which looks more representative than the others. A typical example is investors misperception that a good company necessarily issues good stocks. Those companies are considered good because they are well-known and hence fairly valued. However, may not present an upside potential.

> *"A classic investment mistake is to confuse a great company with a great investment. It is a mistake because a company's well-known virtues are presumably already factored into the price of the company's stock.[14]"*

Implications of Behavioral Finance in the Market

The reluctance to accept a loss, is interpreted as a deterrent to admit a mistake. In finance, this is one of the most common cognitive biases evidence, so that investors may avoid selling securities at a loss, even if that would imply a tax incentive. In his 1999 article, "The End of Behavioral Finance," published in the *Financial Analysts Journal*, Richard Thaler offers this simple model showing which are the implications of behavioral finance in the market.

> *"Suppose a market has two kinds of investors: rational investors (rationals), who behave like agents in economics textbooks, and quasi-rational investors (quasi' s), people who are trying to make good investment decisions but make predictable mistakes. Suppose also that two assets in this market, X and Y, are objectively worth the same amount but cannot be transformed from one into the other. Finally, assume that the quasi's think X is worth more than Y, an opinion that could change (quasi' s often change their minds) while rationals know that X and Y are worth the same. What conditions are necessary to assure that the prices of X and Y will be the same, as they would be in a world with only rational investors? This question is complex, but some of the essential conditions are the following. First, in dollar-weighted terms, such a*

[14] Anderson, J., and G. Smith. 2006. "A Great Company Can Be a Great Investment." Financial Analysts Journal, vol. 62, no. 4 (July/August):86–93
This study tested this 'mistake' by looking at the stock performance of the companies identified each year by Fortune magazine as the most admired companies in the United States for 1983 through 2004. Surprisingly, a portfolio of these stocks outperformed the market by a substantial and. statistically significant margin, which contradicts the efficient market hypothesis.

market cannot have too many quasi' s (in order for the rational investor to be marginal). Second, the market must allow costless short selling (so that if prices get too high, the rationals can drive them down). Third, only rational investors can sell short; otherwise, the quasi' s will short Y when the two prices are the same because they believe X is worth more than Y. Fourth, at some date T, the true relationship between X and Y must become clear to all investors. Fifth, the rationals must have long horizons, long enough to include date T. These conditions are tough to meet."

According to Thaler's words, quasi-rational investors believes about undervalued assets, may cause an asset bubble, which is already planned to burst as soon as quasi-rational investors change their mind. An asset bubble makes the price of stocks to rise exponentially not being backed by a real rise in value of the security. The demand of that security increases up to the point, due to irrational exuberance, the bubble "bursts" and the demand falls pushing down prices as well.

How Could Behavioral Finance Study Come Up with Some Advantages?

Behavioral finance importance is evident in the process of decision making. That is why, if on one hand may cause an impossibility to beat the market, on the other, it helps us to guess which are the beliefs and motivations behind the actions of clients and try to provide better services. According to Statman, M. 1999a. "Behaviorial Finance: Past Battles and Future Engagements", market efficiency is a middle point between standard finance, behavioral finance and investment professionals. However, that medium point operates contemporary along two binaries: investors cannot regularly beat the market and security prices are rational. Rational prices are meant to reflect only utilitarian characteristics such as risk, and not value- expressive characteristics, such as sentiment. Nonetheless, behavioral finance showed that value-expressive characteristics are a determination factor in both investor choices and asset prices. The ultimate conclusion is a concept of market efficiency only bounded to the impossibility to beat the market, and not to prices as rational figures: asset-pricing models reflect both value-expressive and utilitarian characteristics. Each product has a single and unique set of utilitarian and value-expressive characteristics, which may be more visible in some cases, less in others. Jewelry has clear value-expressive characteristics, while a detergent has not. Also, investments have value-expressive characteristics, and are reflected in price differences among those

apparently identical. *Stock exchange advertisements* are a clear sign. The NYSE advertisement emphasizes its solidness, while NASDAQ promotes its innovative potential.

Mutual funds marketing offers another perspective. In 1983, Charles Jarvie was in charge of the mutual funds marketing of Fidelity Investments. Before to be employed in Fidelity, Jarvie was part of Tide and Pringles at Procter & Gamble and he noticed some deficiencies in the mutual funds marketing. Thanks to his leadership and experience, Jarvie brought Fidelity to have a stronger brand name and financial services industry, redefining it as a "family of funds".

Further insights can also be given by some studies on *investment clubs*. In 1998, Brad Barber and Terrance Odean of the University of California at Davis studied performance of 166 investment clubs that had accounts with a large brokerage firm and found that 60% of the clubs lagged the market. The average underperformance was 3.8% a year. Apparently, investment clubs lack utilitarian characteristics, but the story does not end here. Also in 1998, Brooke Harrington of Harvard University studied the identity formation in investment clubs. Her sample included three clubs: an all-men's club where all members were sports car hobbyists, an all-women's club where all members belonged to the American Association of University Women, and a mixed-gender club where all members met each other through a church singles group. She concluded that investment clubs are also social clubs. In terms of our marketing approach, they do have strong value-expressive characteristics.

Is a Compromise in Sight?

The recent literature claims there is no possible reconciliation between traditional and behavioral finance. On one hand the supporters of behavioral finance admit the limitations of this approach. Meir Statman of Santa Clara University, as briefly mentioned before, said that market efficiency ramifies in two notions: the impossibility to systematically beat the market and the rationality of security prices. The latter definition implies that prices only reflect "fundamental" or "utilitarian" characteristics, but not "psychological" or "value-expressive "ones. Finally, Statman concludes with the following quote:

> *"I argue that finance scholars and professionals would do well to accept market efficiency in the beat-the-market sense but reject it in the rational-pricing sense."*

On the other hand, some research modelling effects of opinion differences was produced by standard finance. As the number of sellers and buyers increases, both demand and supply shift to the right. As trading volume varies directly with the investor's opinions, figure 8 shows a simple Marshallian cross analysis of a widening difference in opinions. The magnitude of the volume increases, while the price-effect cannot be determined without any specific data on the supply and demand shift.

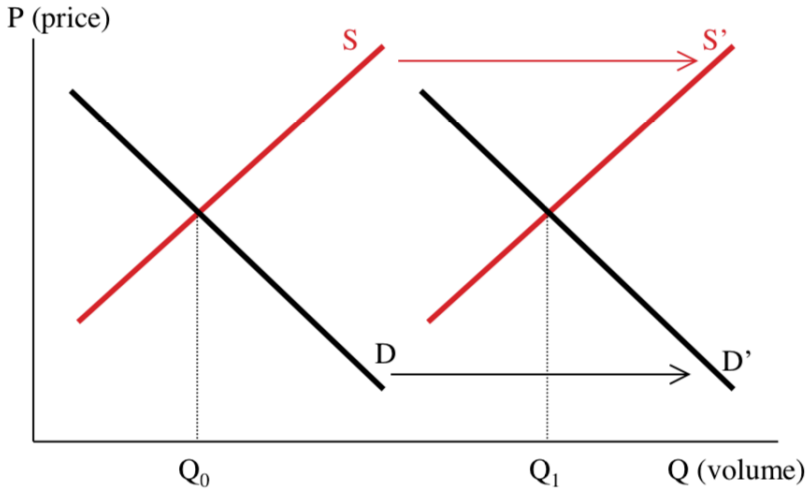

Figure 8. Opinion difference and trading volume

Joseph Chen and Harrison Hong of Stanford University and Jeremy Stein of Harvard Business School, in their 1999 paper, "Differences of Opinion, Rational Arbitrage and Market Crashes," propose a model worth to be discussed.

A and B are two investors, fully rational and risk-neutral arbitrageurs, who receive different private signals modelling their rational perceptions of the same stock value. Even if both the signals are useful for A and B, they only consider their own. For this reason, arbitrageurs asses the best estimate of the stock's value through an average between the two signals.

However, if A and B face short sale constraints and they receive negative signals, the arbitrageurs would not take into account those signals. This means that the negative private information will not affect the market price and it is coherent with the outcome of the empirical research on equity mispricing staying usually on the short side.

If arbitrageurs only figure out positive news, the price of the stock rises, up to the moment in which some of them start to take short positions in the stock, since they suspect an overvaluation. The final outcome is an increase in the trading volume due to the multiple

opinions of the arbitrageurs. If the stream of good news quits, or in the case the private signals of A and/or B go public, then the stock price would fall.

"Forecasting Crashes," is a late paper of Chen, Hong and Stein in which there are some findings about a positive correlation between the probability of a crash a trading volume relative to trend over prior six months and positive returns over the prior thirty-six months.

Afterall, many stock market anomalies can be understood and explained behavioral biases or institutional imperfections. Indeed, Richard Thaler claims that a proper institutional and corporate finance investment should be made applying a behavioral model. The economist Herbert Simon with his 1947 book, *Administrative Behavior,* won the Nobel. The outcome of its research was summarized by the Nobel committe: Simon rejected the classic view of the firm as omniscient, rational, profit-maximizing entrepreneur, by replacing it with the idea of an entrepreneur composed by cooperating rational decision makers with limited capacities imposed by the lack of knowledge of potential consequences and by personal and social ties.

In the 1956 paper by John Lintner, "Distribution of Incomes of Corporations among Dividends, Retained Earnings, and Taxes," published in the *American Economic Review*, is a typical example of the approach stated before, which is still a model of the dividend nowadays. Lintner interviewed the corporate executives about the dividend policy followed and concluded that companies count for the dividend close to a desired payout ratio, but in any case, they avoid cutting it.

Empirical evidence of EMH anomalies in the cryptocurrency world

Diving into the Cryptocurrency World

After a deep explanation and understanding of the EMH and its anomalies, is interesting to examine such issues in the context of the cryptocurrency market.
The latter market is an interesting case as an emerging, unexplored market while being extremely vulnerable to anomalies, given its high volatility relative to the FOREX, stock and commodity markets. (Cheung et al., 2015; Urquhart, 2016; Aalborg et al., 2019).

What is Bitcoin?

With the development of the new technology over the last decades, the creation of a digital currency has been attempted multiple times. However, none has been successful until the introduction of the cryptocurrency Bitcoin in 2008, which differs from fiat money in the way that has no intrinsic value.
As part of the virtual currency scheme as the most successful and controversial, Bitcoin has been designed and implemented by the Japanese programmer Satoshi Nakamoto in 2009. The scheme is a peer-to-peer network, close to BitTorrent, the popular protocol operating with files-sharing, including films, games and music, over the internet. P2P is a decentralized network, hence not presenting a central clearing house, or any financial or other institutions involved in the transactions. Indeed, Bitcoin users are in direct contact with each other, with no need of intermediation between themselves.
For the same reasoning, the money supply is determined by a specific type of "mining" activity, not embracing any activity of a central authority, depending on the amount of resources[15] that "miners" devote to solving specific mathematical problems.
The providers accepting Bitcoins are listed in a database of reference.
The wide transaction-versatility of Bitcoins is mainly due to their divisibility to eight decimal

[15] electricity and CPU time

places: it can be used globally as a currency for any kind of transaction involving both virtual and real goods or services, hence competing with official currencies[16], regardless of the value. Mt.Gox is the most widely used currency exchange platform and allows users to trade US dollars for Bitcoins and vice versa.
Thereafter, purchased Bitcoins are stored in a digital wallet on the user's computer, meaning that in case users do not implement adequate antivirus and back-up measures, may face the risk of losing their money.

Users have Incentives to Use Bitcoin

Bitcoin allows for anonymous transactions. Accounts are not registered, and Bitcoins are sent directly from one computer to another. Furthermore, users have the possibility of generating multiple Bitcoin addresses to differentiate or isolate transactions.
Transaction fees, if any, are low: compared to traditional ones, bitcoin is a high-speed and cheap means of payment.
Eventually, Bitcoin appears to be a good alternative payment system for countries with a non-trustable banking system or a volatile and inflated currency. One of these countries is Venezuela, and the situation will be described more thoroughly later in this paper. The roots of this reasoning stem from the Austrian School of Economics Theory, which explains how a current fiat money system requiring the monetary interventions undertaken by governments and other agencies, invades the business cycles resulting in a massive inflation. The ultimate result of this situation, is entrepreneurs guided by distorted interest rate signals, taking overly ambitious investment projects not matching with their intertemporal consumption preferences. In short, Bitcoin is a means of payment supporting a decentralized system, avoiding the government intervention which has not revealed to be constructive in the long run.

Weak Form of Market Efficiency of Bitcoin Cryptocurrency Market

In the past years some researches about the predictability of Bitcoin prices have been made.

[16] euro or US dollar

In case prices are predictable, then arbitrage opportunities would be present, while in the opposite scenario, prices would follow a random walk so that the market is efficient and strategies to beat the market would be pointless. To test the efficiency of Bitcoin market, you can verify if Bitcoin returns are independently and identically distributed random variables. Andrew Urquhart in 2016, was the first researcher to examine this phenomenon and he found out that Bitcoin market in US was not weakly efficient over the full time period, but was moving towards a weak form of market efficiency in the last subsample.
The University of Agder decided to give a contribute to the existing literature by replicating the study of Urquhart using more recent data and comparing to US, Venezuelan market. The parallelism among those two markets was made to have a closer look at the development and different uses of Bitcoin.
In the US, Bitcoin is seen as an alternative asset, which may diversify a portfolio. On the other hand, the hyperinflation of Venezuelan domestic economy, has led to an increasing part of the population using Bitcoin as a currency, and mining has also become more widespread over the recent years.

US and VENZUELA case

To analyze the US market, Bitfinex exchange platform has been used, one of the largest after Mt.Gox closing in 2014. On the other hand, LocalBitcoin exchange platform was taken into consideration to analyze the Venezuelan market, founded in 2012.
Urquhart studied the returns of Bitcoin between 2010 and 2016, while the later study focused on a more recent time period, from 2014 to 2018. To study the change in prices, daily logarithmic returns are used in order to allow the interpretation of being continuously compounded.

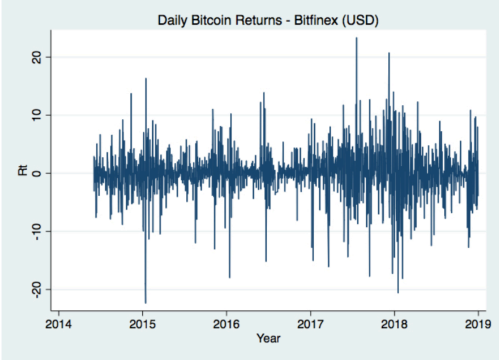

Figure 6.1: Bitcoin returns obtained from Bitfinex

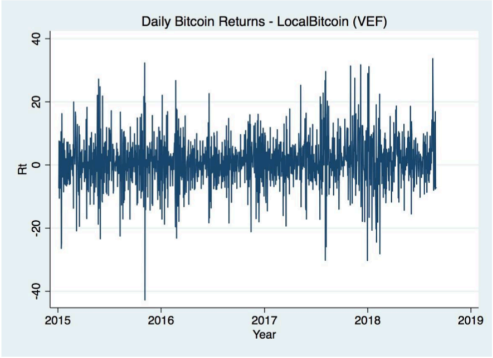

Figure 6.2: Bitcoin returns obtained from LocalBitcoin

The descriptive statistics for both US and Venezuela, suggest some deviations from a normal distribution, which is later verified by the skewness and kurtosis test for normality in Stata. Indeed, the null hypothesis of the data being normally distributed is rejected. The conclusion can also be seen from a plotted histogram of daily returns, showing a higher peak against a normal distribution curve (figure 6.3 and figure 6.4)

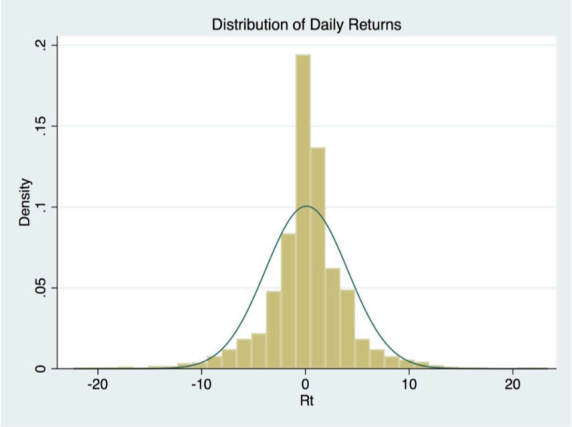

Figure 6.3: Histogram of daily returns with densities, plotted against a normal density curve for the US

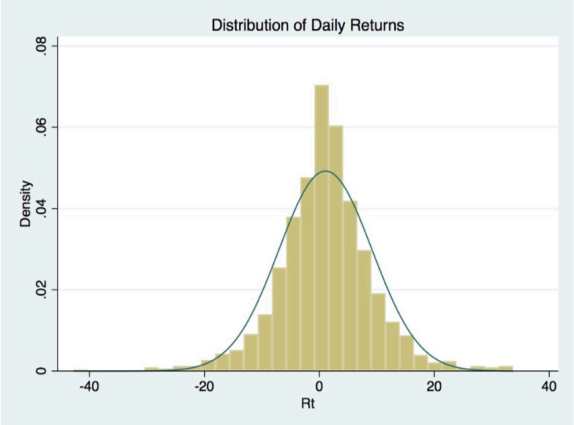

Figure 6.4: Histogram of daily returns with densities, plotted against a normal density curve for Venezuela

The Weak Form of Market Efficiency implies randomness in a time series where observations are serially independent, and a constant probability distribution over time. In order to obtain relevant evidences whether daily Bitcoin results were independently identically distributed, the analysis performed six different statistical tests. Eventually the results about US were coherent with the ones of 2006: the Bitcoin market seems to go towards a weak form of EMH. Venezuela, on its side, showed the total absence of the weak form of market efficiency. Those findings are an interesting starting point to explore more in depth the Bitcoin market efficiency and figure out if the development of trading strategies may lead to the possibility to beat the market.

Month of the Year Effect

The Bitcoin Market might still be relatively inefficient and a good basis for the Month of the Year Effect existence, which is a still not discussed calendar anomaly in the cryptocurrency market.

Anomalies in financial markets, refer to a context in which individual securities or a group of them, do not reflect in their prices all the available information, hence performing differently with respect to the definition of efficient markets.

Calendar anomalies have been studied in the financial literature in depth during the last decade[17], and have been defined as those effects related to a specific time. Among the most popular ones, there are the Weekend effect, Month of the Year effect and the January effect. In our case, we focus on the Month of the Year effect: returns on particular months are higher than other months, hence average returns differ across period, offering the possibility to earn abnormal returns by exploiting the patterns and set trading strategies accordingly. This will violate the efficiency market hypothesis partially developed by the Fama E. in the 1960s. We apply a variety of statistical methods (average analysis, Student's t-test, ANOVA, the Kruskal-Wallis, and regression analysis with dummy variables) to analyze the Bitcoin monthly returns over the period 2013-2019. Among the multiple types of cryptocurrency, we use monthly data for Bitcoin because it is the cryptocurrency with the greatest market capitalisation and longest time-horizon of data (see Table 1).

[17] Bepari K. and Mollik A.T., 2009, Dr.D.S.Selvakumar 2011

Table 1

Top cryptocurrencies by capitalisation (01.05.2019)*

№	Name	Market Cap	Price	Circulating Supply	Data start from
1	Bitcoin	$148 657 197 170	$8 267,84	17 980 175 BTC	28 Apr 2013
2	Ethereum	$19 674 550 330	$182,07	108 059 235 ETH	07 Aug 2015
3	Ripple	$12 017 970 035	$0,278408	43 166 787 298 XRP	04 Aug 2013
4	Bitcoin Cash	$4 236 366 686	$234,76	18 045 263 BCH	23 Jul 2017
5	Litecoin	$3 659 603 443	$57,70	63 420 942 LTC	28 Apr 2013

*Source: compiled by Authors based on (CoinMarketCap, 2019).

The sample covers the period from June 2010 (the first available observation) to the end May 2019. The data source is CoinMarketCap[18] which provides volume-weighted average prices reported for each crypto exchange (for example, BitCoin prices are the average of those from 400 markets). As the result this is the most reliable source of information about prices in the cryptocurrency market.

Statistical Procedure

To test the Month of the Year effect, we are taking into consideration the following hypothesis:
H_1- Returns being different on different months of the year
H_2- Month of the Year effect provides opportunities for the occurrence of abnormal profits from trading in the cryptocurrency market
Ultimately, the null hypothesis (H_0) focuses on whether analyzed data sets (returns of specific month) belong to the same general population (the whole data set).
In case the null hypothesis will be rejected, there will be an evidence of an anomaly; in the opposite case, no anomaly will be observed.
Student's t-tests, ANOVA and Kruskal -Wallis test in two variants have been used. The first executes an overall testing , analyzing all data at once, while the second does a separate testing, comparing data from the period "suspicious for being anomaly" (month of interest) with all the rest of the data, except the values which belong to the "anomaly data set" (month of interest returns).
Furthermore, multiple regressions including a dummy variable to identify certain calendar anomaly have been tracked as well.

[18] https://coinmarketcap.com/coins/

Empirical Results

Visual analysis (Fig.1) shows an evidence of Month of the Year effect. According to the average analysis, Bitcoin returns show a "W" pattern with peaks on March and October, being 3-4 times higher than on other months. Indeed, the perfect time for bitcoin investors in taking a long position is apparently July, August and September.

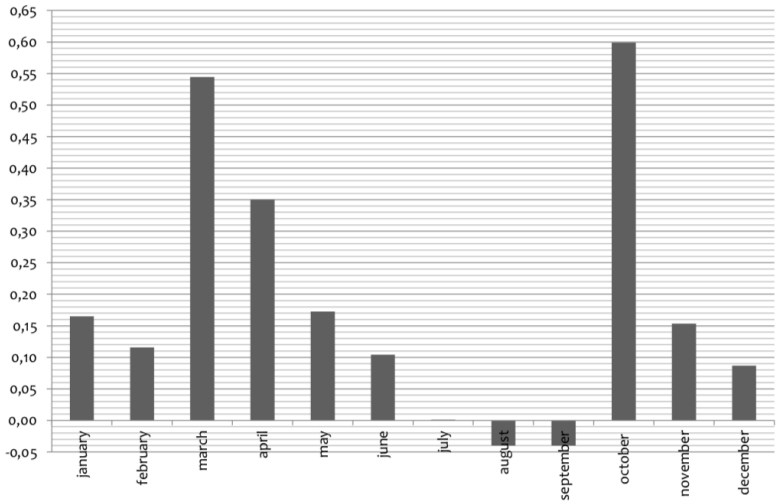

Fig. 1. Average analysis: case of Bitcoin returns*

*Source: compiled based on Author's calculations.

On the other hand, statistical tests, including the regression analysis, present mixed results. According to t-test (Table 2), there is a sign of the anomaly, confirming the Month of the Year Effect. As we can see, some months individual returns statistically differ from all the other data.

Table 2

T-test of the Month of the Year Effect (t-critical (p=0,95) = 2.15)*

Period	All data excluding specific month		Specific month		t-criterion	Null hypothesis	Anomaly status
	Average	Standard deviation	Average	Standard deviation			
	0,22	0,30	0,17	0,33	-0,78	Not rejected	Not confirmed
February	0,22	0,31	0,12	0,64	-0,83	Not rejected	Not confirmed
March	0,18	0,23	0,54	1,11	1,62	Not rejected	Not confirmed
April	0,20	0,27	0,35	0,53	1,38	Not rejected	Not confirmed
May	0,22	0,30	0,17	0,31	-0,71	Not rejected	Not confirmed
June	0,23	0,31	0,10	0,19	-2,90	Rejected	Confirmed
July	0,23	0,30	0,00	0,31	-3,58	Rejected	Confirmed
August	0,24	0,30	-0,04	0,17	-7,19	Rejected	Confirmed
September	0,20	0,25	-0,04	0,17	-6,58	Rejected	Confirmed
October	0,18	0,30	0,60	1,56	1,34	Not rejected	Not confirmed
November	0,22	0,31	0,15	0,30	-1,05	Not rejected	Not confirmed
December	0,23	0,28	0,09	0,35	-1,93	Not rejected	Not confirmed

*Source: compiled based on Author's calculations.

ANOVA analysis (Table 3) confirms only partially the anomaly: overall data set analysis shows no statistically significant differences between different months and the whole data set. Nonetheless, for the case of separate testing returns of August happened to be statistically different from all the remaining data.

Table 3

ANOVA test of the Month of the Year Effect

Period	F	p-value	F critical	Null hypothesis	Anomaly status
Overall	0,80	0,64	1,89	Not rejected	Not confirmed
January	0,13	0,72	4,49	Not rejected	Not confirmed
February	0,21	0,65	4,49	Not rejected	Not confirmed
March	0,91	0,35	4,49	Not rejected	Not confirmed
April	0,55	0,47	4,49	Not rejected	Not confirmed
May	0,10	0,75	4,49	Not rejected	Not confirmed
June	1,06	0,32	4,49	Not rejected	Not confirmed
July	2,60	0,13	4,49	Not rejected	Not confirmed
August	5,88	0,03	4,49	Rejected	Confirmed
September	0,21	0,65	4,49	Not rejected	Not confirmed
October	0,63	0,44	4,49	Not rejected	Not confirmed
November	0,22	0,65	4,49	Not rejected	Not confirmed
December	0,87	0,37	4,49	Not rejected	Not confirmed

*Source: compiled based on Author's calculations.

Non-parametric Kruskal-Wallis test (Table 4) does not confirm the anomaly. However, significant differences in returns emerge in separate testing results on February, July and August which can be taken as evidence in favor of the Month of the Year Effect.

Table 4

Kruskal-Wallis test of the Month of the Year Effect*

Period	Adjusted H	d.f.	P value	Critical value	Null hypothesis	Anomaly status
Overall	12,08	11	0,36	19,68	Not rejected	Not confirmed
January	0,00	1	0,96	3,84	Not rejected	Not confirmed
February	5,07	1	0,02	3,84	Rejected	Confirmed
March	0,16	1	0,69	3,84	Not rejected	Not confirmed
April	0,05	1	0,83	3,84	Not rejected	Not confirmed
May	0,05	1	0,83	3,84	Not rejected	Not confirmed
June	0,24	1	0,63	3,84	Not rejected	Not confirmed
July	4,31	1	0,04	3,84	Rejected	Confirmed
August	5,48	1	0,02	3,84	Rejected	Confirmed
September	0,05	1	0,83	3,84	Not rejected	Not confirmed
October	0,05	1	0,83	3,84	Not rejected	Not confirmed
November	0,10	1	0,76	3,84	Not rejected	Not confirmed
December	1,22	1	0,27	3,84	Not rejected	Not confirmed

*Source: compiled based on Author's calculations.

Regression analysis with dummy variables of the Month of the Year Effect finds no evidences in favor of this anomaly (Table 5). All the slopes are statistically insignificant (p-values are much higher than 0,05) as well as overall model (F is very low).

Table 5

Regression analysis with dummy variables of the Month of the Year Effect*

Parameter	Slope coefficient	p-value
January (a_0)	-0,165196	0,464480
February (a_1)	-0,020526	0,877017
March (a_2)	0,157744	0,236028
April (a_3)	0,076826	0,562771
May (a_4)	0,003030	0,981775
June (a_5)	-0,025402	0,848133
July (a_6)	-0,068313	0,606763
August (a_7)	-0,085275	0,520711
September (a_8)	0,065532	0,621468
October (a_9)	0,180435	0,175768
November (a_{10})	-0,004872	0,970697
December (a_{11})	-0,032599	0,805877
F-test	0,7965	0,643000
Multiple R	0,29	
Anomaly	not confirmed	

*Source: compiled based on Author's calculations.

Eventually, all the empirical results are collected and summarized in Table 6. As we can see, in the cryptocurrency market, particularly in Bitcoin Market, there is no evidence of anomalies.

However, Bitcoin prices provide some anomalous evidences in July and August, being abnormally lower compared to the rest of the year.

Table 6

Overall results for the case of Bitcoin*

Month/Methodology	Average analysis	Student's t-test	ANOVA analysis	Kruskal -Wallis test	Regression analysis with dummies	Overall
January	-	-	-	-	-	0
February	-	-	-	+	-	1
March	+	-	-	-	-	1
April	-	-	-	-	-	0
May	-	-	-	-	-	0
June	+	+	-	-	-	2
July	+	+	-	+	-	3
August	+	+	+	+	-	4
September	-	-	-	-	-	0
October	+	-	-	-	-	1
November	-	-	-	-	-	0
December	-	-	-	-	-	0

*Source: compiled based on Author's calculations.

Conclusion

The Efficient Market Hypothesis is a sensitive topic explored and described by literature over the last decades. The assumptions underpinning the theory were widely discussed and evolved over time. The definition of the Efficient Market Hypothesis was subject to some strict requirements which faded in front of controversial real-world anomalies. Exploring what is behind prices is a massively important implication. Indeed, being aware of which assumptions should be considered as relevant and reliable, is fundamental when taking investment decisions. In recent times, the cryptocurrency market, in particular the Bitcoin, was a new investment opportunity introduced to the 20th century's population. Bitcoin is a means of payment supporting a decentralized system and avoiding the government intervention which has not revealed to be constructive in the long run. In the past years some researchers found out the predictability of Bitcoin prices, hence of arbitrage opportunities. Andrew Urquhart in 2016, found out that Bitcoin market in US was not weakly efficient over the full time period, but was moving towards a weak form of market efficiency in the last subsample. The University of Agder replicated the study of Urquhart using more recent data and comparing to US, the Venezuelan market. The parallelism among those two markets was made to have a closer look at the development and different uses of Bitcoin. Eventually the results about US were coherent with the ones of 2006: the Bitcoin market seems to go towards a weak form of EMH, which is Bitcoin returns are independently and identically distributed random variables. Venezuela, on its side, showed the total absence of the weak form of market efficiency. Those findings were an interesting starting point to explore more in depth the cryptocurrency framework and figure out if the development of trading strategies may lead to the possibility to beat the market. Being a young, unexplored as well as vulnerable market, set a perfect scenario for studying its efficiency and verify for the Month of the Year Effect existence. Empirical results stemming from multiple statistical procedures, present no evidence of anomalies in the Bitcoin Market. Nonetheless, Bitcoin prices provide some anomalous evidences in July and August, being abnormally lower compared to the rest of the year. In conclusion, Meir Statman quote is quite explicative about the general nowadays belief:

> *"People are 'rational' in standard finance; they are 'normal' in behavioral finance. Rational people care about utilitarian characteristics, but not value- expressive ones, are never confused by cognitive errors, have perfect self- control, are always averse to*

risk, and are never averse to regret. Normal people do not obediently follow that pattern.

Standard finance asks for too much when it asks for market efficiency in the rational sense, and investment professionals ask for too much when they insist that the primary contribution of behavioral finance is its potential help in beating the market.

Accepting market efficiency in the sense of beating the markets and rejecting it in the sense of rationality would allow finance researchers to ask questions about the roles of investment professionals that go beyond the role of beating the market. Investment professionals belong to many groups, and we need to understand the benefits, both utilitarian and value expressive, they provide. "

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