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The Efficient Market Hypothesis and Rational Expectations. How Did They Meet and Live (Happily?) Ever After

Thomas Delcey

Université Paris 1 Panthéon Sorbonne; Centre d'Economie de la Sorbonne

Francesco Sergi

University of the West of England Bristol; francesco.sergi@uwe.ac.uk

Abstract

This article investigates the origins and early development of the association between the efficient market hypothesis and rational expectations. These two concepts are today distinctive theoretical benchmarks for mainstream approaches to, respectively, finance and macroeconomics. Moreover, scholars in each of these two fields tend to associate the two ideas as related equilibrium concepts; they also claim that the two have a common historical origin.

Although some historical accounts have been provided about either the origins of rational expectations or of the efficient market hypothesis, very few historians have been investigating the history of the association between the two concepts (or, more generally, the history of the interactions between macroeconomics and finance). The contribution of this paper is precisely to fill this gap in the historical literature, while assessing and challenging self-produced narratives told by practitioners.

We suggest that the two concepts were independently developed in the 1960s. Then, we illustrate how they were associated for the first time in the early 1970s, within a debate about the term structure of the interest rates involving Sargent, Modigliani, Shiller, and Fama. Finally, we discuss some early controversies about the association, which nevertheless became, at the turn of the 1970s, a step-stone for both macroeconomics and finance.

Keywords: Efficient market hypothesis, rational expectations, history of macroeconomics, history of finance, Fama (Eugene), Lucas (Robert E.), Sargent (Thomas J.)

Introduction

The efficient market hypothesis and rational expectations are today benchmark concepts for mainstream approaches to, respectively, finance (or “financial economics”) and macroeconomics. Moreover, most scholarship in each of these two fields *associates* the efficient market hypothesis and rational expectations, i.e. it claims that they are closely related (or even equivalent) equilibrium concepts.

In contemporary literature in finance, the efficient market hypothesis is usually attributed to Paul Samuelson (1965) and to Eugene Fama (1965, which first used the expression “efficient market”). The efficient market hypothesis is usually summarized as the idea that “prices of financial assets fully reflect all available information” (e.g. Lo, 2008, 2)—although several other formulations and definitions exist (see e.g. Walter, 2006; Vuillemeys, 2013). Conversely, rational expectations (attributed to John Muth, 1961) have no standard and synthetic definition. Thomas Sargent, in his entry “Rational Expectations” for the *New Palgrave Dictionary of Economic*, summarizes it as “an equilibrium concept that attributes a common model ... to nature and to all agents in the model” (Sargent, 2008, 1). The key implication is that “the forecasts made by agents within the model are no worse than the forecasts that can be made by the economist who has the model” (*ibid.*).¹

The current association between rational expectations and the efficient market hypothesis postulates that asset prices “reflecting fully all available information” are equivalent to prices reflecting the “best” or “optimal” forecast on the asset future return (or in Sargent’s words, the forecast from the “common model”). For instance, the very popular financial economics textbook by Frederic Mishkin’s (*The Economics of Money, Banking, and Financial Markets*) associates the two concepts as follows:² (i) rational expectations are expectations “identical to optimal forecast (the best guess of the future) using all available information” (Mishkin, 2016, 192);³ (ii) asset prices should reflect expectations on future returns (e.g., for stocks, the expected discounted sum of future dividends, *ibid.* 190); therefore, (iii) market

¹ This echoes Muth (1961, 316)’s original definition of rational expectations as “[expectations that] are essentially the same as the predictors of the relevant economic theory”.

² A similar line of reasoning can be found in other popular finance textbooks (e.g. Burton et al., 2010) and in some macroeconomics textbooks (e.g. Burda and Wyplosz, 2013).

³ This also echoes one of Muth (1961, 316)’s justification for his rational expectations assumption: “information is scarce, and the economic system generally does not waste it”.

participants will converge towards an “equilibrium price” reflecting the optimal forecasting. This is true since all prices reflecting non-optimal forecasts on returns (i.e. non-rational expectations) would lead to over-pricing or underpricing of assets—i.e. the current price would imply higher or lower future return than that implied by “the best guess” (*ibid.*, 196-197). Market participants are assumed to act in order to avoid such unexploited profit opportunities (arbitrage).

The legitimacy of this association is also supported by claims about the common origins of the two concepts; that is, the idea that the two concepts were devised from the start as consistent, related ideas. Claims on this common origin are found in several self-produced historical narratives, i.e. historical accounts produced by practitioners in macroeconomics or in finance. Often, these narratives trace back the origins of the association to the 1960s. One narrative claims that, *thanks to* the efficient market hypothesis, rational expectations were “discovered” by Muth and then “brought into fashion” by new classical macroeconomics in the 1970s. An alternative narrative holds the reverse view: inspired by Muth (1961), the success of rational expectations in macroeconomics during the 1970s *led to* the development of the efficient market hypothesis in finance.

Both these narratives (and others) consist of incidental or anecdotal remarks, relying on sketchy historiographical evidence. However, historians of economics do not dispose of any alternative account on the origins and development of the association between rational expectations and the efficient market hypothesis. Although historians have recently produced a significant amount of work about the post-war evolution either of macroeconomics or of finance, very few contributions have been investigating the relations between the two fields, and none addressed the origins of the association between their benchmark concepts.⁴ The purpose of this paper is precisely to start filling this gap in the historical literature, through an investigation of the origins and early development of the association between rational expectations and the efficient market hypothesis.

Our investigation starts with an assessment of self-produced narratives based on historical literature and evidence (section 1). We conclude that the two concepts are more likely

⁴ An early exception is Hoover (1988, chap. 5). Hoover argues that Fama (1980) provide the influential basis for the extension of new classical macroeconomics to finance, money, and banking. Young (2014) and Mehrling (2005) also provided similar insights on the dialogue between new classical macroeconomics and financial economists: Fischer Black—one of the pioneers of option pricing model (Black and Scholes, 1973)—for instance, played a key role in the development of the real business cycle (RBC) approach, through his comments on different drafts of Kydland and Prescott (1982) and Long and Plosser (1983).

to be characterized as independent developments, stemming from distinct research programs.

We then uncover the first instance of the association between the two concepts in the early 1970s (section 2). We argue that Sargent (1972) was the first published contribution discussing explicitly the connection between rational expectations and the efficient market hypothesis and applying it to the analysis of the term structure of interest rates (i.e. the relation between short-term and long-term interest rates of bonds). Sargent's contribution, together with Franco Modigliani and Robert Shiller (1973)'s and Fama (1975)'s replies, reframed the (pre-existing) debate about the empirical testing of theories of term structure of interest rates. Moreover, we argue that this debate contributed substantially to the redefinition of the efficient market hypothesis as the equilibrium outcome of rational expectations models—first in Fama (1975), then by Fama (1976a; 1976b), and finally by Robert Lucas (1978). This theoretical refinement represented the concluding step of a long process (which had started in the 1950s, Jovanovich, 2008), aiming at anchoring the efficient market hypothesis (and finance) into an “equilibrium discipline” proper to the field of economics.

Although rapidly gaining traction in the mid-1970s, the association between rational expectations and the efficient market hypothesis also came under severe criticism. Section 3 surveys three examples of these early controversies. First, a debate arose around Mishkin (and others)'s attempt to use the existing empirical evidence in favor of the efficient market hypothesis to support the empirical relevance of rational expectations. Somehow symmetrically, the concept of rational expectations was used by Shiller (1979; 1981) to build empirical support against the efficient market hypothesis. Finally, Sanford Grossman and Joseph Stiglitz (1980) developed a first theoretical criticism of the theoretical consistency between rational expectations and the efficient market hypothesis.

1. Self-produced narratives and historical evidence

This section clarifies the current state of the literature (in history, in macroeconomics and in financial economics) with respect to the question of the origins of the association between rational expectations and the efficient market hypothesis. We discuss some examples of self-produced narratives, which are drawn from four types of contemporary (from the 2000s and 2010s) materials: (i) dictionaries (e.g. *The New Palgrave Dictionary of Economics*); (ii) textbooks in macroeconomics and in finance; (iii) literature reviews and surveys on the efficient

market hypothesis;⁵ (iv) personal memories (interviews or autobiographies).⁶ From the analysis of these materials, we identified five distinct narratives about the origins of the association between rational expectations and the efficient market hypothesis. This section presents, in turn, these five narratives and then provide for each a critical assessment based on historical literature. We point out that some claims about the origin of an association in the 1960s seems incompatible or at least very unlikely in light of the available evidence.

1.1 Samuelson (1965) as a precursor of Muth (1961)

In his account of Samuelson's contribution to finance, Robert Merton (2006) claims that Samuelson (1965)'s early formulation of the efficient market hypothesis could be seen as using (implicitly) rational expectations *à la* Muth.⁷

The historical literature on the history of rational expectations already identified several potential “precursors” to Muth.⁸ Keuzenkamp (1991), in particular, discusses Jan Tinbergen (1933 [1932])'s use of expectations that would be “rational, i.e. consistent with the economic relationships”.⁹ Besides, Keuzenkamp refers to a wide set of authors addressing the issue of expectations and coming to formulations close to Muth's one: nevertheless, his list does not mention any financial economist (although Keuzenkamp refers loosely to the interest on expectations by “market analysts”). Young et al. (2004) also highlighted several patterns of

⁵ Literature reviews played a distinctive role in this field. From Fama (1970) onward, literature reviews were instrumental in consolidating concepts, in setting new orientations for the research program (e.g. Fama, 1991), and in raising criticisms (e.g. Jensen, 1978) and counter-attacks (e.g. Malkiel, 2003).

⁶ We follow here the approach taken by other historiographical work on “self-produced” or “standard” or “canonical” narratives (see for instance, for finance, Jovanovic, 2008, and, for macroeconomics, Duarte and Lima, 2012; Sergi, 2019). The materials selected are illustrative of “stabilized” or “consensual” knowledge, which play a key role in structuring, showcasing and reproducing the state of a field. For a discussion of the case of textbooks, see Giraud (2018).

⁷ Moreover, Merton also argues that Samuelson was been disseminating the ideas of his 1965's article for the decade preceding its publication, through communications in several talks, including a lecture at Carnegie (where Muth was based). Merton suggests then that this circulation is likely to have had an impact on rational expectations (Merton, 2006, 14). Bernstein (1993), which relies on Samuelson's interviews, seems to contradict Merton's narrative on this point, including by casting doubt on the fact that the Carnegie's lecture had actually taken place.

⁸ Research on “precursors” is still ongoing. Recent scholarship pointed out for instance the hypothesis of “ideal expectations” by Holbrook Working (1949, 1958)—see Berdel and Choi (2019).

⁹ Young et al. (2004, chap. 4) argues against this interpretation, since they rather see Tinbergen as a precursor of the “implicit expectations” program set in motion by Edwin Mills (on this program, see Young and Darity, 2001).

research on expectations in the 1950s, patterns that ultimately converged, notably, in a collective volume edited by Holt, Modigliani, Muth and Simon (Holt et al., 1960). Young and coauthors briefly discuss also Samuelson (1957)'s model of speculation on perishable commodities, which featured expectations that “as in Muth ... are the predictions of the model itself” (Young et al., 2004, 20). However, they are reluctant to consider this as comparable with Muth's rational expectations, since, they argue, Samuelson relies on the (already existing) idea of “perfect foresight”, i.e. a form of certainty equivalence (*ibid.*). Overall, the literature is rather reluctant to identify any “precursors” to Muth. As suggested by Hoover and Young (2011, 19), although several economists “came close” to this concept before 1961, nevertheless they “never quite capture Muth's definition”.¹⁰

Even if we take Merton's claim less literally and we consider the literature on the efficient market hypothesis beyond Samuelson, we still face a similar problem. Available historical evidence has not highlighted any connection between finance and Muth's own work. Young et al. (2004, chap. 2-3) provided a rich scrutiny of all the research programs connecting with Muth.¹¹ Nevertheless, an important finding leaves the door open to the *possibility* of a connection: indeed, besides Muth and his colleagues at Carnegie Graduate School of Industrial Administration (GSIA), the University of Chicago (through the “Public Finance and Money” workshop) was also actively involved in the research network on expectations (Young et al. 2004, chap. 3). Therefore, it is possible that financial economists located in Chicago (e.g. Harry Roberts, Fama) were discussing—or at least were aware—of the ongoing developments on expectations, including Muth's work on rational expectations. Symmetrically, it is possible that Muth was aware in the 1960s of the ongoing work in finance about the efficient market hypothesis. Nevertheless, this remains a conjecture, which is even contradicted by other self-narratives (see the claim by Merton Miller in section 1.4).

1.2. The efficient market hypothesis and its influence on rational expectations macroeconomics

¹⁰ Lucas also strongly objected against the idea of “precursors”, arguing that “we don't want to go back to all the people who used the words “rational” and “expectations” ... no one had anything like [Muth] before” (*ibid.*, 15).

¹¹ This includes obviously research at Carnegie (notably Herbert Simon's work on bounded rationality), but also other formal and informal research program such as the “Illinois project” led by Modigliani, or the “implicit expectations” program led by Mills.

A second narrative claims that the 1960s literature on the efficient market hypothesis inspired rational expectations (or new classical) macroeconomics. Stephen Ross, in his “Finance” entry to *The New Palgrave Dictionary of Economics*, argues that rational expectations models “consistent with certain versions of the efficient market theories” constituted a very late development compared to Fama (1965) and other early works on the efficient market hypothesis (Ross, 2008). These later developments were “parallel” to the “neoclassical rational expectations view of macroeconomics”, and

This is no accident since the rational expectations school of macroeconomics was clearly influenced by the intuition of efficiency in finance. The original insight that prices reflect the available information lies at the heart of rational expectations macroeconomics (ibid.)

Ross’ claim depicts a consistent chronology, and it sounds plausible: since the efficient market hypothesis was already a well-established theory by the end of the 1960s, it could have inspired new classical macroeconomics as it started gaining momentum in the early 1970s. However, macroeconomists usually do not acknowledge any “inspiration” coming from finance. For instance, the *New Palgrave* entries for “Rational Expectations” (Sargent, 2008) and “New Classical Macroeconomics” (Fischer, 2008) do not mention any connection with finance.¹² If there was an influence or inspiration, it is either neglected or forgotten not only by macroeconomists but historical scholarship investigating the methodological and theoretical turn in macroeconomics set in motion by Lucas and Sargent at the turn of the 1970s (e.g. Hoover, 1988; Vercelli, 1991; Duarte and Lima, 2012; De Vroey, 2016). Even the contributions scrutinizing more closely the originating sources of Lucas and coauthors’ work (see e.g. Louça, 2004; da Silva, 2017) do not uncover any influence of the efficient market hypothesis.¹³

In this context, Ross’ narrative (and, to a lesser extent, Merton’s) seems rather aiming at suggesting that 1960s finance was not a marginal field, but a driving force for the

¹² Blanchard (2016), one (if not the most) popular textbook for macroeconomics, takes a similar attitude: no reference to Fama or other works in finance, even in the final chapter devoted to the history of macroeconomics. Even the expression “efficient market hypothesis” is not mentioned, although Blanchard refers loosely to “the random walk hypothesis”.

¹³ Similarly, Sent (1998) reports “ten stories” (or, “hypothesis”) that she encountered in her investigation about the raise of rational expectations in macroeconomics: again, none of this connects to the efficient market hypothesis or to finance.

development of economics, capable of influencing the development of the discipline as a whole and of other subfields, such as macroeconomics. The idea is rather explicit in one of Ross' early surveys on finance, where he argues that "economics, in general will greatly benefit from the tools and data developed in finance": for instance, "finance gave economics its penchant for rational expectations", since "early work on efficient markets, [which] was the impetus if not the cornerstone of the neoclassical, rational expectations school of macroeconomics" (Ross, 1987, 34).

1.3 Muth as the "father" of both the efficient market hypothesis and rational expectations macroeconomics

A third widespread narrative tells the reverse story compared to Ross and Merton's. Indeed, it identifies Muth as the common source of parallel developments in finance and macroeconomics.

Mishkin (2016, 195) distinguishes three historical lines of work in the 1960s and 1970s: the "theory of rational expectations" (i.e. Muth, 1961); "monetary economics" (i.e. Lucas and Sargent's new classical macroeconomics); and "financial economists" (i.e. Fama). Mishkin places Muth (1961) at the top of the family tree, while the two other strains followed a "parallel development": "While monetary economists were developing the theory of rational expectations, financial economists were developing a parallel theory of expectations formation for financial markets." (Mishkin, 2016, 195)¹⁴ Furthermore he adds as a footnote:

The development of the efficient market hypothesis was not wholly independent of the development of the rational expectations theory in that financial economists were aware of Muth's work (ibid.)

The claim that financial economists working on the efficient market hypothesis were "aware of Muth's work" does not rely on any obvious evidence or source. Notably, self-produced narratives arising from autobiographical accounts are contrasted on this point: while Lucas and Shiller are skeptical of this connection (*cf. infra*, 1.4), Richard Roll claims that he

¹⁴ The structure of this chapter of Mishkin's textbook follows this lineage: rational expectations are discussed first, then the efficient market hypothesis is introduced as "just an application of rational expectations to financial markets" (*ibid.* 195). Other textbooks follow the same presentation: see e.g. Howells and Bain ("The efficient market hypothesis is just one application of the 'theory of rational expectations' first set out by John Muth"; 2013, 573), Burton et al. (2010, 146) or Blake (2001, 398).

was already aware of Muth work while writing his dissertation (1965-1968, under Fama's supervision), "because his fellow students and professors at Chicago had used it as one element in constituting their ideas about market efficiency" (Roll in Sent, 1998, fn. 7). As mentioned earlier, historians have not uncovered any concrete element supporting this connection, although it could be a possibility.¹⁵ Moreover, it seems to remain a rather unlikely possibility, especially given Young et al. (2004)'s compelling thesis on the dissemination of Muth's ideas. Muth's works was not obscure (since it was part of a wide network of research on expectations) and it was presented several times, including at the 1959 annual meeting of the Econometric Society (*ibid.*, chap. 5), and in Chicago (*ibid.* chap. 4-5; 80). Despite this awareness about Muth's work, the idea of rational expectations was far from being fully appreciated as a breakthrough.¹⁶ All along the 1960s, rational expectations were thus "a solution in search of a problem" (*ibid.*, xi): applications of Muth's idea remained scarce, until new classical macroeconomics somehow vindicated Muth by making of him a "father figure" of their approach.¹⁷

1.4 Rational expectations and the efficient market hypothesis as independent discoveries

Whilst the previous three narratives are built on the claim that one concept "influenced" or "inspired" the other in the 1960s, another narrative, mostly found in autobiographical accounts, argues that no connection between the two ideas was established during the 1960s, and that rational expectations and the efficient market hypothesis arose as "independent discoveries". The two ideas were associated later, in the very early 1970s. This latter account seems rather consistent with the absence of available historical evidence on a connection between ideas, authors, or research programs in the 1960s.

¹⁵ Jovanovic (2009, 70) mentions for instance that Fama (1970) had been influenced by Muth (1961), although no clear explanation is provided.

¹⁶ Several explanations are provided for what is, in retrospect, a surprising neglect or lack of reaction: see Young et al. (2004, chap. 4-5), Sent (2002) but also Lucas's own account (in Young and Hoover, 2011, 16).

¹⁷ Bibliometric analysis Hoover and Young (2011, 3) confirms this idea through citations patterns: Muth's paper was cited only 29 times during the decade 1960-1969 (vs. 171 citations in the following decade), and the expression "rational expectations" was used only in 39 articles (vs. 324 citations in the following decade). Domains of these citations are obviously agricultural economics (since Muth's original paper dealt with the cobweb theorem) and general equilibrium theory (Negishi, 1964; Radner, 1967; these examples are also discussed at length in Young et al., 2004, chap. 5).

Young and Hoover (2011, 22) directly asked Lucas: “When rational expectations and the efficient market hypothesis were first connected?” Lucas’s answer rather relies on Merton Miller’s opinion that the two concepts were not connected at all in the 1960s:

Merton Miller was on both thesis committees. He was on Jack’s [Muth] committee at Carnegie Tech; and when he moved to Chicago, he was in Gene Fama’s committee. So I asked him that question once, and said “we didn’t see it”. He knew both theses, but he didn’t see that they were saying very similar things. (Lucas in Young and Hoover, 2011, 22)¹⁸

The further encounter between the two concepts (and the two communities) took place at Carnegie GSIA at the very end of the 1960s. Lucas, in his Nobel autobiography, recalls that “Dick Roll, a student of Eugene Fama’s at Chicago, brought the ideas of efficient market theory to GSIA” (Lucas, 1996). Roll confirms this idea in his own recollection about his arrival at Carnegie in 1968.¹⁹ Sargent confirms that he became aware of the work of Fama and Mandelbrot when meeting Roll at the end of the 1960 (Sargent in Sent, 1998, 167; see also Sargent, 1996, 17-18).

1.5 Rational expectations macroeconomics and its influence on efficient market hypothesis

A fifth set of narratives argues that rational expectations in macroeconomics in the 1970s have been responsible for the blossom of the efficient market hypothesis around the same period. While celebrating Lucas’s Nobel Prize, Robert Hall claimed that Lucas (1978)’s asset pricing model “gave structural content to the relationships alluded to in the finance literature” (Hall, 1996, 42). More specifically, it is Lucas’s model based on rational expectations that reframed the efficient market hypothesis in general equilibrium terms:

¹⁸ Lucas’s comment is part of a panel discussion about the origins of rational expectations, with Lucas, Shiller, Neil Wallace, Dale Mortensen, and Michael Lovell. Note that Shiller followed up on Lucas with similar considerations (*ibid.* 22-23).

¹⁹ “In his personal letter dated October 30, 1996, Richard Roll, who was also at Carnegie Mellon at that time, remembers many discussions with Lucas, Sargent, Simon, Meltzer, and later others such as Prescott, in which Roll was the advocate of rationality and hence efficient information processing by agents, and the others were generally skeptical.” (Roll in Sent, 1998, fn. 7)

[Lucas] integrated ideas from economics and finance into a unified general equilibrium model of asset pricing. In addition, Lucas demonstrated the compelling and rigorous nature of a rational expectations equilibrium ... Before Lucas, the finance literature developed important partial equilibrium models of asset prices (ibid. 41-42).

In a paper written for the same occasion, Stanley Fischer presented the same kind of argument:

Aside from its macroeconomics significance, [Lucas, 1972] was influential also in providing a precise model that illustrates the information-conveying role of prices. It was common in the field of finance to say, without any great precision, that in an efficient market prices reflect all relevant information. Lucas model shows exactly what that might mean (Fischer, 1996, 18).²⁰

In his entry “Efficient market hypothesis”, Andrew Lo subscribes to the same narrative. After “landmark” papers by Samuelson (1965) and Fama (1965), it is only “a decade later” (Lo, 2008, 3) that rational expectations have come to be associated to the efficient market hypothesis. Lo sees this as a turn (operated by Lucas, 1978) in terms of the object and methodology, moving away the field of finance from “statistical descriptions” and “empirical testing” and leading it toward a full-fledged “theory of efficient markets”.²¹ The same idea can also be found in Campbell (2014)’s piece celebrating Fama, Hansen, and Shiller’s Nobel Prize.

The main line of this narrative (rational expectations contributed in substantiating an equilibrium concept for the efficient market hypothesis) is not in itself incompatible with historical literature. However, its chronology (the mid and late 1970s) is puzzling. The existing historical literature portrayed the raise of efficient market hypothesis *in the 1960s* (and not in the 1970) as the strive of financial theorists to anchor their analysis into economic theory and legitimate finance as an academic, scientific discipline within the field of economics (see e.g.

²⁰ Note that Fischer, conversely to Hall, refers to Lucas (1972)’s model for the neutrality of money, and not to Lucas (1978)’s asset pricing model.

²¹ Note that the previous edition of the *Palgrave Dictionary of Economics*, the entry “Efficient Market Hypothesis” (Malkiel, 1987) did not mention rational expectations at all. The historical account provided in that entry focused on early formulation of the random walk hypothesis and its testing (following the “canonical history” uncovered by Jovanovic, 2008). The emphasis is precisely on empirical proof (and “anomalies”), rather than on the theoretical interpretation of the efficient market hypothesis as an equilibrium concept.

Walter, 1996 ; Jovanovic, 2008).²² Also, it is *prima facie* odd to think that Lucas’s articles published in 1972 and 1978 had an influence on the formulation of the efficient market hypothesis, which is traditionally dated back to Fama’s and Samuelson’s work almost a decade earlier. Nevertheless, we will see that this narrative, although it requires some qualification and reflexivity, constitutes a relevant lead.

2. The origins and early development of the association between efficient market hypothesis and rational expectations

The narratives discussed in the previous section helped in suggesting that rational expectations (both in Muth and as an application to macroeconomics) and the efficient market hypothesis were developed independently in the 1960s, and that they were associated later in the 1970s. However, with respect to this encounter in the 1970s, the narratives by practitioners and historical scholarship both provide limited or puzzling accounts. The core contribution of our paper is precisely to complete and clarify how the two concepts were originally associated and how this association grown stronger.

This section starts (2.1) by presenting Sargent’s “Rational Expectations and the Term Structure of Interest Rates” (1972) and Modigliani and Shiller’s reply to Sargent. These, we argue, are the first published articles explicitly discussing and associating rational expectations and the efficient market hypothesis.²³ We then discuss (2.2) how this debate on the term

²² For sure, economic analysis of issues in finance (asset pricing, portfolio choice, ...) dates back to much earlier—for instance to the work by Irving Fisher (Dimand 2007). Nevertheless, it was only in the 1960s that a scientific academic community emerged and became firmly established, thanks to the work of Fama, Samuelson and others. Historians noted that this breakthrough was not only analytical but also material and institutional. The construction of historical financial data by the Center for Research in Stock Prices at Chicago Business School, and especially the treatment of these data by computers, have largely supported the emergence of econometric research in the field of finance. In the same vein, philanthropic foundations led the reform of business school in the 1950s, in which finance practitioners had been replaced progressively by economists and statisticians (Fourcade and Khurana, 2013).

²³ In a footnote to his 1972 article, Lucas also clarifies that “The assumption that traders use the correct conditional distribution in forming their expectations, together with the assumption that all exchanges take place at the market clearing price, implies that markets in this economy are efficient, as this term is defined by Roll (1968). It will also be true that price expectations are rational in the sense of Muth (1961).” (Lucas, 1972, 110, fn.7) However, this is a marginal remark, tangent to Lucas’s reasoning, while the association of the two concepts is the cornerstone of Sargent’s reasoning in his article.

structure rapidly found an echo in Fama (1975)'s and how this led him to a reformulation of the efficient market hypothesis as a rational expectations equilibrium—a reformulation which he achieved in his *Foundations of Finance* (1976a). Finally, we discuss how this reformulation was taken to a further stage by Lucas (1978) by disentangling the idea of efficient markets from any statistical characterization (2.3).

2.1 The origins: Sargent, Modigliani, Shiller, and the term structure of interest rates

Sargent (1972) is a contribution to the debates about the term structure of interest rates or “yield curve”, i.e. the observed relation among the interest rates of bonds that differ only in their maturity. Different theories explaining this relation have been originally devised by Fisher (1896), John Hicks (1939), and Friedrich Lutz (1940);²⁴ in the 1960s, the debate was reinvigorated by the blossoming of econometric testing of these theories (see in particular Meiselman, 1962; Wood, 1964; Modigliani and Sutch, 1966, 1969; Hamburger and Latta, 1969). The main contention of these debates was the explanatory power of what was labelled the “expectations theory” of the term structure. The expectations theory simply states that, on a bond market respecting a non-arbitrage condition, current long-term interest rates should be equivalent to the average of current expectations for future short-term interest rates. Alternative theories suggest that the interest rate differential between long and short term bonds should reflect not only expectations, but also a premium for liquidity and/or risk.

Although very simple, the expectations theory constituted an obvious challenge in terms of econometric testing, since it entailed producing some sort of measurement for expectations on the future interest rates. In their work, Modigliani and Sutch (1966; 1967; 1969) suggested to formalize current expectations as distributed (hump-shaped) lags of past interest rates—in short, as “adaptive” expectations—so that data on past interest rates will allow to quantify current expectations on future rates.²⁵ Modigliani and Sutch also concluded, from their empirical estimations, that the expectations theory alone does not satisfactorily explain the data, while, with the addition of an additional “risk premium” term the fit of the model is considerably improved.

²⁴ See Brillant (2019) for a historical perspective of these contributions.

²⁵ Meiselman (1962) suggested that expectations are formed through a learning process from past errors; Kane and Malkiel (1967) uses questionnaires to measure directly expectations. However, they also conclude that their measurements tend to support Modigliani and Sutch's hypothesis of adaptive expectations.

Sargent suggests, in his paper, both an alternative way of testing the expectations theory of the term structure (“expectations hypothesis” in his words) and a different specification for expectations:

This paper reports some tests of two important hypotheses ... The first is the “expectations hypothesis” ... The second hypothesis is that expectations of investors are rational in the sense of John F. Muth. By this we mean that investors’ expectations are equivalent with the optimal forecast of statistical theory for a certain specified class of statistical models. A convenient way to characterize a market that satisfies both of these hypotheses is as an “efficient market”. (Sargent, 1972, 74)²⁶

For Sargent, the two “hypotheses” (the expectation theory of the term structure on the one hand, and rational expectations on the other hand) have one single implication, i.e. that the bond market is “efficient”. Following the substantial amount of examples developed in the past decade by the literature on the efficient market hypothesis, it is straightforward to test this outcome: in short, both hypotheses would be corroborated if forward interest rates are proven to follow a martingale.²⁷

However, Sargent’s estimations reject the martingale distribution, and therefore the efficiency of the bond market. Nevertheless, Sargent is reluctant to take this result as a rejection of either rational expectations or of the expectations theory of the term structure. In his conclusion, he clarifies how he does not consider as valid solutions “diluted forms of the expectations theory”, such as the liquidity premium, since, although practical in fitting the data, they also are “arbitrary”, i.e. they do not rely on any theoretical justification (Sargent, 1972, 94). Abandoning rational expectations is equally unacceptable: to Sargent, this would entail violating the non-arbitrage condition (embedded in the expectations theory), since expectations that are “non-optimal” (i.e. non-rational) would result in unexploited profit opportunities (*ibid.*).

²⁶ Sargent credits, in a footnote, Roll (1966) and Fama (1970) for devising the expression “efficient market”. It could also be argued, although this is not explicit in the article, that Sargent draws from Fama (1970)’s idea that the test of the efficient market hypothesis is a “joint test” of the hypothesis *and* of an underlying pricing model.

²⁷ Sargent (1972, 75) credits Samuelson (1965) for the martingale model, and Roll (1966) as the first trying to test the distribution of interest rates—indeed, the efficient market hypothesis was mostly tested, along the 1960s, on stock market data.

Shiller (1972) wrote a first comment about Sargent (1972), then came a longer answer by Modigliani and Shiller (1973)—both resulting from Shiller’s PhD dissertation “Rational Expectations and the Structure of Interest Rates” (1969-1972, under Modigliani’s supervision at MIT).²⁸ These replies accept two important aspects of Sargent’s approach to the test of the term structure: first, they acknowledge that the discussion could be framed as a test of the “efficiency” of the bond market, following the literature in finance; secondly, they accept the idea that, in the context of an efficient market, expectations should be “optimal forecasts” or “best guesses”. However, Modigliani and Shiller will consider that extrapolative expectations *do abide by this definition* (i.e. that expectations based on past rates do minimize the prediction error for future rates). Sargent’s results about the martingale, they argue, tend precisely to support this (Modigliani and Shiller, 1973, 29). Besides, they also take issue again with the idea that expectations alone could explain satisfactorily the term structure, restating the empirical relevance of introducing a liquidity or risk premium (*ibid.*, 13). However, they also recognize a weakness of their previous work, namely the underlying assumption that the only “relevant information” for forming expectations on future rates is the history of past rates. Noting the high positive serial correlation of the residuals of their initial model, they suggest that a relevant independent variable was omitted from their specification: the expected inflation rate (*ibid.*, 19-20).²⁹ Implicitly following Fisher famous insight about the relation between nominal and real interest rates, Modigliani and Shiller suggest that a better specification for their model will take into account the effect of inflation on future short term interest rate (especially when an economy is experiencing “considerable variability”, *ibid.*).

2.2 The early development: Fama on the term structure and the reformulation of the efficient market hypothesis

The discussion on the expectations theory of the term structure continued in the following years. Other contributors entered the debate (e.g. Cargill, 1975; Hamburger and Platt, 1975; Laffer and Zecher, 1976).³⁰ Sargent also (indirectly) replied to Shiller and Modigliani’s comments on

²⁸ Note that both Shiller and Sargent had moved to University of Minnesota by 1972: they were colleagues when the article was published.

²⁹ Modigliani and Sutch already mentioned and discussed this problem (1969, 114 and fn. 8), although they did not come to the same conclusions as about how to address it.

³⁰ It is actually likely that Laffer and Zecher completed their article a few years earlier (1971 or 1972) at University of Chicago (we would like to thank Edward Nelson, who pointed this out to us). Thus, this article could actually

his 1972 paper. In “Interest Rates and Prices in the Long Run: A Study of the Gibson Paradox” (1973), Sargent tackled the issue of the impact of inflation on the term structure. In this long article (67 pages), Sargent aspects several theoretical and empirical issues pertaining to the Fisher equation. With respect to the debate illustrated above, we consider that Sargent put on the table two additional arguments. First, he argues that, conversely to what is suggested by the Fisher equation, inflation rates and interest rates are “mutually determined”: therefore, it is not relevant to follow Modigliani and Shiller’s suggestion to add inflation rates to their model. Secondly, Sargent supports again that past interest rates and past inflation rates should not contain any relevant information about future rates: expectations do not follow “naive extrapolations of past rates” (Sargent, 1973, 447). We also can acknowledge how this finding tend to corroborate then the efficient market hypothesis (in his “weak form”, Fama, 1970), although Sargent, this time, does not refer explicitly to this literature.

Fama entered the debate on the term structure by following up on Sargent (1973)’s article, first with “Short-Term Interest Rates as Predictors of Inflation” (Fama, 1975), and later in his “Forward Rates and Predictors of Future Spot Rates” (Fama, 1976b). The purpose of both articles is to disprove empirically that past interest or inflation rates determine current and future rates, which would be “inconsistent with a well-functioning or ‘efficient’ market” (Fama, 1975, 269).

Nevertheless, we argue that the importance of the Fama (1975) rather lies, in his reformulation of the efficient market hypothesis “in the language” of rational expectations. It is important to note that, both in Samuelson’s and Fama’s seminal contributions to the efficient market hypothesis, the randomness of asset prices was already interpreted using an economic framework and some of its distinctive notions—equilibrium, competition, rationality.³¹ However, in these (and subsequent) contributions, the definition of the equilibrium concept underlying an efficient market was rather elusive. Fama (1965, 94) defined this as asset prices that “represent best estimates of the intrinsic values”—the latter being defined as depending on “earnings prospects of the company, which in turn are related to economic and political factors” (*ibid.*, 36). In further refinements, Fama (1970, 384) clarified how the prices of an efficient market might, for instance, be understood as the equilibrium outcome of the capital asset pricing model (CAPM, or “the two parameters model” in Fama’s words: Sharpe, 1964; Lintner,

be the first example associating the efficient market hypothesis and rational expectations, with a line of argument very close to Sargent (1972)’s.

³¹ For a more in-depth analysis on Samuelson and Fama’s papers, see Delcey (2019).

1965).³² Fama (1975) laid down the foundations of a new definition of the efficient market hypothesis through rational expectations, which Fama will then popularize in his book *Foundations of Finance* (1976a).³³ In Fama (1975, 270, equation 6; 271, equation 8), the notion of “best estimate” on future returns is for the first time reformulated following Muth’s definition of rational expectations: the “best estimate” of future real interest rates is the mathematical expected value given all the available information, and it is presented as the market participants use the correct conditional distribution to form their expectations.³⁴ As in Sargent (1972; 1973), this leads to the implication that past inflation and interest rates have no predictive power on current rates, which can be tested empirically by proving that interest rates follow a martingale.

2.3 Taking a step forward: Lucas (1978)’s asset pricing model

Like Fama (1975), Lucas’ “Asset Prices in an Exchange Economy” (1978) laid down new theoretical foundations for the efficient market hypothesis based on rational expectations equilibrium models. Lucas explicitly sets his article as a contribution to finance and to the literature on the efficient market hypothesis. In this respect, he connects both his result and his assumptions to Fama *and* Muth:³⁵

The analysis is conducted under the assumption that, in Fama’s terms, prices ‘fully reflect all available information,’ an hypothesis which Muth (1961) had earlier termed ‘rationality of expectations.’ (Lucas, 1978, 1429)

In his model, Lucas discusses the dynamic properties of “market determined” prices of a financial asset, in a single-good pure exchange economy where productivity of firms varies stochastically. In this model economy, financial assets represent “claims on part of the output” produced exogenously (i.e. with no inputs) by one among a large number of heterogeneous firms. Households (which are assumed identical) can purchase assets in a “competitive stock market”. The problem set by Lucas is thus to determine the price sequence for assets and the produced good, assuming that such prices are market clearing prices (i.e. the prices for which,

³² However, the definition embedded into the CAPM relied on a one-period analysis, where expectations were exogenous and not rational.

³³ Fama (1976c) also uses this new formulation to answer LeRoy (1976)’s criticism of Fama (1970)’s definition of the efficient market hypothesis.

³⁴ However, Fama does not explicitly refer to Muth or use the expression “rational expectations”.

³⁵ Like Sargent (1972), Lucas (1978, 1444, fn. 10) also explicitly refers to Samuelson (1965)’s formulation of the efficient market hypothesis as a martingale.

at each period, households consume all the current output of the economy and they hold all the existing assets). Lucas's result is that the equilibrium asset prices might follow a martingale process, or they might not. In this respect, his conclusion is that the statistical characteristics of a sequence of prices is not a *sufficient* condition to draw inference on "efficiency":

With respect to the random character of stock prices, it is evident that one can construct rigorous economic models in which price series have this characteristics (a martingale) and ones with equally rational and well-informed agents in which they do not. This would suggest that the outcomes of tests as to whether actual price series have the Martingale property do not in themselves shed light on the generally posed issue of market 'efficiency'. (Lucas, 1978, 1444, Lucas's emphasis)

A more explicit claim about the *intentions* of the paper is to be found few lines later, where Lucas clarifies his *methodological* aspirations:

In the main, however, this paper is primarily methodological: an illustration of the use of some methods which may help bring financial and economic theory close together. (Lucas, 1978, 1444).

The bottom line of Lucas's paper is therefore that efficient markets are rather characterized by the equilibrium nature of asset prices (based on rational expectations) than by any particular form of their statistical distribution. We can therefore interpret Lucas's methodological ambition as pushing finance further toward formalizing general equilibrium model of asset pricing, instead of simply pursuing the route of empirical testing of prices distribution. In this respect, Lucas's paper contributed to the process of "anchoring" finance, as a field of research, into an economics' "discipline of equilibrium"—a process started precisely in the 1960s and accelerated, as we have seen, by the association between rational expectations and the efficient market hypothesis.³⁶

³⁶ However, financial economists kept referring to martingales as indissociable from the efficient market hypothesis (e.g. Shiller, 1978, 6): "The essential characteristic of linear rational expectations models is their representation of public expectations of future economic variables as true mathematical expectations conditioned on all information known to the public. [...] Such conditional expectations which develop through time by the addition of new information are the basis of the theory of martingales developed by Levy and Doob over 25 years ago."

3. Early controversies on the association between the efficient market hypothesis and rational expectations

The previous section illustrated how, from 1972 to 1978, the association between the efficient market hypothesis and rational expectations had originated and developed. Starting from 1975, several new applications of Sargent (1972) idea of joint test arose—for instance, applications to the determination of the exchange rate (Niehans, 1975; Dornbusch, 1976; Fama, 1984). Surveys (e.g. Kantor, 1979; Jensen, 1978) and textbooks (e.g. Sargent, 1979; Sheffrin, 1983) on both rational expectations and the efficient market hypothesis started to routinely associate the two concepts. A crucial example is Steven Sheffrin's *Rational Expectations* (1983), which was conceived both as a survey of the rational expectations literature (both theoretical and empirical) and as an “introduction” to the concept of rational expectations for non-specialist audience—in many universities it is indeed still used today (in his second edition, 1996), as a textbook for graduates. Sheffrin's chapter 4 (“Efficient Markets and Rational Expectations”) is entirely devoted to survey the literature in finance and in macroeconomics that makes use of the rational expectations hypothesis in the context of the analysis of markets “processing the information efficiently”. Sheffrin's exposition mostly relies on Lucas (1978) and matches with the modern textbook presentation of the association between the two concepts (*cf.* Introduction).

However, one could hardly argue that the two concepts lived together happily ever after. This section shows how the association between rational expectations and the efficient market hypothesis was immediately at the center of controversial debates. We present three representative examples drawn from these early controversies. A common and somehow paradoxical aspect of these examples is that no one *rejected* the association of the two concepts *per se*; conversely, it has been *embraced in* order to criticize some of its implications. Thus, somehow early controversies contributed to further popularize and make more definite the association between rational expectations and the efficient market hypothesis.³⁷

³⁷ Another common pattern is that criticisms were mostly raised by “outsiders” of financial economics. Scholars discussed below (such as Shiller, Blanchard, Summers, Tirole, Stiglitz or Grossman) had been trained in economics departments in the 1970s, and not in finance departments in business schools. The controversies therefore reflects somehow a clash between fields and their respective methodologies and research questions (see e.g. Summers, 1985; Ross, 1987).

3.1 Mishkin and the empirical support to rational expectations macroeconomics

At the turn of the 1980s, the approach to macroeconomics set in motion by Lucas and Sargent was maturing. Although controversies and reactions were still ongoing (see for instance De Vroey, chap. 14), Lucas and Sargent were actively engaging with spreading their approach, namely publishing textbooks (Sargent, 1979; Lucas, 1987 [1985]), collecting their works (Lucas, 1981; Lucas and Sargent, 1981), and writing rather “methodological” papers or “manifestos” (Lucas, 1977, 1980; Lucas and Sargent, 1978). Within this context, one (controversial) book seems of particular interest for illustrating how the efficient market hypothesis was contributing to the development of this approach to macroeconomics: that is, Frederic Mishkin’s *A Rational Expectations Approach to Macroeconomics: Testing Policy Ineffectiveness and Efficient-Markets Models* (1983).³⁸

The definition of rational expectations that can be found at the very beginning of Mishkin’s book mirrors the definition that can be found 30 years later in his textbook: “[the rational expectations hypothesis] states that expectations reflected in market behavior will be optimal forecasts using all available information.” (Mishkin, 1983, 1) The book was firmly anchored in macroeconomics, and it was actually echoing Lucas and Sargent (1981)’s effort to lay down econometric procedures for testing and estimating rational expectations models (Mishkin, 1983, 1-2). However, Mishkin found worth emphasizing that the “domain of application” of rational expectations had been expanding in the “last few years”, coming to include a large set of financial issues (*ibid.*, 3); Mishkin openly connects the two domains (“the use of rational expectations (or equivalently, the efficient markets) hypothesis”, *ibid.*, 4). In the subsequent chapters, Mishkin highlights “the common elements in procedures” for testing rationality of forecasts, market efficiency, and the short run neutrality of aggregate demand policies (*ibid.*, 4).

A rather innovative aspect of Mishkin’s book lies in his rhetoric, rather than in his analytical content. Indeed, Mishkin uses the empirical literature on the efficient market hypothesis as “an empirical leverage” to support implications about “policy ineffectiveness” of

³⁸ This is actually an edited version of a series of papers published by Mishkin between 1978 and 1981. Mishkin was a PhD student of Stanley Fischer at MIT (1973-1976). Mishkin was then appointed assistant professor at University of Chicago (1976-1983).

the new classical approach.³⁹ Indeed, the widespread popular opinion of the time, even among those critical of the efficient market hypothesis, was that “no other proposition in economics ... has more solid empirical evidence supporting it than the Efficient Market Hypothesis” (Jensen, 1978, 95); while new classical macroeconomics, and especially its policy implications, were still at a stage where their empirical support was disputed—see for instance Goutsmedt et al. (2019) about the Lucas Critique. Mishkin’s strategy obviously attracted the harsh criticism of those macroeconomists opposing the new classical approach. In his comment on Mishkin (1978), Modigliani qualifies indeed Mishkin’s reasoning as arguing “that current procedures for evaluating policy and forecasting with macroeconomic models are inconsistent with market efficiency in bond and stock markets”, a thesis that he bluntly rejects as “unwarranted” and “based on confusion” (Modigliani, 1978). At the same period, Samuelson held a similar stance about dissociating the implications of rational expectations macroeconomics models from those of efficient market hypothesis (Boianovsky, 2019).

Therefore, the association between efficient market hypothesis and rational expectations also enters into the stage of the debate on policy between new classical macroeconomics and “Keynesians”. In finance, a similar opposition was actually already well definite from the very beginning of the development of the efficient market hypothesis, as pointed out by Mehrling (2005), Jovanovic (2008), and Delcey (2019). Two research programs had developed: one around Samuelson, at MIT, using the efficient market hypothesis as a benchmark, rather interested in exploring deviations and anomalies around that benchmark and engaging with discussing relevant policy interventions; and the other research program, around Fama at Chicago, striving to corroborate the efficiency of financial markets and thus supporting lesser State intervention. It could then be argued that the association between the efficient market hypothesis and rational expectations somehow results from or supports a “strategic” alliance between the two Chicago research groups (the efficient market hypothesis and the new classical macroeconomics) holding similar ideological and policy position.

3.2 Shiller and the “anomalies” of the efficient market hypothesis

³⁹ Note that this rhetorical strategy was also employed by Lucas in an informal context, namely at a talk he gave to a Wall Street financial firm in 1977 (Lucas Archives, Box 39, Folder Mitchell, Hutchins Conference). In that talk, about “New Ideas on Economic Policy”, Lucas illustrates his view about money neutrality relying on two examples from the efficient market hypothesis literature (namely stock splits and earnings announcements).

It is widely acknowledged that, within finance, the 1980s have been characterized by several empirical challenges against the efficient market hypothesis (see e.g. Wang, 2008). As mentioned above, Jensen (1978, 95) famously argued that the efficient market hypothesis was considered as largely corroborated empirically. However, Jensen's intention is to question this view: his literature review introduces indeed a symposium regrouping several contributions uncovering empirical "anomalies", contradicting the predictions of the efficient market hypothesis.⁴⁰ As Jensen put it in his piece:

The Efficient Market Hypothesis is an important concept, and it has become increasingly widely accepted since interest in it was reborn in the late 1950's and early 1960's under the rubric of the 'theory of random walks' in the finance literature and 'rational expectations theory' in the mainstream economics literature. (Jensen, 1978, 95)

Therefore, the benchmark against which "anomalies" are detected is a version of the efficient market hypothesis *based* on rational expectations.⁴¹

The perhaps most illustrative and early examples of this line of work are Shiller's twin papers "The Volatility of Long-Term Interest Rates and Expectations Models of the Term Structure" (1979) and "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?" (1981 [1979]). Shiller tackles here the issue of the observed volatility of, respectively, interest rates and stock prices. He argues that such large fluctuations tend to disprove the efficient market hypothesis, at least as based on rational expectations. According to Shiller, for the bond market, the observed high volatility of short term compared to the volatility of long term interest rates is incompatible with the assumption that current long term rates reflect expected future short rates. To make his point, Shiller builds a simple linear rational

⁴⁰ Another similar argument can be found in Modigliani and Cohn (1979): "we readily admit that our conclusion is indeed hard to swallow—and especially hard for those of us who have been preaching the gospel of efficient markets. It is hard to accept the hypothesis of a long-lasting, systematic mistake in a well-organized market manned by a large force of alert and knowledgeable people. In fact, it can be reported as a contribution to intellectual history that, when the hypothesis first crossed the mind of the senior author some four years ago, it was lightly dismissed as too preposterous to be entertained seriously." (Modigliani and Cohn, 1979, 35)

⁴¹ Note that this also implied a reassessment of the methods for testing the efficient market hypothesis. Somehow relating to Lucas (1978) intuition, traditional tests of stock or bond prices as random walks or martingales were progressively complemented by tests about "above-average profitability" (Summers 1986, 591-592) or "excessive volatility" (*cf.* Shiller *infra*).

expectation model, expressing long term interest rates as the weighted average of rationally expected future short term rates, plus a constant liquidity premium (Shiller, 1979, 1194). According to his model, the rational (unobserved) expected short term rates are equal to the past observed short term rates. Then, Shiller computes theoretical long term rates that he can compare to the historical ones. The resulting long term rates estimates are significantly smoother than the actual (observed) long term rates (*ibid.*, 1200), and therefore are not compatible with the predictions of this rational expectations version of the expectations theory of the term structure. Moreover, Shiller shows that zero-covariance restrictions on long vs. short rates (which reflect the idea of “non-forecastability” embedded in the definition of the efficient market hypothesis) are violated by the data, therefore casting doubt on the efficiency of the bond market. Shiller (1981 [1979]) extend this reasoning to the volatility of stock prices: he highlights how the observed volatility of these prices seems inconsistent with a rational expectations model which expresses the fundamental value (or the equilibrium price) of stocks as their expected returns (measured as the ex-post observed dividends). Similarly, as for bonds, the excess volatility of the observed stock prices also goes with a violation of zero-variance restrictions, therefore implying the existence of profit opportunities (*ibid.*, 423-424).

Several other contributions (e.g. Summers, 1986; De Bondt and Thaler, 1985; Poterba and Summers, 1988) followed up on Shiller’s idea—although with different angles.⁴² With respect to the question of the controversies around the association between rational expectations and the efficient market hypothesis, we consider that these works illustrate the following. On the one hand, they have been taking seriously this association, since all rely on the assumption of rational expectations to produce tests of market efficiency. However, on the other hand, based on these tests, they have been rejecting the predictions of the rational expectations version of efficient market hypothesis. Nevertheless, and most interestingly, their findings on the “inefficiency” of the bond and stock market have not been the end of the line for these authors. Conversely, their goal became, as Shiller put it, to find alternative answers to a “more interesting (from economic standpoint) question: what accounts for movements of real stock prices?” (Shiller, 1981, 424) Price valuation became indeed the central issue for the rise of

⁴² Summers and Poterba focused on the mean-reversion phenomenon (that is, long-term miss-valuation of stock prices), as further evidence of the violation in the zero-covariance restrictions discussed by Shiller. Thaler and Bondt focused on market “overreaction” (i.e. the tendency of market participants to overweight new information and underweight prior information) as a possible explanation of the excessive volatility highlighted by Shiller. However, several other contributions actually criticized Shiller’s method and result (for a short summary see Fama 1991, 1586).

behavioral finance (Shiller, 1984; Thaler and Bondt, 1985). This entailed, precisely, the development of several explanation of asset prices, all relying on assumptions about individual behavior that clearly departed from the optimizing rationality implicit in the rational expectations hypothesis.

3.3 Grossman and Stiglitz's paradox: Is the association theoretically consistent?

The efficient market hypothesis also faced, at the turn of the 1980s, theoretical challenges. However, the development of alternative theoretical insights by behavioral finance arise from an empirical criticism of the predictions of the efficient market hypothesis associated with rational expectations (as illustrated just above). A different path of criticisms questioned the association on a purely theoretical and logical ground. One example of the literature on “rational bubbles” (Blanchard, 1979; Blanchard and Watson, 1984; Tirole, 1982; 1985). Closely following the new research program on price valuation (*cf. supra*, 3.2), these contributions aim at showing that asset prices' departures from their “fundamental values” (i.e. departures from market efficiency) arise within rational expectations models—although this literature is rather interested in rigorously formalizing bubbles than in defending a particular assumption on rationality. Another example of this line of theoretical or logical criticism is the new microeconomic literature in finance which used rational expectations as a benchmark to model and discuss the informational efficiency of financial markets equilibrium see, for instance, the “no-trade theorem” (Milgrom and Stokey, 1982 ; Tirole, 1982) , the noise traders (Black, 1985; De Long et al., 1990), the “partially revealing rational expectation equilibrium” (Ausubel, 1990).

This new literature originates from Grossman and Stiglitz's “On the Impossibility of Informationally Efficient Markets” (1980), famously rebranded afterwards the “Grossman-Stiglitz paradox”.⁴³ The article explores if “it is possible that a competitive economy always be in equilibrium” when (i) “competitive equilibrium is defined as a situation in which prices are such that all arbitrage profits are eliminated” and (ii) acquiring information about future returns is costly (Grossman and Stiglitz, 1980, 393). Thus, the model investigates if the price determined on efficient markets (i.e. a price reflecting “all available information”) is also an equilibrium price. In the literature reviewed in previous sections, this is the case: an efficient market is precisely a market where current asset prices are equivalent to their “intrinsic” (or

⁴³ Note that the paper draws on the authors' previous work on the role of information in determining market equilibrium (e.g. Grossman and Stiglitz, 1976).

“fundamental”) value, i.e. to a price reflecting the rationally expected future return based on available information; and, moreover, this is an equilibrium price, since any other price over/under-estimates the intrinsic value, which results in unexploited profit opportunities. However, this is based on the assumption that rational expectations on future returns are based on all freely available information, and that such information is available to all market participants. Grossman and Stiglitz also assume that expectations on future returns are formed rationally in the sense of Muth: however, they assume that agents in the model can decide to either acquire or not information for a given cost, or to try to infer that information from the observed asset price.

The model developed by Grossman and Stiglitz relies explicitly on Lucas (1972) incomplete information model (inspired, in turn, by Phelps, 1970’s “island model”). There are two possible outcomes for this model: (i) the market is efficient, which requires for every market participant to have acquired costly information; (ii) no market participant is informed, which entails that the market is not efficient. Both outcomes are not equilibria. If a market is efficient (i.e. asset prices “reflect all available information” and correspond to the intrinsic value of the asset) then the market will “break down” (no equilibrium can be achieved). Since acquiring information is costly, and that information can be inferred from the efficient price, market participants will stop paying for information. However, when a growing share of market participants forms expectations based on incomplete information (even though these expectations are formed rationally), the prevailing price will then stop being efficient. If then the market is not efficient, acquiring information becomes profitable again, since it could help market participants to assess the current over or under pricing of assets.

Grossman and Stiglitz show that, if information is costly, then the cost of seeking information should be rewarded by market inefficiencies. Therefore, Grossman and Stiglitz conclude that an efficient market requires that information is costless. However, an efficient market with costless information is a paradox, since it undermines the very essence and rationale for a price system conveying information. We can thus point out how the Grossman-Stiglitz paradox highlighted two problems with respect to the association between rational expectations and the efficient market hypothesis. The paradox clarifies how assuming rational expectations do not constitute a sufficient condition for defining the efficient market hypothesis. Furthermore, the paradox uncovers how the efficient market hypothesis is crucially dependent on the auxiliary assumption of freely available information.

Conclusion

This contribution to the history of macroeconomics and the history of finance illustrated how the association between the efficient market hypothesis and rational expectations emerged in the early 1970s within the debate about the theories of the term structure. We discussed the early developments of this association, in particular its use by Fama and Lucas to reformulate the efficient market hypothesis as the outcome of an equilibrium model rather than a characterization of the statistical distribution of prices as a martingale or a random walk. Although the association between rational expectations and the efficient market hypothesis became well-established and widespread by the mid-1970s, we illustrated how it also faced several challenges. We think that our historical account introduces a rather critical and reflexive perspective on the association between the two concepts, which was missing from self-produced narratives.

Taking a broader perspective, the association of the two concepts of rational expectations should be seen as an illustrative example of an emergence, during the 1970s, of stronger relations between finance and economics. However, the broader history of these relations (i.e. beyond the efficient market hypothesis and rational expectations) still represent an uncharted territory for historians. Our investigation has left also unexplored the evolution of the association between rational expectations and the efficient market hypothesis during the following three decades up to today, and in particular the evolution of this association during the last decade, i.e. since the events of the global financial crisis in 2008. Although the association seems to have been surviving through these decades, keeping a very close formulation to the one given by Fama (1975), it is precisely this resilience to controversies and debates that requires further investigation.

References

- Ausubel, L. M. (1990). Partially-revealing rational expectations equilibrium in a competitive economy. *Journal of Economic Theory*, 50(1), 93–126.
- Berdell, John, and Jin Wook Choi. 2018. Clashing Analyses of Speculation and the Early Regulation of US Futures Markets. *Journal of the History of Economic Thought*, 40(4), 539-560.

- Bernstein, Peter L. 1993. *Capital Ideas: The Improbable Origins of Modern Wall Street*. New York: Simon and Schuster.
- Black, Fischer. (1986). Noise. *The journal of finance*, 41(3), 528-543
- Black, Fischer; Scholes, Myron. 1973. The Pricing of Options and Corporate Liabilities, *Journal of Political Economy*, 81(3): 637–654
- Blake, David. 2001. *Financial Market Analysis*. 3rd edition. New York: John Wiley & Sons.
- Blanchard, Olivier J. 1979. Speculative Bubbles, Crashes and Rational Expectations. *Economics Letters*, 3(4): 387-389.
- Blanchard, Olivier J. 2016. *Macroeconomics*. 7th Global edition. London: Pearson.
- Blanchard, Olivier J., and Watson, Mark W. 1984. Bulles, anticipations rationnelles et marchés financiers. *Annales de l'INSEE*, 1984: 79-100.
- Boianovsky, Mauro. 2019. Paul Samuelson's Ways to Macroeconomic Dynamics. Center for the History of Political Economy at Duke University Working Paper Series. Available at SSRN: <https://ssrn.com/abstract=3386201>
- Brillant, Lucy. 2019. On the origins of the theory of the term structure of interest rates in the XXth century: Irving Fisher and John M. Keynes. Communication, European Society of the History of Economic Thought, Lille, May 2019.
- Burda, Michael and Charles Wyplosz. 2013. *Macroeconomics: A European Text*. 6th edition. Oxford: Oxford University Press.
- Burton, Maureen, Reynold F. Nesiba, and Bruce Brown. 2010. *An Introduction to Financial Markets and Institutions*. 3rd edition. London: Routledge.
- Campbell, J. Y. 2014. Empirical Asset Pricing: Eugene Fama, Lars Peter Hansen, and Robert Shiller. *The Scandinavian Journal of Economics*, 116(3): 593-634.
- Cargill, Thomas F. 1975. The Term Structure of Interest Rates: A Test of the Expectations Hypothesis. *The Journal of Finance*, 30(3): 761-771.
- Da Silva, Danilo Freitas Ramalho. 2017. Lucas's Research in the Late 1960s and the Natural Rate of Unemployment. *History of Political Economy*, 49(1): 137-159.
- De Bondt, Werner F., and Richard Thaler. 1985. Does the Stock Market Overreact? *The Journal of Finance*, 40(3): 793-805.
- De Long, J. B., Shleifer, A., Summers, L. H., & Waldmann, R. J. (1990). Noise Trader Risk in Financial Markets. *Journal of Political Economy*, 98(4), 703–738.

- Delcey, Thomas. 2019. Samuelson vs Fama on the Efficient Market Hypothesis: The Point of View of Expertise. *Æconomia. History, Methodology, Philosophy*, 9(1): 37-58.
- De Vroey, Michel. 2016. *A History of Modern Macroeconomics from Keynes to Lucas and Beyond*. Cambridge: Cambridge University Press.
- Dimand, Robert W. 2007. Irving Fisher and Financial Economics: The Equity Premium Puzzle, the Predictability of Stock Prices, and Intertemporal Allocation under Risk. *Journal of the History of Economic Thought*, 29(2): 153-166.
- Dornbusch, Rudiger. 1976. Expectations and Exchange Rate Dynamics. *Journal of Political Economy*, 84(6): 1161-1176.
- Duarte, Pedro Garcia and Lima, Gilberto Tadeu (eds). 2012. *Microfoundations Reconsidered. The Relationship of Micro and Macroeconomics in Historical Perspective*. Cheltenham: Edward Elgar.
- Fama, Eugene F. 1965. The Behavior of Stock-Market Prices. *The Journal of Business*, 38(1): 34-105.
- Fama, Eugene F. 1970. Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance*, 25(2): 383-417.
- Fama, Eugene F. 1975. Short-Term Interest Rates as Predictors of Inflation. *American Economic Review*, 65(3): 269-282.
- Fama, Eugene F. 1976a. *Foundations of Finance: Portfolio Decisions and Securities Prices*. Basic Books.
- Fama, Eugene F. 1976b. Forward Rates as Predictors of Future Spot Rates. *Journal of Financial Economics*, 3(4): 361-377.
- Fama, Eugene F. 1976c. Efficient Capital Markets: Reply. *The Journal of Finance*, 31(1): 143-145.
- Fama, Eugene F. 1980. Banking in the Theory of Finance. *Journal of Monetary Economics*, 6(1): 39-57.
- Fama, Eugene F. 1984. Forward and Spot Exchange Rates. *Journal of Monetary Economics*, 14(3): 319-338.
- Fama, Eugene F. 1991. Efficient Capital Markets: II. *The Journal of Finance*, 46(5): 1575-1617.
- Fischer, Stanley. 1996. Robert Lucas's Nobel Memorial Prize. *The Scandinavian Journal of Economics*, 98(1): 11-31.

Fischer, Stanley. 2008. New classical macroeconomics. In Steven N. Durlauf, and Lawrence E. Blume (eds), *The New Palgrave Dictionary of Economics*. Basingstoke: Palgrave Macmillan.

Fisher, Irving. 1896. Appreciation and Interest. *Economic Journal*, 11(4): 567-570.

Fourcade, Marion, and Rakesh Khurana. 2013. From Social Control to Financial Economics: The Linked Ecologies of Economics and Business in Twentieth Century America. *Theory and Society*, 42(2): 121-159.

Giraud, Yann. 2018. Textbooks in the Historiography of Recent Economics, In Till D ppe and E. Roy Weintraub (eds), *A Contemporary Historiography of Economics*, Oxon: Routledge, 137-154.

Goutsmedt, Aur lien, Erich Pinz n-Fuchs, Matthieu Renault, and Francesco Sergi. 2019. Reacting to the Lucas Critique: The Keynesians' Replies. *History of Political Economy*, 51(3): 533-556.

Grossman, Sanford J., and Joseph E. Stiglitz. 1976. Information and Competitive Price Systems. *American Economic Review*, 68(2): 246-253.

Grossman, Sanford J., and Joseph E. Stiglitz. 1980. On the Impossibility of Informationally Efficient Markets. *American Economic Review*, 70(3), 393-408.

Hall, Robert E., 1996. Robert Lucas, Recipient of the 1995 Nobel Memorial Prize in Economics. *The Scandinavian Journal of Economics*, 98(1): 33-48.

Hamburger, Michael J., and Cynthia Latta. 1969. The Term Structure of Interest Rates: Some Additional Evidence. *Journal of Money, Credit and Banking*, 1(1): 71-83.

Hamburger, Michael J., and Elliot N. Platt. 1975. The Expectations Hypothesis and the Efficiency of the Treasury Bill Market. *The Review of Economics and Statistics*, 57(2): 190-199.

Hicks, John. 1939. *Value and Capital*. Oxford: Clarendon Press.

Holt, C. C., Franco Modigliani, John F. Muth, and Herbert A. Simon. 1960. *Production Planning, Inventories, and Workforce*. Englewood Cliffs: Prentice-Hall.

Hoover, Kevin D. 1988. *The New Classical Macroeconomics. A Sceptical Inquiry*. Oxford: Basil Blackwell.

Hoover, Kevin D., and Warren Young. 2011. Rational Expectations: Retrospect and Prospect. Economic Research Initiatives at Duke (ERID), Working Paper.

Howells, Peter, and Keith Bain. 2010. *The Economics of Money, Banking and Finance*. 6th edition. Prentice Hall.

- Kane, Edward J. and Burton G. Malkiel. 1967. The Term Structure of Interest Rates: An Analysis of a Survey of Interest-Rate Expectations. *The Review of Economics and Statistics*, 49(3): 343-355.
- Kantor, Brian. 1979. Rational Expectations and Economic Thought. *Journal of Economic Literature*, 17(4): 1422-1441.
- Keuzenkamp, Hugo A. 1991. A Precursor to Muth: Tinbergen's 1932 Model of Rational Expectations. *The Economic Journal*, 101(408): 1245-1253.
- Kydland, Finn E. and Edward C. Prescott. 1982. Time to Build and Aggregate Fluctuations. *Econometrica*, 50(6): 1345–1370.
- Jensen, Michael C. 1978. Some Anomalous Evidence Regarding Market Efficiency. *Journal of Financial Economics*, 6(2/3): 95-101.
- Jovanovic, Franck. 2008. The Construction of the Canonical History of Financial Economics. *History of Political Economy*, 40(2), 213-242.
- Jovanovic, Franck. 2009. Le modèle de marche aléatoire dans l'économie financière de 1863 à 1976. *Revue d'histoire des sciences humaines*, 2009(1): 51-78.
- Laffer, Arthur B. and Richard Zecher. Some Evidence on the Formation, Efficiency and Accuracy of Anticipations of Nominal Yields. *Journal of Monetary Economics*, 1(3): 327-342.
- LeRoy, Stephen F. 1976. Efficient Capital Markets: Comment. *Journal of Finance*, 31(1): 139-141.
- Lo, Andrew. 2008. Efficient Market Hypothesis. In Steven N. Durlauf, and Lawrence E. Blume (eds), *The New Palgrave Dictionary of Economics*. Basingstoke: Palgrave Macmillan.
- Long, John B. and Charles I. Plosser. 1983. Real Business Cycles. *Journal of Political Economy*, 91(1): 39–69.
- Louçã, Francisco. 2004. Swinging All the Way: The Education of Doctor Lucas and Foes. *History of Political Economy*, 36(4): 689–735.
- Lucas, Robert E. 1972. Expectations and the Neutrality of Money. *Journal of Economic Theory*, 4(2): 103–124.
- Lucas, Robert E. 1976. Econometric Policy Evaluation: A Critique. *Carnegie-Rochester Conference Series on Public Policy*, 1:19–46.
- Lucas, Robert E., 1977. Understanding Business Cycles. *Carnegie-Rochester Conference Series on Public Policy*, 5: 7-29.

- Lucas, Robert E. 1978. Asset Prices in an Exchange Economy. *Econometrica*, 48(6): 1429-1445.
- Lucas, Robert E. 1980. Methods and Problems in Business Cycle Theory. *Journal of Money, Credit and Banking*, 12(4): 696–715.
- Lucas, Robert E. 1981. *Studies in Business Cycle Theory*. Cambridge, Mass.: MIT Press.
- Lucas, Robert E. 1987. *Models of Business Cycles*. Oxford: Basil Blackwell.
- Lucas 1996. Robert E. Lucas Jr. Biographical. In Tore Frängsmyr (ed.), *The Nobel Prizes*, Stockholm: Nobel Foundation, available at https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1995/lucas-bio.html
- Lucas, Robert E. and Thomas J. Sargent. 1978. After Keynesian Macroeconomics. In *After the Phillips Curve: Persistence of High Inflation and High Unemployment*, Boston, Mass: Federal Reserve Bank of Boston, 49-72.
- Lucas, Robert E. and Thomas J. Sargent. 1981. *Rational Expectations and Econometric Practice*. London: George Allen and Unwin Ltd.
- Lucas, Robert E. and Stokey, Nancy L. 1987. Money and Interest in a Cash-in-Advance Economy. *Econometrica*, 55(3): 491–513.
- Lutz, Friedrich. 1940. The Structure of Interest rates. *Quarterly Journal of Economics*, 55(1): 36-63.
- Malkiel, Burton G. 1987. Efficient Market Hypothesis. In Steven N. Durlauf, and Lawrence E. Blume (eds), *The New Palgrave Dictionary of Economics*. Basingstoke: Palgrave Macmillan
- Malkiel, Burton G. 2003. The Efficient Market Hypothesis and its Critics. *Journal of Economic Perspectives*, 17(1): 59-82.
- Mehrling, Perry. 2005. *Fischer Black and the Revolutionary Idea of Finance*. New York: Wiley.
- Meiselman, David. 1962. *The Term Structure of Interest Rates*. Englewood Cliffs: Prentice-Hall.
- Merton, Robert C. 2006. Paul Samuelson and Financial Economics. *The American Economist*, 50(2): 9-31.
- Milgrom, P., & Stokey, N. (1982). Information, trade and common knowledge. *Journal of Economic Theory*, 26(1), 17–27.
- Mishkin, F. S. (1978). Efficient-Markets Theory: Implications for Monetary Policy. *Brookings Papers on Economic Activity*, 1978(3), 707-752.

- Mishkin, Frederic S. 1983. *A Rational Expectations Approach to Macroeconometrics. Testing Policy Ineffectiveness and Efficient-Markets Models*. Chicago: University of Chicago Press.
- Mishkin, Frederic S. 2016. *The Economics of Money, Banking, and Financial Markets*. Eleventh Edition (Global Edition). Harlow: Pearson.
- Modigliani, Franco. 1977. The Monetarist Controversy or, Should We Forsake Stabilization Policies? *American Economic Review* 67(2): 1-19.
- Modigliani, Franco. 1978. [Efficient-Markets Theory: Implications for Monetary Policy]. Comments and Discussion. *Brookings Papers on Economic Activity* 1978(3): 753-768.
- Modigliani, Franco, and Richard A. Cohn. 1979. Inflation, Rational Valuation and the Market. *Financial Analysts Journal*, 35(2): 24-44.
- Modigliani, Franco and Robert J. Shiller. 1973. Inflation, Rational Expectations and the Term Structure of Interest Rates. *Economica*, 40(157), 12-43.
- Modigliani, Franco and Richard Sutch. 1966. Innovations in Interest Rate Policy. *American Economic Review*, 56(1-2): 178-197.
- Modigliani, Franco and Richard Sutch. 1967. Debt Management and the Term Structure of Interest Rates: An Empirical Analysis of Recent Experience. *Journal of Political Economy*, 75(4): 569-589.
- Modigliani, Franco and Richard Sutch. 1969. The Term Structure of Interest Rates: A Reexamination of the Evidence: Reply. *Journal of Money, Credit and Banking*, 1(1): 112-120.
- Muth, John F. 1961. Rational Expectations and the Theory of Price Movements. *Econometrica*, 29(6): 315–335.
- Negishi, Takashi. 1964. Stability and Rationality of Extrapolative Expectations. *Econometrica*, 32(4): 649-651.
- Niehans, Juerge. 1975. Some Doubts about the Efficacy of Monetary Policy under Flexible Exchange Rates. *Journal of International Economics*, 5(3): 275-281.
- Poterba, James M. and Lawrence H. Summers. 1988. Mean Reversion in Stock Prices: Evidence and Implications. *Journal of Financial Economics*, 22(1): 27-59.
- Radner R. 1967. Efficiency Prices for Infinite Horizon Production Programmes. *The Review of Economic Studies*, 34(1): 51-66.
- Roll, Richard. 1966. The Efficient Market Model Applied to U.S. Treasury Bill Rates. PhD Dissertation, University of Chicago.

- Ross, Stephen. 1987. The Interrelations of Finance and Economics: Theoretical Perspectives. *American Economic Review*, 77(2): 29-34.
- Ross, Stephen. 2008. Finance. In Steven N. Durlauf, and Lawrence E. Blume (eds), *The New Palgrave Dictionary of Economics*. Basingstoke: Palgrave Macmillan.
- Samuelson, Paul A. 1957. Intertemporal Price Equilibrium: A Prologue to the Theory of Speculation. *Weltwirtschaftliches Archiv*, 181-221.
- Samuelson, Paul A. 1965. Proof that Properly Anticipated Prices Fluctuate Randomly, *Industrial Management Review*, 6: 41-49.
- Sargent, Thomas J. 1972. Rational Expectations and the Term Structure of Interest Rates. *Journal of Money, Credit and Banking*, 4(1), 74-97.
- Sargent, Thomas J. 1973. Interest Rates and Prices in the Long Run: A Study of the Gibson Paradox. *Journal of Money, Credit and Banking*, 5(1): 385-449.
- Sargent, Thomas J. 1979. *Macroeconomic Theory*. New York: Academic Press.
- Sargent, Thomas J. 1996. Expectations and the Nonneutrality of Lucas. *Journal of Monetary Economics*, 37(3): 535-548.
- Sargent, Thomas J. 2008. Rational Expectations. In Steven N. Durlauf, and Lawrence E. Blume (eds), *The New Palgrave Dictionary of Economics*. Basingstoke: Palgrave Macmillan.
- Sent, Esther-Mirjam. 1998. *The Evolving Rationality of Rational Expectations. An Assessment of Thomas Sargent's Achievements*. Cambridge: Cambridge University Press.
- Sent, Esther-Mirjam. 2002. How (not) to Influence People: The Contrary Tale of John F. Muth. *History of Political Economy*, 34(2): 291-319.
- Sergi, Francesco. 2019. The Standard Narrative about DSGE Models in Central Banks' Technical Reports. Forthcoming. *European Journal of the History of Economic Thought*.
- Sheffrin, Steven M. 1983. *Rational Expectations*. Cambridge: Cambridge University Press.
- Shiller, Robert J. 1972. Rational Expectations and the Term Structure of Interest Rates: Comment. *Journal of Money, Credit and Banking*, 5(3): 856-860.
- Shiller, Robert J. 1978. Rational Expectations and the Dynamic Structure of Macroeconomic Models: A Critical Review. *Journal of Monetary Economics*, 4(1): 1-44.
- Shiller, Robert J. 1979. The Volatility of Long-Term Interest Rates and Expectations Models of the Term Structure. *Journal of Political Economy*, 87(6): 1190-1219.

- Shiller, Robert J. 1981. The Use of Volatility Measures in Assessing Market Efficiency. *The Journal of Finance*, 36(2), 291-304.
- Summers, Lawrence H. 1985. On Economics and Finance. *The Journal of Finance*, 40(3): 633-635.
- Summers, Lawrence H. 1986. Does the Stock Market Rationally Reflect Fundamental Values? *The Journal of Finance*, 41(3): 591-601.
- Tinbergen, Jan. 1933 [1932]. The Notions of Horizon and Expectancy in Dynamic Economics. *Econometrica*, 1(3): 247-264.
- Tirole, Jean. 1982. On the Possibility of Speculation under Rational Expectations. *Econometrica*, 50(5): 1163-1181.
- Tirole, Jean. 1985. Asset Bubbles and Overlapping Generations. *Econometrica*, 53(6): 1499-1528.
- Vercelli, Alessandro. 1991. *Methodological Foundations of Macroeconomics: Keynes and Lucas*. Cambridge: Cambridge University Press.
- Vuillemeys, G. 2013. Sur le statut épistémologique de l'hypothèse d'efficience des marchés. *Revue de philosophie économique*, 14(2): 93-118.
- Walter, Christian. 1996. Une histoire du concept d'efficience sur les marchés financiers. *Annales. Histoire, Sciences Sociales*, 51(4) : 873-905
- Walter, Christian. 2006. Les martingales sur les marchés financiers. *Revue de synthèse*, 127(2), 379-391.
- Wang, Y. 2008. Finance (New Developments). In Steven N. Durlauf, and Lawrence E. Blume (eds), *The New Palgrave Dictionary of Economics*. Basingstoke: Palgrave Macmillan.
- Wood, John. The Expectations Hypothesis, the Yield Curve and Monetary Policy. *Quarterly Journal of Economics*, 78(3):457-470.
- Working, Hoolbrook. 1949. The Investigation of Economic Expectations. *American Economic Review*, 39(3): 150-166.
- Working, Hoolbrook. 1958. A Theory of Anticipatory Prices. *American Economic Review*, 48(2): 188-199.
- Young, Warren. 2014. *Real Business Cycle Models in Economics*. London: Routledge.
- Young, Warren and William A. Darity. 2001. The Early History of Rational and Implicit Expectations. *History of Political Economy*, 33(4): 773-813.

Young, Warren, William A. Darity, and Robert Leeson. 2004. *Economics, Economists and Expectations*. London: Routledge.