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Is Modern Finance Geared Up to Support Financial Regulation?

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Abstract

The chief intellectual assumptions behind financial regulation are that capital markets are efficient and market participants act rationally. These assumptions have always been subject to some challenges and their empirical verification occupies a large portion of modern finance literature. Nevertheless, they represented the leading financial market theory during the decades preceding the 2007-8 crisis. The crisis demonstrated that modern theory does not allow for solid risk assessment and reliable macroeconomic forecasting. Such challenges suggest that modern finance may be facing a paradigm crisis. While a debate must be opened to assess how to move forward from the current mainstream paradigm, today there are no viable alternatives that can replace the current paradigm.

Keywords

Financial crisis, rational markets, market efficiency, behavioral finance, modern finance, paradigm, financial regulation

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I. Introduction

The chief intellectual assumption behind financial regulation is that capital markets are efficient and market participants (in well-regulated and liquid markets) are rational.[i] Stock prices in liquid markets follow 'random walks' and adjust instantaneously to new information thanks to the assessment of a widely distributed network of independently rational economic agents. This mechanism creates a tendency toward an efficient equilibrium. These assumptions have always been subject to some challenges from different quarters and their empirical verification occupies probably the most conspicuous portion of modern finance literature. Nevertheless, they represented the leading financial market theory during the decades preceding the 2007-8 crisis.

The 2007-8 crisis was characterized by such massive turmoil in the capital markets that to find a similar episode one would have to go back to 1929 (Rich (2013)). The S&P 500 index fell 57% from its October 2007 peak of 1,565 to 676 in March 2009. The Dow Jones Industrial Average fell 54% from its high of 14,164.43 – reached on October 9, 2007 – to 6,443.27 by March 6, 2009. On September 29, 2008, financial markets experienced the biggest ever single-day crash in Dow Jones history (a drop of 777.68 points or 6.98%), which was a consequence of the news that the U.S. House of Representatives rejected the government's proposed $700 billion bank bailout. The second biggest single-day loss happened just six days later, and during 2008 the Dow also experienced the fourth, fifth, and tenth largest single-day crashes ever seen in its history.

In the US, three of the top 5 investment banks (Goldman Sachs, Morgan Stanley, Merrill Lynch, Lehman Brothers, and Bear Stearns) either filed for bankruptcy or were acquired after coming close to bankruptcy. In March 2008, JP Morgan acquired Bear Sterns for a mere $10 a share, with the Fed guaranteeing large parts of Bear's liabilities. On September 15, 2008, Lehman Brothers filed for the largest bankruptcy in US history. During the same month, Merrill Lynch,

struggling for survival, sold itself to the Bank of America. With a $180 billion federal government bailout, AIG was nationalized the day after Lehman failed. In the US, the rate of bank failures went through the roof. In 2007 only 3 banks failed, but in the following years the rate of failure accelerated to its peak in 2010 (25 in 2008, 140 in 2009 and 157 in 2009); after that, the rate of bank failures began a gradual return to lower levels (92 in 2011, 51 in 2012, 24 in 2013, 18 in 2014, 8 in 2015 and 5 in 2016).

In Europe, a number of similar dramatic events reshaped the banking industry. On September 18, 2008, Scottish HBOS was acquired by British Lloyds TSB, and the group was bailed out by the British government just one month later, together with the Royal Bank of Scotland. On October 5, 2008, the French BNP Paribas acquired the Belgian and Luxembourg assets of Fortis, a Belgian bank bailed out just a week before. In September 2008, the Franco-Belgian Dexia Group was bailed out by the Belgian government, and reorganized in 2012; the healthy operations were renamed Belfius, and the remaining part left in a "bad bank". Swiss-based UBS was bailed out (for US$9.7 billion) in December 2007 by the Government of Singapore Investment Corporation (one of the bank's largest shareholders) and in 2008 by the Swiss National Bank ($60 billion) and the Federal administration of Switzerland. Between 2010 and 2012, the Spanish sector of *cajas* (savings and loan associations) was completely restructured, with the $19 billion bailout of Caja Madrid – renamed Bankia – being the most notable.

The capital market crisis anticipated what could later be observed in the broader economy, namely the beginning of what has been called the Great Recession, which for the US began in December 2007 and ended in June 2009 (the longest recession since World War II). In this period, the American real gross domestic product (GDP) fell 4.3% in the period from 2007 Q4 to 2009 Q2. The US unemployment rate rose from 5% in December 2007 to 9.5% in June 2009 and peaked

at 10 percent in October 2009 while US home prices fell approximately 30%, on average, from their mid-2006 peak to mid-2009.

The reaction of policy makers was not mild. The Fed reduced its policy interest rate (the Fed Funds rate) from 5.25% in September 2007 to 0-0.25% in December 2008. At that point, the Fed also initiated quantitative easing programs to relieve financial stress by purchasing housing-related debt, short- and long-term Treasuries, and other assets. The ECB followed the rate reduction, but with a one-year lag as they initiated the decrease only after Lehmann collapsed.

The objective of this paper is not to add to the abundant literature on the causes of the crisis. Rather, the goal is to highlight that, facing such dramatic developments, the macroeconomic forecasts completely missed what was coming, and that the standard sophisticated quant models were unable to provide a realistic view of the financial risks that institutions were exposed to. Did market prices correctly reflect company valuations just before the crisis? Did momentum, herd behavior, or other market anomalies affect these valuations? Did market participants act rationally (in the sense defined by mainstream finance) before and during the crisis? The dramatic events described above suggest a clear negative answer to these questions. Furthermore, a growing body of academics and industry practitioners are convinced that irrational market behavior contributed to that crisis. See for example Shiller (2008) and Cooper (2008).

The reaction of financial regulators to the crisis was instantaneous and colossal. For example, a substantial amount of literature has been published by the Basel Committee of Banking Supervisors (BCBS) to analyze the crisis and identify the causes. As part of this effort, and in order to fix the gaps of the existing regulatory framework, a major capital requireme*f*nt upgrade called Basel III was published between 2010 and 2011. Similarly, in the US, the Dodd-Frank Act was approved in 2010. This bill encompassed a number of reforms, including indications on how to

support the Fed by enhancing capital requirements and financial stability. However, these reforms relied on the same framework and assumptions (efficient markets and rational choice) that were used to design the previous version of these regulations. Moreover, they leveraged and extended the same risk measurement techniques such as Value at Risk (VaR).

In order to assess whether regulators took appropriate actions to improve financial stability, in Section 2 I assess the current status of mainstream finance and highlight the limitations that were uncovered during the 2007-8 financial crisis. In Section 3, I draw the conclusion that there is a crisis in current mainstream finance, and that there is a need for debate to assess how to move forward. The options to evolve the current paradigms, evaluated in Section IV, conclude that modern finance and the current financial regulatory frameworks are outdated, and that a profound intellectual debate is required in order to define how and in which direction the finance discipline should move in order to support sustainable financial stability.

II. Current Status of Mainstream Finance

According to Ardalan (2008), mainstream modern finance embraces a broad spectrum of theories, namely: portfolio theory, the efficient market hypothesis, the capital asset pricing model, option theory, agency theory, arbitrage pricing theory, capital budget policy, capital structure policy and dividend policy. The first three of this list are commonly reunited under the label Modern Portfolio Theory. In this section I review the elements of mainstream modern finance that came under scrutiny after the 2007-8 crisis, that is Modern Portfolio Theory and Value at Risk (the main technique used by the industry and the regulators to measure market risk).

II.1 Modern Portfolio Theory and Diversification

Although Modern Portfolio Theory (MPT) has been the object of severe criticism during its short life, Markowitz's principles have always been treated with gratitude and respect due to the leap forward they represented for the investment discipline. As a demonstration that innovation always encounters resistance, it must be pointed out that the initial impact of these new principles was insignificant. They were originally published in 1952, but it took the 1973-74 stock market crash (when the S&P 500 fell 43% from December 1972 to September 1974, or 50% after adjusting for inflation) to convince the industry that risk should be part of decision-making in investment management (Bernstein (1996)).

The first key insight introduced by Markowitz was the notion of diversification as a means to reduce the variance of an investment portfolio. The second important idea Markowitz pioneered was a new framework, known today as mean-variance, which allows asset allocation decisions to be based on two dimensions that can be measured quantitatively: expected return and risk. Although this was not the explicit intention of Markowitz, the investment industry generalized this framework, adopting the rule that the standard measure of an asset's risk is the asset's volatility.

Markowitz's work revolutionized the investment management profession, but it also received severe criticism. Bernstein (1996) highlighted three main shortcomings.

First, before Markowitz, investment decisions were based on historical returns and a qualitative assessment of risk (expert-judgment-based). Portfolio selection removes intuition from the equation and provides a prescriptive recipe about what investments to undertake, based on a given arbitrary dose of risk.

Second, critics questioned whether variance is the proper proxy for risk. Value investors have demonstrated multiple times the weaknesses of this approach. According to MPT, high

volatility corresponds to high risk, and consequently higher potential gain. However, a stock may have high volatility due to strong buying pressure (irrational exuberance), just before the end of its bull cycle. Clearly, it is a risky stock with low potential gains. Conversely, a high volatility stock may be bottoming out of its bear cycle and represent a great potential buy.[ii] Finally, stocks with low volatility due to low momentum but high upward potential (based on fundamental analysis), may be seen by an orthodox viewer as a low volatility-low risk security, when instead they hide a great high return-low risk opportunity. An additional problem with volatility as a proxy of risk is the assumption in MPT that volatility is constant, when in reality it is not. Some solutions have been found to overcome this issue (especially with stochastic models such as that of the GARCH-family), but their use, due to computational complexity, remains limited. Furthermore, investment managers are aware of the importance of assessing an investment against the risk taken (risk-adjusted performance management), but by measuring risk as volatility, risk-adjusted measures become biased toward low volatility instead of risk. The idea that a portfolio can be composed solely around two numbers (risk and return) holds only if returns are normally distributed (a normal distribution can be identified by its mean and standard deviation), but the limitations of the normality assumption (how to address the tail?) are well known. Alternative measures to variance have been proposed, for example, in Dowd (2002).

Third, what if the positive monotonic relationship between risk and return is falsified? Empirical evidence such as that described by Murphy (1977) has highlighted anomalies in the relationship volatility – return (capital markets line), therefore the proportional relationship does not hold. Additionally, we have to ask the question, should we treat extra return as a risk premium?

In addition to Bernstein's (1996) concerns, I'd like to highlight some further issues. As a fourth issue, the debate around the performance of MPT has been going on for decades. DeMiguel,

Garlappi and Uppal (2009), for example, were able to show that MPT did not outperform a portfolio based on equal allocation. The debate has been fuelled by industry practitioners that seek to demonstrate the superiority of active management (where the portfolio manager implements a specific investments strategy with the goal of outperforming a benchmark reference, such as for example the S&P 500) vs. passive management.

A fifth limitation involves the diversification principle. Blanque (2014) is very vocal on the impossibility of obtaining reliable results with diversification as an investment strategy. In order to diversify properly, one has to invest in market segments that are weakly correlated, which requires specializing in a broad spectrum of investment types. As a result, an investor may be diversified, but have a weak idea of what is going on in his portfolio from a fundamental analysis perspective. According to Iyiola, Munirat, and Nwufo (2012), diversification (or MPT) forces the investor to invest in assets without analyzing security fundamentals, solely for the benefit of eliminating non-systematic risk. This provides upward pressure on assets which have low fundamental value, but which have characteristics in terms of historical mean-variance that help achieve the diversification goal. The same point is made by Scott (2011). In contrast, a concentrated portfolio may be exposed to a reduced range of risk factors but may have been conceived with a solid understanding of the fundamentals. Moreover, large funds (especially mutual funds) reach such a gargantuan size that for the number of stocks they hold, they prove to be "over-diversified", with the consequence that it becomes tougher to beat the indexes. Finally, if every investor follows this strategy, we will observe herd behavior tending toward favoring low volatility portfolios, with the logical consequence that in times of crisis every investor would begin to sell as soon as volatility increases (systemic risk).

As a sixth point, we should underline the amount of research that has been dedicated, for decades, to the computational complexity of the mean-variance framework. In order to calculate the optimal asset allocation, one has to overcome the problem of estimating the mean, variance, and correlations. Blanque (2014) emphasizes that this complexity is due to the heavy data and computational requirements needed to assess correlations between arrays of assets. Using historical values to estimate future risk, return, and correlations is an option that entails adopting an inductive view of the future. What if the past does not contain sufficient information about the risks we could possibly face in the future? In this respect, correlations are very difficult to estimate, and correlation breakdowns in times of crisis remain an unsolved issue. This can be partially moderated with a frequent (and computationally expensive) recalibration of correlations. The approach of using historical values is opposed to Probabilistic Risk Assessment, (used in nuclear plants and other complex engineering undertakings typically associated with low frequency events), where the risk is assessed through the probabilistic assessment of risk factors.

Seventh, MPT is focused on a single time period perspective. While the capital asset pricing model (CAPM) introduces this assumption explicitly (as we will see below), Portfolio Theory requires the assumption to be in place, in order to enable comparative evaluation among different investment alternatives.

Finally, MPT assumes infinite access to liquidity. This has been abundantly challenged by academics (Pedersen (2015)). In addition to this, the financial crisis has shown that portfolio managers were generally unprepared to cope with the dramatic fluctuations of the financial crisis.

The financial crisis was not kind to those investors following MPT and the principle of diversification. DeMiguel, Garlappi, and Uppal (2009), confirms that a majority of investors, following the diversification principle, were unprepared for the crisis.

II. 2 The Random Walk Hypothesis and the Efficient Market Hypothesis

A random walk is a game in which the outcome is determined by chance (like a coin flip). Kendal (1953) was the first to show that prices of stocks and commodities look like a random walk, an observation which was confirmed by evidence from Samuelson (1965) and Fama (1965). Stock prices are said to follow a random walk, because it is not possible to find a pattern in share price changes. Adopting such an assumption enables us to reuse all the theoretical architecture built by physicists regarding the random walk of physical particles (Einstein, Brownian motion, Martingales). We just assume that market prices will move the same way.

The point of the Random Walk Hypothesis (RWH) is that price changes of an individual stock are independent from one another. A good way to see this is to assess the degree of dependence of the price change on successive days. For example, if we consider pairs of days, we could assess the correlation of the price change on day t and day t+1 in order to calculate the correlation coefficient (in this case we speak of autocorrelation or serial correlation, since we are concerned with the correlation of a stock price change with itself). Empirical studies abound in the literature which confirm that stocks have a very weak serial correlation.

The RWH is justified on the basis that past prices do not allow predictions of future prices. If this was possible, that is, if past prices enabled the identification of future price trends, then an easy profit would appear in the market and investors would immediately react by buying or selling until the market price matched the value of the asset (Net Present Value, intrinsic value, etc.). As a result, prices adjust to new information.

Value investors have pointed out that the RWH is a solution for the problem that we do not understand the determinants of price changes. The random walk approach offers an easy short cut

to such lack of visibility, rather than an explanation. If we do not understand soccer, we can find evidence that there is a 33% chance that one team will win, a 33% chance that the other will win, and a 33% chance that the result will be a draw. In the same way, stock prices are the result of random chance in so far as we lack the basic understanding about why they occur. Moreover, according to Fisher (1996), the problem with this type of thinking is that it focuses on the short term. Since we cannot find recurring patterns to obtain a profit by trading stocks based on short-term forecasts, RWH proponents concluded that prices follow a random walk. If one moves the time horizon to a longer term (taking the perspective of the investor rather than the trader), prices become "efficient" (Fisher (1996)).

The RWH explains that prices in one period (yesterday) are uncorrelated to prices in the following period (today). One could wonder why we should stop at the information represented by past prices and not consider all the information available to investors? The Efficient Market Hypothesis (EMH) extends the idea to all information, suggesting that today's prices reflect all information available to investors. According to Fama (1976), in an efficient capital market, the prices of securities at any time are based on correct evaluation of all information available at that time. In such a market, prices should reflect the available information for the simple reason that if this were the case, then arbitrage opportunities would trigger a process that closes the gap.

II.2.a Empirical Challenges to the Efficient Market Hypothesis

In its early stages, the theory gathered a quasi-plebiscitary consensus among researchers, quickly becoming mainstream (Cootner (1962; 1964), Fama (1963; 1965a), Fama and Blume (1966), and Osborne (1959), all cited in Lo (2007)). Eventually, the drive toward originality promoted a set of studies aimed at dissecting the deviations from the stock value forecasted by the EMH. Such deviations were defined as "anomalies", that is, market situations in which the security

price differs from the fundamental value (commonly defined as the Net Present Value, where the cost of capital is determined by the capital asset pricing model). Empirical testing of the EMH represents one of the most hotly debated subjects in the history of financial literature. Michael Jensen was unequivocal in his editorial introducing the 1978 special issue of the new Journal of Financial Economics dedicated to the testing of the EMH: "I believe there is no other proposition in economics which has more solid empirical evidence supporting it than the Efficient Market Hypothesis" (Jensen (1978) p. 95), quoted in MacKenzie (2006) p. 95.

Nevertheless, the number of empirical findings published against the predictions of the EMH is overwhelming. I provide here merely a concise list of the main anomalies:

1. *Random Walk Hypothesis*: In a 1988 paper entitled "Stock market prices do not follow random walks: evidence from a simple specification test", Lo and MacKinlay use weekly US stock returns indexes from 1962 to 1985 to derive a positive serial correlation in weekly returns. For holding periods longer than one week (three to five years) different studies – for example Fama and French (1988) and Poterba and Summers (1988) – obtain a non-zero serial correlation in US stock returns indexes from 1962 to 1985. However, the amount of data used in these studies to reject the RWH was not sufficient to reach the usual level of significance.

2. *Value investing, overreaction, underreaction, and reversion to the mean*: Value investing was invented by Benjamin Graham and David Dodd long before Fama's idea. When the debate on the market anomalies began, scholars found that stocks with a low price multiplier over earnings returned, on average, higher returns than stocks with higher price multipliers. This was a substantial confirmation of the main principles of value investing. Moreover, empirical testing confirmed that stock prices may overreact by buying stocks that had recent gains or selling stocks that suffered recent losses. Similarly, they may underreact to the news. Overreactions push prices

away from their 'equilibrium' or 'rational' value and are brought back in line by the 'arbitrage' activity of rational investors. Reversion to the mean refers to the general phenomena of the market price reverting to the equilibrium value after a certain time lag. Lo (2007) provides the main references in the literature for such phenomena: The classical studies are DeBondt and Thaler (1985), Poterba and Summers (1988), Summers (1986), Conrad & Kaul (1988), Chopra, Lakonishok and Ritter (1992), Lehmann (1990). The debate was not settled and it was actually the object of a revival starting in 2007 (Spierdijk and Bikker (2013)).

3. Size effect (small firms outperform large ones): Fama and French (1992) is a cornerstone in the study of the size effect on stock returns.

4. Calendar effects: Different effects fall under this category. The January effect implies that the main portion of the relative outperformance of small firms occurs at the turn of the calendar year. Lo (2007) also recommends referring to Banz (1981), Keim (1983), Roll (1983), and Rozeff and Kinney (1976). I also recommend Haugen and Lakonishok (1988) and Chopra, Lakonishok, Ritter (1992). Other effects are that Monday returns are lower and that most of the daily returns come at the beginning and end of the trading day (BMA (2011)).

5. Momentum effect: An investment strategy that buys winners (stocks with high returns in a short time period of 3 to 12 months) and sells losers. This is the anomaly that most troubled Fama, [iii] (Jegadeesh, and Titman (1993)). This anomaly echoes the behavioral assumption that investors underreact to new information. This investment strategy is widely exploited in trading: see for example, Jegadeesh, and Titman (2001), MacKenzie's interview with Ross and Roll Asset Management (MacKenzie (2006) p.102), and the research published by AQR Capital.

6. Post-earnings announcement drift: the idea that investors underreact to good news was documented for the first time by Ball and Brown (1968). BMA (2011) also recommends Bernard and Thomas (1990) and Chordia and Shivakumar (2005).

7. Bubbles and market efficiency: Financial bubbles represent deviations from the trajectory of "efficient" stock prices. It is not straightforward to identify whether a bubble is developing in a particular asset market. Conversely, it is quite simple to identify a bubble ex-post when a bust makes it evident retrospectively. What is less easy is to set up a reference in order to determine the amplitude of the asset price inflation during the bust and, ultimately, how long it took to return to normality after the bust. The same difficulty found by econometricians in studying bubbles is encountered by investors trying to evaluate single stocks. It takes strong rigor and discipline to assess the prospective value of a public company using fundamental analysis. According to BMA (2011), many investors therefore rely on easier decision-making practices such as assessing the current market price against a reference benchmark (comparable securities, etc.).

8. Smooth dividends with volatile market prices: Shiller's (1981) and Leroy and Porter's (1981) volatility tests found that stock market volatility was far greater than could be justified by changes in dividends. By showing that prices were more volatile than they should be, Shiller implied that markets cannot be an efficient mechanism that perfectly reflects all the relevant information.

9. Other notable anomalies include: closed-end funds, index inclusion (when shares of a company are included in a stock price index, the price of these shares suddenly increases) and Siamese twins (dual-listed companies sharing the same underlying cash flow but having different stock quotations).

There is also a large body of literature that has supported the EMH, arguing that these anomalies are instead evidence in favor of it, because market opportunities behind the anomalies cannot be exploited to a significant extent due to risk and transaction costs. BMA (2011) supports this line of argument by citing the words of Professor Roll, a market efficientist and authority in the field of anomalies: "Over the past decade, I have attempted to exploit many of the seemingly most promising "inefficiencies" by actually trading significant amounts of money according to a trading rule suggested by the "inefficiencies" . . . I have never yet found one that worked in practice, in the sense that it returned more after cost than a buy-and-hold strategy" (Roll (1994)). According to Lo (2007), the possibility of profiting from anomalies due to the existence of transaction costs, liquidity issues, institutional rigidities and non-stationaries cannot be demonstrated scientifically. Therefore, the economic value of the anomalies must be assessed in the long term.

II.2.b Theoretical Challenges to the Efficient Markets Hypothesis

In the 1990s a new "behavioral" approach to finance gained attention. According to its advocates, human decision making cannot be rational because it is affected by systematic biases (endowment effect, sunk costs, hyperbolic discounting, difficulties in maximizing utility, etc.: the catalog of biases can be long). For example, investors may follow the herd, assuming that market leaders or the majority of people will know what will happen. If investors' decisions are not 100% rational, then market prices cannot be efficient (MacKenzie (2006) p. 97). Behavioral finance has fostered much of the empirical research that challenged the EMH. The list of anomalies that are not compatible with the notion of market efficiency has grown to such an extent that behaviorists like Shleifer (2000) are confident that asset prices do not reflect neoclassical fundamentals.

When the 2013 Nobel Prize in economics was assigned to both Fama (representing the EMH) and Shiller (representing the most prominent behavioral challenger to the EMH), Clifford Asness and John Liew, who had written their doctoral thesis under Fama twenty years before, provided an interesting view about the EMH in Asness and Liew (2014). They argued that it is not possible to test the EMH without adopting an asset pricing model, which is why EMH and the capital asset pricing model (CAPM) go hand in hand. So, when one observes efficient market anomalies, they must be referred to the joint couple EMH + CAPM. They claimed that the empirical evidence against the EMH has divided academia into two camps. According to one side of the debate, the CAPM is wrong, because risk is not only about beta factors but also about other factors (in line with the position taken by Fama against the CAPM).[iv] According to the other side of the debate (the behaviorists), markets are not efficient because people are not rational; their thinking is imperfect and is unconsciously influenced by heuristics (biases), hence market prices do not fully reflect the available information. Surprisingly, Asness and Liew take a mid-way position between Fama and Shiller. They believe the EMH is mostly right, except for a couple of difficult anomalies which need to be dealt with: value and momentum. One would expect that their opinion derives from the fact that the CAPM does not tell the full story and a multifactor model would be more appropriate. But this is not entirely true. They believe that the absence of market players that would intentionally represent the counterparty of a value + momentum investment strategy (long on cheap stocks and short on expensive ones) suggests that there is a behavioral component to be taken into account.

Another theoretical challenge came from the idea that it is impossible to reach an "informationally efficient" equilibrium (Grossman and Stiglitz (1980)). If the market cannot be beaten, the idea is to invest in the market portfolio. However, if every investor adopts this strategy,

nobody will have the incentive to be the first to bid stock prices up based on new available information. As a result, prices will not 100% reflect all information, as otherwise the incentive to operate to gather information would vanish. While the idea is appealing, MacKenzie states that this approach never reached mainstream acceptance (MacKenzie (2006) p. 327, note 7).

II.2.c Market Episodes That Challenge the Efficient Market Hypothesis

The stock market crash of 1987 was the first episode that generated a broad debate around the EMH. It is characteristic of that period to remember the position of the leaders of the two main parties to that debate. On one side, Robert Shiller took a bold position against it: "The efficient market hypothesis is the most remarkable error in the history of economic theory. This is just another nail in its coffin." (Fox (2009) p. 232). On the other side Eugene Fama admitted the frustration of not being able to identify the news that triggered the crash; other fathers of the theory such as William Sharpe or Fisher Black were not able to provide an account of the event fully consistent with the theory (Smith (2003) p. 234).

Fast-forwarding thirteen years, a vast amount of research has been dedicated to study the Internet bubble: the Nasdaq index was 1140 in March 1996, reached its apex at 5048 in March 2000, and then started a steady decline that returned to 1140 in October 2002. The excesses observed especially during the last two years of the bubble were defined as Irrational Exuberance by Nobel Prize winner Robert Shiller. EMH advocates engaged in intellectual contortions to justify the validity of the theory. For example, Pastor, and Veronesi (2006) claim that the fundamental value of a firm increases with uncertainty, thus stock market prices were consistent with this view and therefore the theory was not necessarily invalidated. Surely, fundamental investors must have been impressed by the argument that we must pay more when we know less. Eugene Fama defended the EMH claiming that markets were victims of the recession (rather than the other way

around) but conceded that "poorly informed investors could theoretically lead the market astray" and that stock prices could become "somewhat irrational" as a result (Hilsenrath (2004)).

However, the most challenging capital markets episode for the EMH was the financial crisis of 2007–08. A number of industry practitioners have claimed that the EMH was responsible for it. Jeremy Grantham stated that the belief in the hypothesis led investors to a "chronic underestimation of the dangers of asset bubbles breaking" (Nocera (2009)). Roger Lowenstein declared "The upside of the current Great Recession is that it could drive a stake through the heart of the academic nostrum known as the efficient-market hypothesis" (Lowenstein (2009)). Academics and policy makers followed along the same lines. Paul Volcker chimed in, saying it is "clear that among the causes of the recent financial crisis was an unjustified faith in rational expectations [and] market efficiencies" (Volcker (2011)). Laurence Siegel, at the Research Foundation of CFA Institute, said that "By 2007–2009, you had to be a fanatic to believe in the literal truth of the EMH" (Siegel (2010) p. 7).

II.3 Capital Asset Pricing Model

The year 2014 was the 50th anniversary of the capital asset pricing model (CAPM). This model is still the cornerstone of MBA investment courses, and it is often the only asset pricing model taught in these programs. As a result, today the model is used to estimate the firms' cost of capital and to evaluate the performance of managed portfolios.

The CAPM rests on three pillars (Bernstein (1996) p. 257-8). The first one is Harry Markowitz's Portfolio Theory. The main point of this theoretical element is that investors only care about the mean and variance of their one-period investment return. As a result, investors choose "mean-variance-efficient" portfolios. The second and third pillars represent two

assumptions introduced by Sharpe (1964), Lintner (1965) and Mossin (1966), who independently came to the same conclusions. The first assumption, introduced by Sharpe (1964), is the possibility of borrowing and lending infinite amounts at a risk-free rate. According to the second assumption, all investors agree on the distribution of expected returns at t+1, therefore they all see the same opportunity set. Hence, all investors hold the same portfolio of risky assets, and this portfolio must be the market portfolio. As a result, the expected return of a portfolio consisting of riskless and risky assets, can be calculated as a function of the market beta (systematic risk), the sensitivity (or correlation) of the asset's return to the fluctuations of the market portfolio.

The CAPM introduced a substantial set of assumptions which immediately attracted a great deal of criticism. Fama and MacBeth (1973) was one of the first empirical studies to successfully test the returns forecasted by the CAPM. Other studies demonstrated the opposite, the most prominent of which was Black, Jensen, and Scholes (1972). They found that low-beta portfolios outperformed market portfolios (and, vice versa, high-beta portfolios had lower returns), which led them to conclude that their evidence was "sufficiently strong to warrant rejection of the traditional form" of the CAPM (MacKenzie (2006) p. 90). Black (1972) also represented an attempt to provide an alternative form of CAPM where Sharpe's assumption of unlimited borrowing at the risk-free rate was dropped.

The most serious theoretical critique of the CAPM came from Richard Roll, who had previously been one of Fama's Ph.D. students at the University of Chicago. In Roll (1977), he highlighted the issue that the market portfolio must necessarily include every asset available in the economy; it could not be represented only by the S&P; a broader definition was required, including other asset types such as real estate, bonds, precious metals, rare art, collections, human capital, etc. Many of these assets will not have readily available market prices to be observed, therefore

the market portfolio is by definition unknowable. As a consequence, the CAPM cannot be tested, a conclusion that was conceded even by Professor Sharpe (MacKenzie (2006) p. 93).

The financial literature observed an accumulation of the empirical refutations of the CAPM. Fama himself revised his initial assessment and with Fama and French (1992) put forward what Mackenzie called the most influential empirical critique (MacKenzie (2006) p. 91). According to the paper, the linear relationship between beta and average return predicted by the CAPM was confirmed only in the period 1941–1965, while it was refuted with data after 1965. Fama and French's paper became known in the literature as the "the death of beta", and it represents, together with Roll's critique, the most important blow to the CAPM. It is interesting to note that even Markowitz presented his formal dismissal of the CAPM. In Markowitz (2005), he contested the realism of two of the model's assumptions, that is a) investors can borrow infinite amounts of money at the risk-free rate, and b) investors can short without limit (which allows them to obtain significant leverage). If the assumptions are made more realistic, then the market portfolio is not efficient anymore, making passive asset management nonsensical (Bernstein (1992) p. 129).

One of the most highly disputed assumptions of the CAPM was that concerning infinite access to liquidity. However, the role of liquidity in the global financial crisis of 2007-8 taught us a few lessons (Blanque (2014) p.31). First, the assumption of infinite access to liquidity has been clearly proven wrong by the crisis. Liquidity can suddenly dry up and evaporate. However, the presence of a lender of last resort may introduce a moral hazard component to liquidity assessment. In this case, liquidity premia will be lower than in absence of a lender of last resort, since the provider of liquidity of last resort will always provide support at prices that will be sub-Bagehot standards. On the role of central banks as providers of liquidity of last resort, see Mehrling (2010).

Second, liquidity risk before the crisis was mispriced. Regardless of the origins of the issue, and the tools used by the monetary authorities to address the crisis, investors observed low liquidity premia before the crisis, and higher liquidity premia after the crisis. This has shown that standard theory needed to be updated in order to embed liquidity risk into asset valuation models. The lesson was also learnt by banking regulators, who moved from Basel II to Basel III, where one of the most important updates is the introduction of quantitative capital requirements for liquidity risk, which were completely absent in the previous version of the regulation.

Third, liquidity risk is particularly important for investments where asset-liability matching is a concern. Exposures to illiquid assets are usually consistent with long-term investors that are not subject to asset/liability mismatch risk. They hunt for opportunities where (il)liquidity premia may allow higher long-term returns. According to Pedersen, liquidity risk consists of three components: i) market liquidity risk: the risk of renouncing a portion of the market price, when urged to sell an asset quickly; ii) funding liquidity risk: due to asset liability mismatch; iii) demand pressure risk: when, for example, a hedge fund needs to accommodate high demand pressure (buying low and selling high) (Pedersen (2015) p. 42).

II.4 Value at Risk

Value at Risk (VaR) is a simple market risk measurement technique invented by Man Raymond at JP Morgan in 1994 to be able to tell an executive how much a trading portfolio can lose probabilistically speaking, meaning with a certain level of confidence and over a given time period. The VaR gained tremendous success both in academia and industry thanks to two appealing characteristics. First, it provides a common consistent measure of risk across different positions and risk factors (it makes it possible to compare a fixed income position with an equity position).

Second, it accounts for the correlations among positions, so that if two risks offset each other, then the overall risk measurement will be lower.

II.4.a Main Theoretical Critiques to the Value at Risk

A number of criticisms have been raised against the VaR since its inception. The main ones are:

1. Failure to capture fat-tail risks. As highlighted in Dowd (2002), the VaR was conceived to provide a statistical estimation valid 95% or 99% of the times. It does not provide any information regarding what happens to the remaining 5% or 1% of occasions, therefore when a tail event occurs, the VaR provides no indications. In consequence, investment decisions based on the VaR will favor assets with low VaR under most circumstances with potentially significant losses on rare occasions. In other words, the VaR introduces a distortion in basic risk-return analysis since it breaks down the monotone risk–return relationship when we enter tail territory. This distortion is overcome only in specific circumstances such as when risks are elliptically distributed or ranked by first-order stochastic dominance, an empirically not very common situation (Yoshima and Yamai (2001) p.16-17; Dowd (2002) p. 26).

2. VaR's lack of sub-additivity defies diversification. According to the sub-additivity property, the risk of the sum should not be greater than the sum of the risks; in other words the aggregation of the individual risk should not increase the overall risk. The VaR is not sub-additive when built on top of normal or generally elliptical distributions (Artzner, et al. (1999) p. 217). This provides the incentive to build less diversified portfolios, since a diversified portfolio may have a higher VaR than a less diversified one.

3. Built looking at the past. The two main methods to calculate the VaR are based on past data. *Historical simulation* (the favorite of banks) simulates portfolio behavior over a preselected historical period and takes the worst loss. The *variance-covariance method* (the original method, more computationally intense) uses past market data to estimate future volatilities and correlations between portfolio components (Triana (2012) p.17). In both cases, if a crisis is preceded by a long period of low volatility (the pre-2007 period was labeled the "death of volatility" or the "great moderation"), then in either case the VaR will underestimate the real risk. In addition to that, if a financial institution can select the historical period over which the historical simulation is performed (as is the case in banking regulation), there is an incentive to cherry pick to select past data to allow the highest correlation, which makes it possible to minimize the capital requirement.

4. It increases concentration risk; it is pro-cyclical and fails to capture systemic risk. The VaR provides the incentive to invest in high-return/low-VaR instruments, that is, securities that experienced low volatility in the recent past. The market players that use it as an investment strategy or regulatory capital optimization strategy will arrange their portfolios around the same positions. As Persaud (2000) has shown, the model makes it possible to identify calm areas in the sea of financial markets in order to exploit their low VaR characteristics and settle there for a while. As soon as the wind picks up in these spots, a general sell off will occur and investors will move to the next placid spot. This provides the incentive to discriminate fundamentally sound investments from shakier ones with a low VaR profile. Most importantly, such an incentive creates a self-feeding effect. A localized sell-off will increase the volatility of the security, triggering a contagion that could build up into a liquidity shock (haircuts rise and correlations go to 1). This is what happened for example during the crises of 1997 (Asia) and 1998 (Russia), where the low

VaR numbers were hit by a sudden increase in volatility, kicking off a liquidation cascade that led, in the end, to the LTCM default (Triana (2012) p. 29).

This concentration risk was highlighted in Jorion & Taleb (1997), which according to Dowd (2002) is the most convincing argument against this issue since it was written before the 1998 financial crisis. Other studies supporting this position are: Danielsson (2001), Danielsson and Zigrand (2001), Danielsson, et al. (2001), and Basak Shapiro (2001). At the same time, one could note that diversity in risk assessment brings diversification to risk approach and position-building, eliminating the pro-cyclicality issue and lowering systemic risk.

5. It ignores the fundamental characteristics of an asset. What matters for the VaR are not the intrinsic characteristics, but the recent past behavior of the asset. As an example, the VaR can treat a toxic CDO and a Treasury in the same way.

6. It creates a false sense of security around highly leveraged portfolios. The issues above show why it is possible to build a portfolio with VaR that underestimates the real risks. Consequently, it is possible to engineer highly leveraged portfolios with a low VaR figure. To give an idea of this, before the crisis, in Wall Street and the City of London, institutions were able to design portfolios leveraged 100 to 1 by following the VaR regulatory rules, that is, the bank had to post 1% of capital for its trading book (Triana (2012) p. xvii).

II.4.b Adoption of the VaR by Regulators

The VaR was quickly adopted by regulators in their market risk capital frameworks to determine the regulatory capital required for the trading book of banking institutions. The 1996 Amendment to Basel I came as a response to the industry's request to allow banks to use proprietary in-house models for measuring market risks (BCBS (1996)) This made it possible to

adopt an internal model based on a 10-day 99% VaR based on a minimum of one year's worth of historical data, where it was allowed for correlations within and across asset families. Basel II was released in 2004, and it basically introduced new requirements for credit risk (banking book) while keeping the same arrangements for market risk (trading book). The recommendations of the Basel Committee for Banking Supervision (BCBS) do not have the force of law but the regulatory frameworks proposed by the Committee (Basel I and Basel II) were adopted by almost all the supervisors worldwide, except for the US, where the SEC initially refused to substitute its requirements. However, in 2004 the SEC also incorporated the VaR-model as a capital charge calculation methodology for the trading book following a methodology similar to Basel's (SEC (2004)). The new rule incentivized a race toward the lowest capital figure. Before April 2004, the regulatory capital for toxic, illiquid assets (for example subprime CDOs), was much higher than traditionally less risky assets (Treasuries, T-Bonds). The new rule made it possible to treat the two asset classes in the same way.

II.4.c The Challenge of the Financial Crisis to the VaR

The 1998 LTCM crisis had already raised tough challenges for the VaR as a measure of market risk. Risk controls at LTCM relied on a VaR model (one day 99% VaR) which systematically failed to detect the fundamental market movements during the six months leading to the crash. The literature to this effect is abundant: (Davis (1999), GAO (1999), Lowenstein (2000), Crouhy, Galai, Mark (2001), Pablo Triana (2012)) and – probably because it was considered a unique episode due to the idiosyncrasies of the hedge fund – it did not lead to a revision of the mainstream view of the VaR. Above all, it did not represent a sufficient case to prevent regulators from adopting VaR on a large scale.

The 2007-8 financial crisis severely challenged the VaR-framework. Triana (2012) defends the thesis that the crisis was caused by the introduction of innovative toxic instruments representing a risk that was underestimated by VaR, considered as the official measure followed by supervisors globally. The thesis is supported by solid evidence. In 2007, financial institutions were on average highly leveraged (30/1 leverage, with trading book leverage of 10/1), and with mortgage positions in the trading book larger than the equity capital base (Triana (2012)). Turner (2009) shows that this was a trend that started in the early 2000s. However, the capital requirements for the trading book did not account for such extreme leverage and for the riskiness of the new toxic positions. For example, Turner (2009) shows that the trading risk capital was 4-11% of total capital requirements, and the trading book's market risk capital requirements as a percentage of the total capital requirements were in the range of 0.1%-1.1%. The trading book capital requirements based on the 10-day 99% VaR severely underestimated the underlying risk, especially because of its inability to account for tail risk.

The failure of VaR to estimate the risks embedded in the trading books was immediately recognized by the BCBS in the publications that led to the release of Basel III. Furthermore, BCBS (2009) recognized the weaknesses of VaR in accounting for tail risk and large price movements developing over a large period of time: "the current VaR framework ignores differences in the underlying liquidity of trading book positions. In addition, these VaR calculations are typically based on a 99%/ one-day VaR which is scaled up to 10 days. Consequently, the VaR capital charge may not fully reflect large daily losses that occur less frequently than two to three times per year as well as the potential for large cumulative price movements over periods of several weeks or months." Bias toward recent historical data and inability to account for tail risk was reiterated in BCBS (2013): "the 10-day VaR calculation did not adequately capture credit risk or market

liquidity risks; it incentivized banks to take on tail risk; inadequately captured basis risk and proved procyclical due to its reliance on relatively recent historical data."; as well as in BCBS (2016): "A shift from Value-at-Risk (VaR) to an Expected Shortfall (ES) measure of risk under stress. Use of ES will help to ensure a more prudent capture of "tail risk" and capital adequacy during periods of significant financial market stress." Finally, BCBS (2013) recognized the violation of the assumption of unlimited liquidity supply upon which the regulatory VaR was built: "The recent financial crisis was characterised by a sudden and severe impairment of liquidity across a range of asset markets. As a result, banks were often unable to promptly exit or hedge certain illiquid risk positions without materially affecting market prices. This violated a key assumption that was implicit in the 10-day VaR treatment of market risk."

III. The Crisis of the Current Paradigm

The debate over the elements which compose current mainstream theory is controversial and generates stormy reactions. However, there are two conclusions that are difficult to oppose: 1) portfolio managers were on average unprepared to cope with the dramatic fluctuations of the financial crisis of 2007-8; and 2) the financial regulation in place at the time did not prevent the financial crisis.

According to Cliff Asness, few people think the markets are perfectly efficient, rather, they are aware of anomalies and constantly try to exploit them, although this is not so easy to do (Buttonwood (2015)).

Pascal Blanqué, Chief Investment Officer at Amundi, has suggested that Modern Portfolio Theory has depicted the financial markets as a heaven populated by "sacred cows" that have dominated investment thinking, and that were proven wrong by the crisis. For example, in Blanqué (2014), he elaborates on the false promises of diversification implemented in a way that did not deliver safe and good portfolio returns. He also points to the notion of risk-free assets, which in theory should represent a low return asset with zero correlation with risky assets, while in practice we have observed US 10-year Treasuries violating these basic premises over the past three decades.

Triana (2011) has provided evidence that the crisis started in 2007 brought to the surface serious malfunctions of the financial mathematical models broadly adopted across the industry. These models also provided a false sense of security, displaying the tendency to behave according to expectations in normal times, and to break down in times of crisis, exactly the opposite of what one would expect from risk models. The adoption of sophisticated mathematical models is at the center of an endless methodological debate, for three main reasons. First, mainstream academia

assumes that markets can be mathematized. The mathematization of finance began after WWII, driven by neoclassical economics, which fostered the formal treatment of rational and optimizing economic agents interacting together and generating a tractable and efficient equilibrium. In 1951, 2% of the pages of the *American Economic Review* contained an equation; in 1978 the percentage was 44%. The mathematization of finance followed in parallel a number of developments in the wider discipline of economics (MacKenzie (2006) p. 7).[v] The trend towards the mathematization of finance, and the risks that it embeds, are today also recognized by academia. Robert Shiller, for example, has affirmed that "theorists like models with order, harmony and beauty. […] Academics like ideas that will lead to econometric studies. […] People in ambiguous situations will focus on the person who has the most coherent model" (Bottonwood (2015)). Dowd (2014) and Dowd (2002) refer to the same concern, and if we go slightly back in time, Jorion, and Taleb (1997) represents an excellent debate, just before the LTCM debacle, around the presumptuous use of mathematics to model risky financial events. Likewise, Hoppe (1999) offers a critical assessment of LTCM's risk models, which considered the type of event that brought down the hedge fund to be statistically impossible (as a reminder: an 8 standard deviations event should not happen during the entire lifetime of the universe; LTCM was hit by a 14 standard deviations event; in 2007 we observed 25 standard deviation events several days in a row). These studies warned against the transfer of mathematical and statistical models to the social sciences, where economic agents learn and react, making the environment non-stationary and prone to changes in behavioral patterns and correlations.

The second and third reasons are suggested by Turner (2009). If we assume, for the sake of the argument, that the event under scrutiny can be mathematized, are we putting a misplaced reliance on these models, as happened with VaR before the 2007-8 crisis? Moreover, is top

management able to understand the complexity underlying the mathematical models used for risk management, or rather are the latter used as a checkbox exercise in order to communicate a false sense of security?

Finally, some commentators would argue that financial regulation actually exacerbated the crisis. Studies which support this view include Friedman, and Kraus (2011) and Cooper (2008). The latter suggests that economics and finance need the kind of scientific revolution that physics witnessed with the contributions of Newton and Einstein. In the section above, we have shown that the 2007-8 crisis severely undermined the current paradigm of modern finance. Current mainstream theory does not allow investment managers to be prepared for critical market fluctuations. The authors of this paper also believe that modern finance is not geared up to provide a solid theoretical framework to financial regulation either.

A paradigm crisis that calls for a scientific revolution echoes the revolution that Thomas Kuhn proposed for theoretical physics. Kuhn (1996) defines a scientific paradigm as a framework of concepts, results, and procedures within which subsequent work is structured. If we adopt a Kuhnian view of the potential scientific revolution the discipline may need, three points are worthy of further elaboration. First, a theory never elucidates completely and with absolute precision all the challenges that it encounters because it is bound to the empirical context in which it has been conceived. Second, the falsification of a theory does not occur because of the emergence of a falsifying observation. “Instead, it is a subsequent and separate process that might equally be called verification since it consists in the triumph of a new paradigm over the old one” (Kuhn (1996) p. 147). In the history of science, paradigm competition has been settled (meaning rejection of a theory) by employing not falsification but a more complex mixture of elements, defined by Kuhn as “incommensurability of competing paradigms.” In this context: a) “the proponents of the

competing paradigms will often disagree about the list of problems that any candidate for paradigm must resolve"; b) the new paradigm will involve partial usage of the terminology associated with the old one and this will inevitably generate misunderstandings between the competing schools; c) the supporters of a theory see the world with a different prism than the supporters of the competing paradigms. "Before they can hope to communicate fully one of the two groups must also experience a conversion that we have been calling a paradigm shift" (Kuhn (1996) p. 148-50).

MacKenzie (2006) reports that the accumulation of a large number of anomalies in a theory of the natural science was seen by Kuhn as a sign of a coming scientific revolution, and that Jensen indeed suggested that the accumulation of EMH anomalies pointed to "a coming mini-revolution in the field", albeit one that required a more accurate and general adoption of market efficiency, rather than its abandonment (MacKenzie (2006) p. 97).

IV. What Are the Options on the Table?

Buttonwood (2015) affirms: "The best hope lies with the behavioral school". Many value investors (who have criticized the EMH since its inception and are among the main beneficiaries of its anomalies) believe that the capricious behavior of market prices can be explained by behavioral finance. Moreover, in academia, the body of knowledge supporting this school of thought has grown tremendously.

The major theoretical and empirical contributions of behavioral finance come from renowned scholars. Its fathers are the cognitive psychologists Daniel Kahneman and Amos Tversky, who have focused on the cognitive biases and the heuristics involved in financial decision-making. The former received the Nobel Prize in Economics in 2002 precisely for his analysis of rationality in economics. Two additional key contributors are the economist Richard

Thaler, who was able to connect human psychology with market anomalies, and Robert Shiller who, as mentioned above, received the 24th Nobel Prize in Economics for his work on asset pricing irrationalities. Behavioral economics has advanced our understanding of the effect of biases in decision making such as the endowment effect, sunk costs, and hyperbolic discounting. Thaler, for example, has addressed unrealistic mainstream assumptions such as the assumption that profit maximization is sought until marginal cost equals marginal revenue. Surveys have shown that corporate executives do not follow such an approach at all.

Behavioral economics has been around for 40 years, but its conclusions were dismissed by the mainstream. Behavioral studies are able to find empirical evidence against market efficiency and have accumulated a large number of laboratory experiments to show human biases in decision making. However, these studies are still considered impractical as an explanation of the behavior of an entire economy. Moreover, behavioral economics has not yet come up with a coherent model that produces testable predictions.

The main criticisms to behavioral finance obviously came from the EMH advocates. Fama (1998) holds that, in the long term, market efficiency survives the behavioral challenge. All in all, many anomalies in the short term compensate for each other, canceling each other out in the long term. Moreover, some anomalies can be due to methodology, and tend to disappear with changes in technique.

Even if behavioral economics has not been accepted by the mainstream, its influence in policy making has grown. The US government has adopted their core ideas through reforms like consumer protection. This has been another source of criticism. According to the EMH, an optimal market equilibrium exists that removes the need for government intervention. If the EMH is flawed, then behaviorists think that we need the government to tow the economy back to optimal

equilibrium. This is the reason why behavioral economics has often been used to justify increased policy making to fix supposed market failures. This has attracted further criticism of behavioral economics from the advocates of unregulated markets.

There are also critics of behavioral economics outside the realm of the EHM advocates. For example, Frydman and Goldberg (2011) argue that both the rational and the behavioral theories of the market rest on the notion of rational expectations. Rationalists believe the framework provides exact predictions, while behaviorists believe human behavior is biased away from the rational benchmark. Consequently, policies are required in order to correct suboptimal human behavior toward the benchmark. In order words, both camps believe there is an optimal benchmark, and if decision-making is purged of biases, markets can become fully predictable. As an alternative, the authors present a framework based on imperfect knowledge economics. According to this framework, the 2007 bubble was not fueled by herd behavior, but rather by market players' attempts to interpret (imperfectly) the economic fundamentals. This is consistent with Borio (2014), who argues that we should move away from rational expectations. Albeit a licit standpoint, pretending that economic agents have a full understanding of the economy is unrealistic. Relaxing the assumptions of rational expectations does not imply bringing irrational behavior or model inconsistency into the model. Furthermore, acknowledging the existence of heterogeneous and incomplete knowledge, coupled with the need to deal with fundamental uncertainty, means bringing more realism to the model.

Besides Rizzo (2012), there is limited Austrian research in relation to behavioral economics. Austrian economics intrinsically provides an alternative approach to rational and behavioral theory, namely a view of the economic agent that is not about a deterministic utility maximizer (like with rational expectations), but rather about the entrepreneurial function as the equilibrating

factor (Kirzner (1979) and Kirzner (1997)). Entrepreneurship and economics have always had an awkward relationship. In economics, entrepreneurship does not belong to the mainstream, since rational theory is based on the notion of equilibrium, therefore there is no need for equilibrating forces. Conversely, management scholars are familiar with the work of Kirzner, Schumpeter, Baumol, etc. In this domain, entrepreneurship is one of the pillars of the 'paradigm'.

Buttonwood (2015) suggests that there are alternatives to behavioral finance, such as adaptive market theory (Lo) or ad fractal market hypothesis (Joshi). In addition to this, there are alternative explanations to the momentum effect such as the presence of a principal-agent condition (Woolley and Vayanos).

5. Conclusion

In this paper I have shown why mainstream modern finance has been challenged by the 2007- 8 crisis and is undergoing a paradigm crisis. I have also demonstrated that the tools used by standard macroeconomics are unable to provide reliable forecasts. In both disciplines, critics have started a disorganized offensive, but for the moment orthodoxy still rules.

Regulators have also admitted the inadequacy of the pre-crisis regulatory environment. Still, in order to address the crisis and guarantee financial stability in the future, they have added many new requirements based on the theories belonging to modern finance. What are the certainties that the same flaws that led to error ten years ago are not at work today?

Thomas Kuhn taught that a paradigm shift can only occur when the new paradigm exists and has gained acceptance. Today, I do not yet see any viable alternative that can replace the current paradigm.

I believe that a methodological approach that welcomes any mathematization of financial events should be questioned, and that greater discipline should be applied in testing whether financial models are able to cope with reality. Researchers should not hesitate when facing resistance from traditionalists.[vi]

It is essential to advance quantitative finance by analyzing what went wrong with quant models. An ambitious research program should make standard practice of the analysis of the failures of the discipline, emphasizing the flaws in the model and the potential unintended consequences.

I also invite researchers to challenge the rationale behind new financial regulation based on models that have failed in the past. The goal of the regulators should not be to altogether eliminate financial crises or the exposure to financial risk. After all, Cliff Asness warned that: "Making people understand that there is a risk (and a separate issue, making them bear that risk) is far more important, and indeed far more possible than making a riskless world. And if I may go further, trying to create and worse, giving the impression you have created, a riskless world makes things much more dangerous" (Bottonwood (2015)).

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Footnotes

i. Turner (2009): "The predominant assumption behind financial market regulation – in the US, the UK and increasingly across the world – has been that financial markets are capable of being both efficient and rational and that a key goal of financial market regulation is to remove the impediments which might produce inefficient and illiquid markets."

ii. Consider, as an example, Warren Buffet's valuation of the Washington Post, when he purchased the newspaper in 1973. See Greennwald, Kahn, Sonkin, van Biema (2001) p. 11.

iii. In a 2009 interview, Fama affirmed: "Well there is evidence that there is somewhat more momentum in stock returns that can't easily be explained by a risk theory-that gives me a little trouble…then there is another one that says that the market returns following earnings announcements tend to persist a little more than you would expect if the markets were completely efficient but neither of these present a lot can be made-because it involves so much trading and trading costs…but as far as I know those two are the biggest contradictions or potentially biggest contradictions of market efficiency…" Fama (2009).

iv. "The dominant response of Eugene Fama and his University of Chicago students to the growing list of anomalies was to suggest that the fault lay in the Capital Asset Pricing Model, not in the efficient market hypothesis" (MacKenzie (2006) p. 98).

v. One of these developments was Friedman's 1953 "The Methodology of Positive Economics," and the debate that followed (about, among other subjects, the over simplistic assumptions that the approach allowed), especially against its main opponent, Paul Samuelson, the champion of mathematical rigor in economics. It is not the goal of this paper to resuscitate such methodological debate, but it interesting to highlight that Samuelson (1974) argued that active portfolio managers should "go out of business – take up plumbing, teach Greek, or help produce the annual GNP by serving as corporate executives" and that investor should invest their capital in highly diversified and passively managed funds.

vi. The anecdote recounted by Münchau (2015) is representative: "Revolutions are always countered by traditionalists. It is instructive to go back to one episode, concerning the German mathematician Richard Dedekind. He was one of the rebels of his time and used a new technique to prove an important result. His method would be considered standard stuff today but was revolutionary then. The response from the traditionalists was harsh. Leopold Kronecker, another German mathematician, decried Dedekind's proof as useless on the grounds that it had no practical applications. Dedekind retorted, not helpfully, that he wanted "to put thoughts in the place of calculations."