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Samuelson vs Fama on the Efficient Market Hypothesis: The Point of View of Expertise

Thomas Delcey*

This paper investigates the polysemic character of the Efficient Market Hypothesis through a comparison of the contributions of the two authors who introduced this hypothesis in 1965, Eugene Fama and Paul Samuelson. While both had a normative approach, it is argued that the key point distinguishing the two contributions is the expertise developed by each author. Fama interpreted his model to make practical recommendations for investment strategy. Samuelson interpreted his model to discuss and promote a political expertise that would be useful for policymaking such as the Pareto optimality of speculative price or the social benefit of speculation. The second part investigates the context of paper writing. We suggest that two elements are central to explain Fama and Samuelson's stance: first, the contrasting viewpoints of their research institutions, respectively Chicago and MIT, and second, the position of each author in early financial economics. Finally, we show how their early contrasted stance is consistent with Fama and Samuelson's opposite reactions to the Efficient Market Hypothesis controversy in the 1980s. In conclusion, we suggest that this opposition between Fama and Samuelson is useful to discuss the early EMH controversy in the 1980s.

Keywords: efficient market hypothesis, expertise, polysemy, Samuelson (Paul A.), Fama (Eugene F.)

Samuelson vs Fama sur l'efficience informationnelle des marchés financiers : le point de vue de l'expertise

Cet article étudie le caractère polysémique de l'efficience des marchés financiers à travers une comparaison des contributions des deux auteurs qui ont introduit cette théorie, Eugene Fama et Paul Samuelson. Nous montrons que, si les deux auteurs avaient tous les deux une approche normative, l'élément principal qui les différencie est leur conception de l'expertise. Fama interprétait son modèle pour donner des recommandations pratiques en termes de stratégie d'investissement. Samuelson interprétait son modèle pour discuter et mettre en avant une expertise politique utile pour le décideur public comme l'optimalité parétienne des prix spéculatifs ou les bénéfices sociaux de la spéculation.

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La seconde partie de l'article étudie le contexte des deux contributions. On suggère que deux éléments sont centraux pour expliquer les positions normatives de Fama et Samuelson : premièrement, le point de vu contrasté de leurs institutions respectives de recherche, l'université de Chicago et le MIT, et deuxièmement, la place qu'occupent les deux auteurs dans le champ émergeant de l'économie financière. Nous montrons dans une dernière partie que ces positions sont cohérentes avec les réactions opposées de Fama et Samuelson à la controverse concernant l'efficience des marchés financiers dans les années 1980. L'article conclut en suggérant que cette comparaison peut être utile à l'analyse de cette controverse.

Mots-clés : efficience des marchés financiers, expertise, polysémie, Samuelson (Paul A.), Fama (Eugene F.)

JEL: B26, B31, B41

1. The Polysemy of EMH

The Efficient Market Hypothesis (EMH) constitutes a cornerstone of financial economics while being paradoxically considered to be a very ambiguous concept. Indeed, the polysemic character of the EMH is commonly acknowledged in view of its multiple and coexisting interpretations (Walter, 2006; Challe, 2008; Vuillemey, 2013). However, except for Jovanovic (2008), historians have not investigated the emergence of this polysemy. Besides its polysemy, the EMH also carries dual normative recommendations (Charron, 2016; Brisset, 2017). The EMH has been guiding both investors' practices (MacKenzie, 2008) and policy making (LeRoy 1989, 1620–1621), the most recent example of the latter being the role of the EMH in providing a framework for the regulation of financial markets since the 1980s (see for instance Jovanovic, Andreadakis, and Schinckus, 2016).

This paper investigates the origins of EMH polysemy by focusing on its multiple normative recommendations. We compare the work of Eugene Fama and Paul Samuelson, who set in motion the EMH research program. Fama's contributions to the EMH are well-known and, in particular, we owe him the term "efficient market" (Fama, 1965a; 1965b) and its best known formulation: "A market in which prices always 'fully reflect' available information is called 'efficient'" (Fama, 1970). While Samuelson's contributions to finance are usually less well-known even though he was involved in the emergence of financial economics (as pointed out by Merton, 2006). He was a pioneer in the development of the EMH (Samuelson, 1965a) and of many

aspects of modern financial economics such as the pricing of options (Samuelson, 1965b).[1]

In this paper, we argue that despite the analytical refinement of their respective views, Fama and Samuelson have constantly had two different viewpoints on the normative recommendations implied by the EMH. We do not interpret this difference as a clear analytical discrepancy between their models, but as a difference in terms of expertise. Fama, on the one hand, interpreted the EMH as normative knowledge about trader's practices, i.e. expertise concerning investment strategies. Samuelson, on the other hand, viewed the EMH as normative knowledge that could help practitioners but would be mostly of use to policymakers, i.e. expertise on the functioning of financial markets to be used in order to serve the general interest.[2]

We first investigate the papers they both published in 1965. As mentioned previously (Bernstein, 1993; Merton, 2006; Guerrien and Gun, 2011), Samuelson's paper analyzed the validity of assuming that financial markets are "well-functioning" by addressing issues such as free competition, Pareto-optimality and the social benefits of speculative markets. Fama on the other hand focused mostly on the irrelevance of investment strategies of certain investors implied by his model. We then explore how each author's normative stance in 1965 can be related to his institutional environment. Based on the current literature on the history of the EMH, we show how the difference between Fama and Samuelson reflects the opposition between the research traditions at their respective research institutions, Chicago and MIT. We also suggest that the specific position of each author in the field of financial economics (Samuelson as an outsider and Fama as an insider), is significant to explain their contrasting views on the EMH. Lastly, we present each author's standpoint on the EMH in the 1970s and 1980s. In particular, we show that they became explicitly opposed during the EMH controversy in the 1980s, when the EMH was criticized for its ambiguous formulation. This controversy set in motion new research endeavors on the fundamental valuation of assets: this was rejected by Fama whereas Samuelson embraced these

[1] Apart from Fama and Samuelson, there is a substantial set of contributors to the development of the EMH in the 1960s (a few examples are Working, 1949; Roberts, 1959; Cootner, 1964). Furthermore, there are many other formal definitions of the EMH than those of Samuelson and Fama (see for instance Malkiel, 1989; Jensen, 1978; Black, 1986; Shiller, 2003). This paper focuses on Samuelson and Fama because we consider they are important for the issue we are investigating. This does not imply that Fama and Samuelson were historically the only main contributors to this research program. For a comprehensive perspective on the history of the EMH, see Jovanovic (2009) and Walter (2013).

[2] This distinction is inspired by Mehrling's view (2012, 195) who identifies two types of expertise at MIT: one that focuses on practical applications, the main clients of which are businessmen, and one that focuses on political applications, which are of most interest to governments.

contributions as an answer to the questions he had raised in the 1960s and 1970s.

2. Fama and Samuelson's EMH: The 1965 Pioneered Contributions

2.1. Fama's Random Walk Model

Fama was the first to introduce the notion of an efficient market in 1965 in one of his first publications (which summarized his PhD dissertation) entitled "Behavior of Stock Market Prices" and published in the *Journal of Business*. Fama had been a PhD student at the Chicago Graduate School of Business (CGSB) at the University of Chicago in the early 1960s, when a research program emerged on the random character of price changes (Jovanovic, 2008; Walter, 2013). The CGSB was one of the leading institutions involved in this research program, together with another group of researchers from the Industrial School of Management, i.e. the business school of the Massachusetts Institute of Technology (MIT) (see Jovanovic, 2008). At the time, the random character of price changes was represented by a random walk process.[3] A random walk is a stochastic process with independent and identically distributed increments. Fama investigated the issue empirically and established the independence of changes in stock prices.[4] In order to explain the independence of price changes, Fama developed and introduced the notion of an efficient market:

> We … saw that a situation where successive price changes are independent is consistent with the existence of an "efficient" market for securities, that is, a market, where given the available information, actual prices at every point in time represent very good estimates of intrinsic values (Fama, 1965a).

Fama defined the intrinsic value (hereafter, the fundamental value) of an asset as "the earning prospects of the company which in turn are related to economic and political factors" (Fama, 1965a, 36).[5] Fama

[3] See Jovanovic (2008) and Walter (2013) for a history of the random walk model in finance.

[4] Fama's thesis also discussed the relevancy of the Alpha-Stable distribution compared to the Gaussian distribution.

[5] The term "intrinsic value" had been historically used by practitioners. It was popularized by the famous investor manual *Security analysis* written by Benjamin Graham and David Dodd in 1934 (Bernstein 1993). According to Graham and Dodd, the intrinsic (fundamental) value referred to all kinds of information used to estimate company earnings. However, this distinction between the price and the value of an asset seems to go back much further in finance. Jules Regnault (1863) for instance, already discussed the distinction between price and value. In his thesis, published as a book (*The Theory of Investment Value*) in 1938, John Burr Williams [1900-1989] formally defined the intrinsic (fundamental) value as the

assumed that the stock market was partly composed of what he called "sophisticated traders":

> For example, let us assume that there are many sophisticated traders in the stock market and that sophistication can take two forms: (1) some traders may be much better at predicting the appearance of new information and estimating its effects on intrinsic values than others, while (2) some may be much better at doing statistical analyses of price behavior. (Fama, 1965a, 37)

Fama referred here to two common sets of practices among traders: the fundamental analysis and the chartist analysis, also called "technical analysis". The fundamentalist analysis assumes and estimates a fundamental value for each asset. From this estimation, traders determine if a given asset is over-valued, correctly valued or under-valued, i.e. if its price is above, equal to or below the price implied by the fundamental value. The chartists assume that the stock market price follows trends that can be profitably exploited.

According to Fama, these two kinds of sophisticated traders may lead the price to converge to his fundamental value. For the fundamentalists, the benefits for companies are not certain so that a change in the fundamental value cannot be estimated with certainty. The fundamentalists may potentially under-estimate or over-estimate the fundamental value. However, these errors cannot be dependent (in the statistical sense) because this would imply a systematic discrepancy between the market price and the fundamental value of the asset. Such a discrepancy would be exploitable by sophisticated traders: either by fundamentalists, who would spot systematic discrepancies between market prices and the fundamental characteristics of companies, or by chartists, who would identify dependencies based on the statistical analysis of trends. Thus Fama concluded that "prices will initially overadjust to new intrinsic values as often as they will underadjust" (Fama, 1965a, 39). In an efficient market, asset prices fluctuate randomly around their fundamental values and thus, on average, the price is the best estimation of the fundamental value.

2.2. *Samuelson's Martingale Model*

The same year, Samuelson published an article in the review of the MIT business school, the *Industrial Management Review* (today the *Sloan Business School Review*). Samuelson had begun working on topics associated with finance when he was full professor in the economics department at MIT in the 1950s. Samuelson probably developed his 1965 model at the end of the 1950s but the simplicity of the result

discounted expected dividend of companies. For a recent analyze of the notion, see Brian and Walter (2008).

made him hesitate to publish it before 1965.[6] In this article, Samuelson challenged the relevance of random walk to describe a competitive speculative market:

> [the random walk] is not particularly related to perfect competition or market anticipations. For consider a monopolist who sells (or buys) at fixed price. If the demand (or supply) curve he faces is the resultant of numerous independent, additive, sources of variation each of which is limited or small, his resulting quantity may well behave like a random walk (Samuelson, 1965a, 42)

Samuelson suggested replacing the random walk by another stochastic process, the martingale.[7] Samuelson applied the martingale to future prices on the commodities market.[8] We note P_{t+T} an estimation at t of the discounted spot price in T periods of a commodity. Assume that P_{t+T} is representable by a given distribution law. Now suppose a futures market for the same commodity. We note $Y_{t,T}$ the price of the discounted futures contract at time t with T the time for the contract to reach maturity. For n periods, we can write $Y_{t+n,T-n}$. At $T + 1$ the future price is $Y_{t+1,T-1}$. At T+2, the future price is $Y_{t+2,\ T-2}$, etc. At the $t + T$ period, the price of the future is $Y_{t+T,0}$ Samuelson aimed at characterizing the relationship between the sequence P_{t+T} and the sequence $Y_{t,T}$. Based on arbitrage reasoning (Samuelson 1965a, 43), it is possible to characterize the relationship between P_{t+T} and $Y_{t,T}$ for a particular case. At the $t + T$ period, by definition, P_{t+T} is known. Thus, the spot price must be equal to the future price. If not, an arbitrage opportunity will exist, and investors will exploit it.

At t+T, $P_{t+T} = Y_{t,T}$. But before the t+T period, no one knows P_{t+T} with certainty. Thus, Samuelson proposed an assumption he calls "Mathematically Excepted Price Formation". This axiom asserts that investors know and use the probability distribution describing the sequence P_{t+T} to evaluate $Y_{t,T}$. Using the expected value:

$$(1)\ Y_{t,T} = \mathrm{E}[P_{t+T} \mid I_t]$$

Samuelson extended the arbitrage argument to uncertainty[9] considering that, because of competition, investors evaluate $Y_{t,T}$ by the

[6] Robert Merton (2006) argues that Samuelson was already presenting his model in conferences and seminars by the end of 1950s. In his correspondence, Samuelson discusses his theorem starting at least from 1961 (S-ARC, letter from Samuelson to Working, May, 1961).

[7] That same year, Benoit Mandelbrot also described financial fluctuations by the martingale process (Mandelbrot, 1965).

[8] A future is a financial contract that allows buying or selling an asset, such as commodities, at a predetermined date and quantity.

[9] This is not strict arbitrage reasoning in his modern sense since P_{t+T}(and therefore profit) is not certain. Samuelson (1957) already used arbitrage reasoning to characterize the relationship between futures and spot under certainty.

expected value of the random variable $Y_{t,T}$ conditionally to the market information $I_t = (P_t, P_{t-1}, \ldots)$. The best estimation of tomorrow's spot price is the actual price of the future contract. The valuation of futures price by investors takes into account the past sequences P_{t+T}. The economic justification for this hypothesis was based on information maximization in a competitive environment:

> it is tempting to assume that people in the market place make as full use as they can of the posited probability distribution of next period's price and $Y_{t,T}$ bid by supply and demand to the mean or the mathematically expected level of tomorrow's price. (Samuelson, 1965b, 42)

Futures market was interpreted by Samuelson as a pricing mechanism for expectation of tomorrow's spot price. Futures prices represent the best expectations of the next spot prices. Then, using the iterative exception law[10], a property of probability theory independent of his model, Samuelson concluded that (3) implies that the sequence $Y_{t,T}$ follows a martingale:

$$E[(Y_{t+1,\,T+1}) \mid I_t] = Y_{t,T}$$

If the sequence of prices follows a martingale, the current price $Y_{t,T}$, given the information at t, can be interpreted as the best estimation of any future price.

2.3. A Contrasted Stance on Expertise

Despite the considerable analytical difference between the two models, both showed that if traders have the correct expectation, this may result in prices fluctuating randomly. Both Fama and Samuelson described a competitive market composed of somehow self-interested and intelligent traders. Thus, it is not surprising that both authors have been considered pioneers of the EMH (Lo, 2017). Both models have also been interpreted as early developments of rational expectations in finance (see Merton, 2006; Hoover and Young, 2011). This should not belittle the strong differences between the two contributions, although we will ignore this issue here. First, Fama and Samuelson adopted a different methodology (Jovanovic, 2008; Mehrling, 2012): Fama's 1965 paper relied on the interpretation of his (and others') empirical analysis, whilst Samuelson's paper relied on purely deductive reasoning based on axiomatic and formal methodology. Beyond methodological differences, the analytical content varied greatly between the two papers: random fluctuations were character-

[10] The iterative exception law can be written formally as follow: $E[X \mid I_1] = E[E[X \mid I_2] \mid I_1]$ if and only if I_1 is a subset of I_2 (see Campbell, Lo, and MacKinlay, 1997; LeRoy, 1989). The Samuelson model says that $Y_{t,T} = E[P_{t+T} \mid I_t]$ so that $Y_{t+1,\,T-1} = E[P_{t+T} \mid I_{t+1}]$. Thus, using the iterative exception law, $E[Y_{t+1,T-1} \mid I_t] = E[E[P_{t+T} \mid I_{t+1}] \mid I_t] = E[P_{t+1} \mid I_t] = Y_{t,T}$.

ized by different stochastic processes, i.e. random walk and the martingale. Moreover, Fama analyzed the stock market, while Samuelson characterized the behavior of the future price and its relationship to the spot price on the commodity market. Furthermore, in 1973, Samuelson showed that his 1965 model also works for the relationship between stocks and their fundamental values (Samuelson, 1973; see also LeRoy, 1989, 1590-1591). If a future price can be interpreted as an estimation of the expected spot price (equation 1), a stock price can be interpreted as the estimation of expected dividends. Thus, if agents are correctly evaluating stocks by the discounted sum of expected dividends, stock prices will follow a martingale.[11] Yet, even if Samuelson applied his model to the stock market, his analysis was still significantly different from Fama's. In particular, as noted by LeRoy (1989), Samuelson's martingale model implies a strict equality between the fundamental value and the stock price, whereas this was only true on average in Fama's paper.

The difference that we investigate here pertains to the normative recommendations provided by each article. Both Fama and Samuelson casted serious doubt on the effectiveness of existing practices of investors (Samuelson, 1965a, 47; Fama, 1965b, 55). Fama developed the implication of his result for investor practices rather extensively. He even published a shorter version of his article in several practitioner journals, first in the *Financial Analysts Journal* (1965), later on in the *The Analysts Journal* (1966, reprint of the 1965 article), and finally in *The Institutional Investor* (1968) (Bernstein, 1993).

According to Fama, the independence of price changes, which characterizes an efficient market, implied that any chartist analysis based on identifying trends was irrelevant:

> If the random-walk model is a valid description of reality, the work of the chartist, like that of the astrologer, is of no real value in stock market analysis (Fama, 1965a, 59)

Concerning the fundamentalist analysis, Fama had a more nuanced view. A fundamentalist can make a profit if his estimation of the change in the fundamental value is systematically better than that of other investors:

> additional fundamental analysis is of value only when the analyst has new information which was not fully considered in forming current market prices, or has new insights concerning the effects of generally available information which are not already implicit in current prices. (Fama, 1965a, 59)

[11] While Samuelson's model gives an example of a market composed of well-informed individuals possibly implying that price changes follow a martingale, LeRoy (1973) and Lucas (1978) later showed that the link between martingales and efficiency is not systematic.

Samuelson defended an equivalent normative recommendation in his two articles: he briefly mentioned and dismissed chartist analysis in 1965 and, in his 1973 paper, he concluded that a successful fundamentalist strategy would not be inconsistent with the random character of price changes. However, as already noted by several authors (Bernstein, 1993; Merton, 2006; Guerrien and Gun, 2011), Samuelson's conclusions discussed an additional normative implication of the idea of efficient markets, namely the issue of "well-functioning" financial markets (from a broader, social perspective). This discussion aimed at providing a form of expertise for policy makers rather than for traders. Indeed, Samuelson pointed out that his model does not investigates whether competitive market performance is adequate or whether speculative markets produce any good for society:

> It does not prove that actual competitive markets work well. It does not say that speculation is a good thing or that randomness of price changes would be a good thing. It does not prove that anyone who makes money in speculation is *ipso facto* deserving of the gain or even that he has accomplished something good for society or for anyone but himself. (Samuelson, 1965b, 48)

In the same vein, Samuelson also pointed out the issue of the Pareto-optimality of random prices:

> Do price quotations somehow produce a Pareto-optimal configuration of *ex ante* subjective probabilities? This paper has not attempted to pronounce on these interesting questions. (Samuelson, 1965b, 49)

Let us clarify that we are not attempting to determine to what extent Fama and Samuelson should or should not have formulated their respective normative recommendations based on their respective models. As already mentioned in the introduction, we do not see the difference between their models as an analytical difference, but as a difference in terms of expertise. Thus, it is enough to note that these authors had a different attitude with respect to the normative implication of their model. While Fama focused extensively and solely on practical expertise, that is knowledge of interest to practitioners, Samuelson also (and mainly) discussed governmental expertise, that is knowledge of interest to policy makers: the efficiency of free competition, the Paretian optimality of prices, and the social benefit of speculation.

Moreover, we should not push these considerations too far by drawing a Manichean opposition between Fama and Samuelson. A contrasted stance on a specific point does not imply perfect opposition. For instance, while Samuelson raises issues that concern policy makers, he also addresses his contribution to practitioners, as Fama does. Samuelson himself was a successful investor (Warsh, 2011). Thus, Samuelson's stance should be viewed as a hybrid case combining both practical and political expertise about the EMH. Conversely,

while Fama was mostly concerned with practical expertise in his 1965 paper, and would later remain particularly discreet about political issues (Klein, 2018), this does not mean that Fama was not concerned *at all* with policy making. For instance, in a less well-known paper published a few years after his 1965 paper, Fama also wrote about the Pareto optimality of free competition in situations of uncertainty (Fama, 1972b). However, it can be said that Fama and Samuelson developed a rather similar explanation of random changes in 1965, although their conclusions focused for the most part on different forms of expertise. Can we identify the origin(s) of these differences in attitude? The next sections investigate this issue by a contextualization of each paper.

3. The MIT-Chicago Opposition Enters Business Schools

The postwar institutional opposition between Keynesian research at MIT and the pro-market view at the University of Chicago, where Samuelson and Fama respectively spent their entire career, is well-known.[12] The research at Chicago University was traditionally empirical and pro-market: the government was "the natural enemy of the market" (Mehrling, 2012, 67). Conversely, at MIT, the government was considered the "natural client" of economists. The MIT group favored more analytical research, in order to develop engineering-like expertise for public policy making and an "intellectual basis for governmental intervention" (Mehrling, 2012, 67). In this section, we present how these ideological and theoretical oppositions between MIT and Chicago University were introduced in early financial economics through their business schools. We then show how this opposition is helpful in contextualizing Fama and Samuelson's 1965 papers.

MIT and Chicago University were predominant in promoting the emergence of financial economics in the 1960s through the development of their business schools (Fourcade and Khurana, 2017). The MIT business school, the School of Industrial Management, was developed in 1950 thanks to a grant from Alfred P. Sloan, a former student and CEO of General Motors at the time. The school was later renamed the Sloan Business School of Management (SBSM) for that reason. During the same period, the Chicago Graduate School of Business (CGSB) had just received a grant from the Ford Foundation. In both cases, the reform aimed at creating a closer relationship between the business school and the economics department. At the time, finance was traditionally taught in business schools by practitioners (Fourcade and Khurana, 2013). In Chicago, the CGSB's reform was led by Wilson A. Wallis, dean of the CGSB between 1958 and

[12] Even if until recently, the "MIT" group has been less studied than the "Chicago School" (see Weintraub, 2014, for a recent attempt to fill this gap).

1962, and a close friend of Milton Friedman and George Stigler, with whom he had participated in the constitution of the Mont Pélerin Society (Fourcade and Khurana, 2017). The CGSB hired the economist Merton Miller to lead the research in finance: Miller was Fama's Ph.D. advisor, and was a firm pro-market advocate (Mehrling, 2012, 155). At MIT, there was a good deal of interaction between the economics department and the SBSM. We already saw that Samuelson contributed actively to the research program on the EMH, and also supervised dissertations on finance in the 1960s, notably those of Richard Kruizenga and Robert Merton. However, Samuelson was not the only economist to be involved in this new area of research at MIT. Other members of MIT, Franco Modigliani and Paul Cootner, have largely contributed to early financial economics (Modigliani and Miller, 1958; Cootner, 1964).

The MIT and Chicago University had already developed strong and generally opposed identities in the 1960s. But, the process of "scientification" of business schools reinforced the interactions between them and between the economics departments, which also led the formers to adopt the ideological and theoretical viewpoints of the latter. The early EMH research program in the 1960s was indeed divided between the Chicago and the MIT viewpoint (Jovanovic, 2008). Researchers from Chicago University defended the pro-market view. The CGSB fitted into this picture due to its relentless effort to validate the random character of price changes in financial markets through the multiplication of empirical work. Empirical research at CGSB was actually supported by the creation of the Center for Research in Stock Prices (CRSP), which significantly improved the accessibility of quantitative research in finance (Fox, 2011; Mehrling, 2012). Fama was one of the first students of the center and the CGSB hired him at the end of his thesis to form the next generation of students. The MIT group around Samuelson was more nuanced: if the market worked well, it could be defective in the sense that predictable patterns could occur in the fluctuations. The random walk model was considered only in as much as it provided a first approximation of actual market phenomena. The research prioritized capturing the imperfections of the random walk model in order to develop a more realistic description of financial fluctuations. The MIT group held views that were closer to those of Holbrook Working at Stanford University, an isolated pioneer of the EMH in the 1930s and 1940s, who had observed the random fluctuations of prices on the commodities market (Working, 1934), and who has suggested an explanation close to the modern formulation of the EMH (Working, 1949, 1958).[13] Samuelson himself had been in contact with Working when he was developing his mar-

[13] See Berdell and Choi (2018) for a recent account of Holbrook Working's contributions to financial economics.

tingale model.[14] Samuelson was impressed by Working's research and later repeatedly praised Working as one of the most prominent and forgotten pioneers of financial economics. Conversely to other researchers active in the 1930s and 1940s, Working had shown early that speculation, especially on the commodities futures market, may lead commodity prices closed to economic fundamentals. His stance was however far more cautious than that of future supporters of the EMH (Berdell and Choi, 2018). Indeed, according to Working, observing a pure random walk was more evidence of the limits of statistical tests than evidence of a perfect well-functioning market. Moreover, Working shared this remark with Samuelson:

> Then I face the problem that the best statistical tests for non-randomness that I knew failed to show any significant departure from randomness in the price movements. (We cannot believe actual markets to be perfect, hence a showing of pure non-randomness in price movements must be taken as evidence of inadequacy of the statistical tests). (S-ARC, letter from Working to Samuelson, May 2nd 1961).

Working convinced Samuelson of the virtue of speculation in commodity markets but both acknowledged its limitations. They were also *a priori* more skeptical about the danger of speculation in other markets, especially on the stock market in which information on fundamentals was *a priori* more uncertain than on the commodity market.[15]

These different institutional views capture part of the differences identified between Fama and Samuelson's 1965 contributions. Fama's empirically-oriented work contrasts with Samuelson's purely analytical work, reflecting the respective approaches of the Chicago school and MIT. Fama's research was mainly empirical and clearly aimed at corroborating the idea of random fluctuations of stock prices within the existent random walk model, whereas Samuelson sought to devise an alternative to the random walk model. Furthermore, in terms of expertise and policy recommendations, the opposition between the Chicago pro-market view and the Keynesian view at MIT emerged noticeably from both Fama and Samuelson's contributions. Fama characterized a competitive market in which price behave randomly as efficient. Samuelson concluded his 1965 article with rather cautious

[14] Hendrick Houthakker, who knows Working from Stanford, mentioned Working's name to Samuelson in the 1950s, when Samuelson began his work on finance (S-ARC, letter from Houthakker to Samuelson, February 12th 1953). Houthakker also suggested to Mandelbrot to work on cotton prices and then stock prices in 1961 (Mandelbrot, 1963, 394, n.*)

[15] "It seems to me that the relative paucity of reliable information pertinent to forming price expectations for stocks must tend to favor the occurrence of a greater amount of 'irrational' movement in stock prices than in commodity prices" (S-ARC, letter from Working to Samuelson, May 31st 1961).

comments about the benefits of free competition and speculation activities for society.

4. Different Targets for the Expertise: Practice versus Policy Making

Samuelson's nuanced conclusion about free competition could be understood by the broader view in favor of governmental intervention held at MIT; conversely, Fama's silence on governmental policy and his exclusive focus on practical expertise did not explicitly reflect the Chicago school's general reluctance to governmental intervention. Although he defined himself as an ultra-libertarian, Fama (unlike other Chicago figures) rarely addressed political questions using his expertise (Klein, 2018). Our view is that, beyond their ideological opposition, another aspect that differentiated Fama and Samuelson was the position of each author in the scientific field of finance. Fama received his Ph.D. in the mid-1960s and wrote his paper during the emergence of financial economics. At the time, financial economics aimed at earning legitimacy by producing practical knowledge. Conversely, Samuelson worked on his paper as one of the central figures of the MIT economics department, where the production of knowledge for policy making was central.

Early financial economics expertise was concerned with producing practical knowledge for businessmen. Despite their close connection with economics departments, business schools still had their own specific goals, namely educating a new corporate elite (Fourcade and Khurana, 2017, 358). Even at MIT, the engineering style of expertise was applied differently to economics and to finance: the SBSM aimed at advising businessmen, while the main client of the economics department remained the public sector (Mehrling, 2012, 195).[16] From the time it was created, the CRSP at Chicago intended to reform financial practices by producing rigorous knowledge about finance. The center had been initially founded by the Merry Lynch bank, which aimed at reforming trader practices by promoting stock investments (Fox, 2011; Winthrop, 2014). As emphasized by Mehrling: "the whole point of the CRSP seminar was to proselytize for the efficient markets side of the great religious war then being waged between the new academic thinking on the one side and traditional practice on the other" (Mehrling, 2012, 67). Financial economics, as a new field aiming to replace the traditional methods of investors, tried to earn legitimacy by producing objective knowledge with strong normative implica-

[16] "The essential difference between the economics department and the business school at MIT was that in the latter the imagined client of economic science was business, not the government. At the Sloan School, the idea was to transfer basic economic knowledge into practical business applications." (Mehrling, 2012, 195)

tions on practices. Fama, as one the first Ph.D. students in this research program, was more concerned with developing practical expertise than supporting the Chicago pro-market view.

As mentioned *infra*, Samuelson also developed a practical expertise in his paper. However, one of the specificities of Samuelson's 1965 contribution compared to Fama's is that it brought to the EMH issue a form of expertise that was less practical. In 1965, Samuelson had spent 25 years in economics and was already full professor in the economics department at MIT. Although he contributed to research in finance in many respects, he considered himself as an outsider to financial economics:

> Finance was my Sunday painting… Sunday painters are not quite in the Club. They publish in unrefereed journals and are not read much. However, by word of mouth and letter, through visiting lectures and distributed blue ditto manuscripts, I kept… the club informed and honest. (Samuelson cited in Bernstein, 1993, 121)

Our thesis is that Samuelson raised issues such as the social utility of finance, optimal allocation, and free competition because he was an economist and an outsider to finance. As such, he was concerned with producing expertise for policy makers rather than for traders. For Samuelson, as leader of the MIT economics department, the main "clients" of economics were not business practitioners, but governments (Mehrling, 2012, 195). Samuelson's inclination to digress on policy making issues is clearly apparent in his earliest paper on finance:

> It will be noted that I have not … invoked element of (1) monopoly restrictionism by speculators, (2) deliberate rumor spreading or other action by speculators which successfully creates profits by causing *deviations* from the equilibrium pattern, (3) non-deliberate action by speculators which non the less, in a word of uncertainty, turns to create *deviations* from the equilibrium patterns. Of course, no policy maker can decide on the optimum until he has pragmatically formed empirical judgments concerning the factual importance of these elements. (Samuelson, 1957, fn, 209-211)

The relationship between Working and Samuelson might also have played a role in drawing Samuelson's attention to policy making issues. Indeed, Working was involved in the regulation of US futures markets in the 1920s and 1930s; Working had notably supported a discretionary view on futures market regulation, in contrast with the view of the Grain Futures Administration (supporting a regulation by rules; see Berdell and Choi, 2018). Samuelson also discovered the random character of price changes through the regulatory issues discussed by Working (Working, 1937; 1963).

5. From the 1965 Papers to the EMH Controversy in the 1980s

Beyond the 1965 papers, the above described opposition between Fama and Samuelson lived on in their further development of the EMH in the 1970s and 1980s. While they both participated in spreading the EMH view in the 1970s, the development of literature challenging the EMH in the 1980s highlighted and reinforced their opposition of 1965.

In the early 1970s, the general dissemination of the EMH contributed to a deep transformation of trading practices (Mackenzie, 2008). Both Samuelson and Fama were leading actors of this transformation, which criticized the current practices of investors and promoted the idea of "passive management". Beyond chartism, the two authors criticized the active management of mutual funds, that is, an investment strategy where managers regularly modify their portfolio according to their expectations. Fama and Samuelson praised passive management and index strategies, where managers passively replicate and follow a specific index.[17] Beyond further contributions to the EMH (for instance Fama et al., 1969; Fama, 1970), Fama participated in the research program on the measurement of fund performance (Fama, 1972a) which shows that actively managed mutual funds exhibit poor performance (Sharpe, 1966; Jensen, 1968). In the form of critical essays, Samuelson advocated several times the role of "objective science" as opposed to the "esoteric practices" of investors (Samuelson, 1974; 1989; 1994; 2004). In 1974, he advocated passive management in the issue of the *Journal of Portfolio Management* and this was heard by many investors (Samuelson, 1974). For instance, John Bogle - the founder of the Vanguard Group, today one of the largest investment fund in the world and a pioneer in passive management - explicitly referred to Samuelson as having inspired his own practice (Bogle, 2011). In the same vein, David G. Booth, a former student and co-author of Fama, applied passive management at Well Fargo Bank in the 1970s before creating his own fund (Guth, 2008).[18] Samuelson was still concerned by policy making issues in his discussions of the EMH (Samuelson, 1965a, 48; 1973a, 22; 1989, 9). In a 1973 review of mathematical tools used in finance, for instance, he stressed the unresolved question of the social optimality of price behavior in specula-

[17] For instance, a fund creates a portfolio which replicates the SP-500 by buying stocks from every SP-500 firm, and the amount of stock of a firm in the portfolio is weighed by the firm capitalization.

[18] The Chicago School of Business has been renamed Chicago Booth School of Business in honor of a recent donation from Booth (Guth, 2008).

tive markets, mentioning Working and Keynes as holding two opposite views on this issue:

> In a well-known passage, Keynes has regarded speculative markets as mere casinos for transferring wealth between the lucky and unlucky, the quick and the slow. Holbrook Working has produced evidence over a lifetime that futures prices do vibrate randomly around paths that a technocrat might prescribe as optimal. (Samuelson, 1973a, 3)

In the 1980s, the EMH was challenged in many respects.[19] In the late 1970s and in the 1980s, the relationship between random price changes and the idea of a well-functioning market was weakened (Lucas, 1978; Sims, 1980). New literature investigated to what extent prices reflect economic fundamentals: among the most famous examples of this were the test of variance volatility by Robert Shiller (1981) and the mean reversion phenomenon highlighted by James Poterba and Lawrence Summers (Summers, 1986; Poterba and Summers, 1988).[20] Among other issues, these criticisms pointed out the lack of accurate analysis of the actual functioning of financial markets. As an example, Summers pointed out the absence of explanation in the literature regarding historical crashes and rises of the stock market, which could be viewed as dysfunctional: "virtually no mainstream research in the field of finance in the last decade has attempted to account for the stock market boom of the 1960s or the spectacular decline in real stock prices during the mid-1970s". (Summers, 1985, 634)

These contributions directly questioned the fundamental valuation of stock prices. Facing these criticisms, Fama argued that the Shiller and Summer tests did not provide clear-cut evidence of inefficiency, because irrational discrepancies from fundamental value are indistinguishable from "rational time-varying expected returns" (Fama, 1991, 1581). Interestingly, although Fama rejected these works, these criticisms pushed him to investigate directly the relationship between the financial market and economic fundamentals. For instance, with Kenneth French, he investigated the relationship between stock returns and business conditions, and concluded that they are closely

[19] Of course, the EMH had been criticized before, especially toward the end of the 1970s (Grossman and Stiglitz, 1976; LeRoy, 1976; Jensen, 1978; Modigliani and Cohn, 1979). However, these contributions suggested a reformulation, rather than radically challenging the EMH.

[20] Among other scholarly writings challenging the EMH, we should mention the literature on rational bubbles (Blanchard, 1979; Blanchard and Watson, 1982; Tirole, 1982; 1985), the literature on the Grossman and Stiglitz paradox (Grossman and Stiglitz, 1976; 1980), and the literature on early behavioral finance (Bondt and Thaler, 1985) and early experimental finance (Smith, Suchanek, and Williams, 1988).

related (Fama and French, 1988).[21] Fama remained skeptical about the reformulations of the EMH research program. In his 1991 review following the controversy, he concluded that "In the end, I think we can hope for a coherent story that … relates the behavior of expected returns to the real economy in a rather detailed way. *Or we can hope to convince ourselves that no such story is possible*." (Fama, 1991, 1661, our emphasis)

For his part, Samuelson distinguished two interpretations of the EMH in order to clarify his standpoint. Regarding the practice of investors, he still defended the approximate martingale property of any individual asset which implies near unpredictability for assets fluctuations. Nevertheless, he supported Shiller's general view (Samuelson, 1989) by defending macro inefficiency, which means that at a macroeconomic level, market prices can show strong discrepancies from any definition of fundamental value (ibid). He notably supported this distinction in his correspondence with actors involved in the controversy such as Summers, Shiller, Campbell or Blanchard. Samuelson's view was later supported by Shiller who proposed an empirical test of Samuelson's distinction (Jung and Shiller, 2005).[22] Samuelson remained strongly convinced that in terms of micro efficiency, the EMH was the best model for guiding investment strategy.[23] For policy making expertise, however, he felt the challenging literature on the EMH seemed to be an answer to his 1960s skepticism on the well-functioning of stock markets.

6. Concluding Remarks

By contrasting the pioneer contribution of Fama and Samuelson to the EMH, this article identified two interpretations of the EMH, which differ in their normative content: Fama has extensively developed the practical implications of his model whereas Samuelson has developed the implications for policy making. We have related these differences to two institutional factors: (a) the theoretical and ideological opposition between the MIT and the Chicago school and (b) the position of Fama and Samuelson in the scientific field. However, we should not push this interpretation too far and any explanations cannot be reduced to these two albeit important institutional elements. Moreover, as mentioned previously, Fama and Samuelson's standpoints regard-

[21] Fama's views remain unchanged. See for instance his recent debate with Thaler, which mentions the distinction between the two interpretations of the EMH (Fama and Thaler, 2016).

[22] If Samuelson states that he has "always" used this distinction (S-ARC, letter from Samuelson to Siegel, August 1991), only from the 1990s onwards does he use it frequently.

[23] In this perspective, he has been very skeptical about proponents of the EMH as a promotor of market timing.

ing the EMH were not in Manichean opposition. In particular, we emphasized that their thinking about investor practices are consistent. In the same vein, the categorizations of practical versus policy making expertise, or financial economics versus economics should not be viewed as clear-cut distinctions: for instance, some sets of knowledge could be interpreted as useful for both practitioners and policymakers. This distinction is however useful to discriminate certain aspects of Fama and Samuelson's pioneering contributions to the EMH, especially to point out that, beyond sharing the same object and a similar analysis, they also asked fundamentally different questions.

This opposition between the two authors in 1965 was reflected in the discussion following the EMH controversy in the 1980s. The main criticisms of the EMH that emerged in the 1980s did not try to challenge existing literature on the EMH per se, but to stress a new and what they considered a *more important* problem to solve *for economists*. For instance Shiller, in his introduction on his volatility test, argued that the relationship between price and dividends was "a more interesting (from an economic standpoint) question" (Shiller, 1981). Comparing economists and financial economists in a short essay, Summers pointed out that financial economists had so far ignored "the right" and the "more fundamental questions" regarding financial markets. Stiglitz and Grossman in their famous critique of the EMH (Grossman and Stiglitz, 1980, 405) concluded that there was a need to investigate the "social benefits of information", the "welfare properties of equilibrium" and "whether it is socially optimal to have 'informationally efficient markets'". Hence, the different challengers of the EMH did not aim at challenging the theory but rather at building and making legitimate another research question. The EMH controversy is commonly seen as a theoretical opposition between "rational" or "irrational market" proponents (Rubinstein, 2001). Before a challenge of rationality however, the debate was about the opposition between fields that disagree on what is considered to be the important question to ask about financial markets. If this opposition became apparent in the 1980s, Fama and Samuelson's work in 1965 were an early example of this EMH duality.

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