



HAL
open science

**A tale between finance and economics : four essays on
the history and methodology of the efficient market
hypothesis**

Thomas Delcey

► **To cite this version:**

Thomas Delcey. A tale between finance and economics : four essays on the history and methodology of the efficient market hypothesis. Economics and Finance. Université Panthéon-Sorbonne - Paris I, 2021. English. NNT : 2021PA01E008 . tel-03370638

HAL Id: tel-03370638

<https://theses.hal.science/tel-03370638v1>

Submitted on 8 Oct 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



UNIVERSITÉ PARIS I PANTHÉON SORBONNE

UFR 02: École d'Économie de la Sorbonne

Centre d'Économie de la Sorbonne

THÈSE

Pour l'obtention du titre de Docteur en Économie

Présenté et soutenu publiquement

le 11 JANVIER 2021

Thomas DELCEY

A tale between finance and economics: four essays on the history and methodology of the efficient market hypothesis

Sous la direction de Mme Annie L. Cot,

Professeur, Université Paris I Panthéon Sorbonne

Membres du Jury:

Mme. Valerie Mignon (rapporteur)	Université Paris Nanterre
M. Perry Mehrling (rapporteur)	Boston University
M. Gunther Capelle-Blancard	Université Paris I Panthéon Sorbonne
Mme. Muriel Dal Pont Legrand	Université Cote d'Azur
M. Christian Walter	Fondation Maison des Sciences de l'Homme
Mme. Annie L. Cot	Université Paris I Panthéon Sorbonne

L'université Paris 1 Panthéon-Sorbonne n'entend donner aucune approbation, ni improbation aux opinions émises dans cette thèse ; elles doivent être considérées comme propres à leur auteur.

Résumé:

Cette thèse propose une analyse historique et méthodologique de l'hypothèse d'efficience des marchés financiers, qui représente l'un des piliers théoriques de l'économie financière et une des notions les plus controversées du domaine. Cette analyse a pour objectif d'éclairer les débats sur ce concept central et ambigu dont l'histoire est marquée par la diversité de ses formulations et de ses interprétations. Dans ce travail, j'étudie ces formulations et les contextes dans lesquels elles sont apparues. J'analyse l'évolution de cette hypothèse, depuis ses origines dans les années 1920 jusqu'aux récentes transformations du début des années 1980. J'interprète l'hypothèse d'efficience des marchés financiers comme un *pont* entre l'économie financière et l'économie, c'est-à-dire comme un concept au coeur de l'identité de l'économie financière, mais aussi le principal objet par lequel cette sous-discipline dialogue avec le reste de la discipline. Cette histoire intellectuelle s'articule autour de quatre articles, qui discutent en détail ces dialogues. Dans le premier épisode, j'examine les analyses pionnières des marchés financiers menées par les économistes agricoles pendant l'entre-deux-guerres et leur influence sur l'économie financière moderne. Dans un deuxième temps, je me concentre sur le développement moderne de cette hypothèse dans les années 1960 et sur la relation étroite entre les économistes et les premiers économistes financiers. Le troisième épisode étudie la place croissante des macro-économistes dans la recherche des années 1970 et du début des années 1980 conduisant à la critique et à la reformulation de l'hypothèse. Enfin, le quatrième chapitre propose une analyse méthodologique qui examine le lien entre l'efficience des marchés et la théorie de l'information de Hayek. Dans ce quatrième épisode, j'analyse les similitudes et les différences conceptuelles entre ces deux théories de la formation des prix.

Summary:

This thesis provides a historical and methodological analysis of the efficient market hypothesis, which represents one of the theoretical pillars of financial economics, but also one of the most controversial notions in the field. This research aims to shed light on the debates about this central and ambiguous concept, whose history is characterized by the diversity of its formulations and interpretations. In this thesis, I study these formulations and the contexts in which they emerged. I analyze the evolution of this hypothesis, from its origins in the 1920s to the recent transformations of the early 1980s. I interpret the efficient market hypothesis as a *bridge* between financial economics and economics, that is, as a concept at the heart of the identity of financial economics, but also as the main object through which this sub-discipline dialogues with the rest of the discipline. This intellectual history is structured around four articles, which discuss in detail these interactions. In the first episode, I examine the pioneering analyses of financial markets pursued by agricultural economists during the inter-war period and their influence on modern financial economics. In the second episode, I focus on the modern development of this hypothesis during the emergence of financial economics in the 1960s and on the close relationship between economists and early financial economists. The third episode explores the growing role of macroeconomists in the 1970s and early 1980s, which ultimately led to the questioning and reformulation of the hypothesis. Finally, the fourth chapter offers a methodological analysis that investigates the link between market efficiency and Hayek's information theory. In this fourth episode, I analyze the conceptual similarities and differences between these two theories of price formation.

Mots-clés:

Histoire de la pensée économique—méthodologie de l'économie—hypothèse des marchés efficients—économie financière

Keywords:

History of economics—methodology of economics—efficient market hypothesis—financial economics

Contents

Contents	xiv
0 General introduction	1
0.1 The efficient market hypothesis	6
0.2 Origins and modern developments of the hypothesis	9
0.2.1 The pre-history of the hypothesis	9
0.2.2 Developing the modern hypothesis	13
0.3 Research question and contribution of the thesis	18
0.4 Methodological framework and selection of the corpus	23
0.4.1 The figure of the “precursor”	24
0.4.2 The study of contemporary theory	25
0.4.3 Delimitation of the corpus and selection of sources	27
0.5 Outline and results	30
1 “The Eyes and Ears of the Agricultural Markets”: A History of Information in Interwar Agricultural Economics	33
1.1 Introduction to chapter 1	35
1.2 Introduction	38
1.3 The growing demand for economic information of market participants (1862-1926)	41

1.4	The establishment of the Bureau of Agricultural Economics and the Grain Futures Administration	44
1.5	Producing and editing information	47
1.6	Diffusing information countrywide: The example of the market news service	51
1.7	Making things theoretical: The debates between the GFA and Working	54
1.8	Conclusive remarks	59
1.9	Conclusion to chapter 1	59
2	Samuelson vs Fama on the Efficient Market Hypothesis: The Point of View of Expertise	63
2.1	Introduction to chapter 2	64
2.2	Introduction	66
2.3	Fama and Samuelson's EMH: the 1965 pioneered contributions	69
2.3.1	Fama's random walk model	69
2.3.2	Samuelson's martingale model	71
2.3.3	A contrasted stance on expertise	74
2.4	The MIT-Chicago opposition enters business schools	78
2.5	Different targets for the expertise: practice versus policy making	82
2.6	From the 1965 papers to the EMH controversy in the 1980s . .	85
2.7	Concluding remarks	89
2.8	Conclusion to chapter 2	91
3	The Efficient Market Hypothesis and Rational Expectations. How Did They Meet and Live (Happily?) Ever After ?	93
3.1	Introduction to chapter 3	95
3.2	Introduction	98
3.3	Self-produced Narratives and Historical Evidence	101

3.3.1	Samuelson (1965) as a Precursor of Muth (1961)	102
3.3.2	The Efficient Market Hypothesis and its Influence on Rational Expectations Macroeconomics	104
3.3.3	Muth as the “Father” of both the Efficient Market Hy- pothesis and Rational Expectations Macroeconomics .	105
3.3.4	Rational Expectations and the Efficient Market Hypoth- esis as Independent Discoveries	107
3.3.5	Rational Expectations Macroeconomics and its Influe- nce on the Efficient Market Hypothesis	108
3.4	The Origins and Early Development of the Association be- tween Efficient Market Hypothesis and Rational Expectations	110
3.4.1	The Origins: Sargent, Modigliani, Shiller, and the Term Structure of Interest Rates	111
3.4.2	The Early Development: Fama on the Term Structure and the Reformulation of the Efficient Market Hypoth- esis	116
3.4.3	Taking a Step Forward: Lucas (1978)’s Asset Pricing Model	118
3.5	Stabilization of the Association and Challenges to the Efficient Market Hypothesis	120
3.5.1	Shiller and the “Anomalies” of the Efficient Market Hypothesis	122
3.5.2	Grossman and Stiglitz’s Paradox	125
3.6	Conclusive remarks	127
3.7	Conclusion to chapter 3	130
4	When Efficient Market Hypothesis Meets Hayek on Information: Beyond a Methodological Reading	133

4.1	Introduction to chapter 4	134
4.2	Introduction	136
4.3	Hayek, the introduction of information as a core concept . . .	141
4.3.1	An economics of information	142
4.3.2	Hayek's conception of market and competition	145
4.3.3	Two features of the market and competition	151
4.4	When the efficient market hypothesis meets Hayek.	153
4.4.1	Holbrook Working: information and forecasting. . . .	154
4.4.2	Fama and the efficient market hypothesis	159
4.5	The problem of comparisons	162
4.5.1	Hayek and mainstream economics	163
4.5.2	Methodology and epistemology: survey and definitions	165
4.5.3	Formalization as a methodological difference	167
4.6	A common core	169
4.6.1	The same epistemology: information and symmetry .	169
4.6.2	Market and competition	171
4.6.3	Informational efficiency in Hayekian theory?	173
4.7	Concluding remarks	174
4.7.1	Conclusion to chapter 4	175
5	General conclusion	177
	Bibliography	185
	Remerciements	219

Chapter 0

General introduction

En achetant ou en vendant dans l'espoir que les cours iront en s'élevant ou s'abaissant, le joueur entend par là que les cours sont au-dessous ou au-dessus de leur véritable *valeur*: car il faut pour le déterminer qu'il aperçoive dans la situation présente une cause de hausse ou de baisse dont il n'est pas tenu compte en ce moment. En vain prétendrait-il que ce n'est que dans les conséquences futures et lointaines qu'il voit ces motifs de hausse ou de baisse; nous savons que ces conséquences, si elles existent, sont contenues dans le cours actuel; or, si on réfléchit à ce que veut dire le mot *valeur*, on verra que la valeur est et ne peut être déterminée que par le *cours* même, qu'il ne peut donc y avoir deux sortes de valeurs, une véritable, et une qui ne le serait pas, que par conséquent cette opinion souvent exprimée, que les cours sont au-dessus ou au-dessus de leur valeur n'a, le plus souvent, aucune signification, et revient à cette autre proposition, évidemment absurde, que ce qui est n'est pas.

(Regnault 1863, p. 30)

In 1841, the Scottish journalist Charles Mackay introduced the notion of "tulipomania" in his book *Extraordinary Popular Delusions and the Madness of Crowds*. Under this name, Mackay described the irrational passion of the

population of the United Provinces for tulip bulbs in 1637. This passion resulted in a considerable increase and then a sudden drop in prices. He said that, at its highest level, the selling price of the rarest bulbs had reached more than 3,000 florins, ten times the salary of a craftsman of that period (Garber 2001, p. 81).

This historical episode has been interpreted for a long time by economists as one of the very first historical examples of speculative bubbles, i.e. the situation where the action of investors leads asset prices to deviate durably and excessively from economic fundamentals (in this case, from the cost of producing tulips). Thus, Paul Samuelson (1957, p. 215) evokes tulipomania as a typical example of “the market [that] literally lives on its own dreams”. More recently, however, economists have reexamined this historical episode and challenged these early interpretations (Garber 1990, 2001; Thompson 2007). Far from being an example of irrational speculation, these works argue that, given the information available at the time, the level of prices was fully warranted from an economic viewpoint. Hence, “tulip contract prices before, during, and after the tulipomania appear to provide a remarkable illustration of efficient market prices” (Thompson 2007, p. 109).

The evolution of economists’ views on tulipomania reveals the deep changes in the economic thought concerning finance in the 20th century. In particular, the new interpretation of tulipomania proposed since the 1990s has become prevalent and is based on the hypothesis of the efficient market hypothesis. This hypothesis has been at the heart of the debates after the global financial crisis of 2007. While some economists dismiss the validity of this hypothesis and its inability to account for financial crises (e.g. Krugman 2009; Posner 2009), other authors, on the contrary, consider it to be a valid description of financial markets (e.g. Lucas 2009; Siegel 2009).

This thesis enlightens the ongoing debate on this controversial hypothesis by taking an historical perspective. I analyze the evolution of this hypothesis, from its origins in the 1920s to recent transformations in the early 1980s. This intellectual history is based on the analysis of the work of economists: their books, their academic publications, and also the archives of economists and the institutions in which they worked. I also focus on the contexts in which these works appeared in order to shed light on the many different formulations and interpretations of the ambiguous concept of efficient market hypothesis (Mignon 2008).

This analysis aims to understand the evolution of economic thought concerning financial markets and their functioning in the 20th century. In particular, I analyze the origins and developments of financial economics. At the frontier between economics and management, financial economics emerged in U.S. business schools in the 1960s around four areas of research: the efficient markets hypothesis, options pricing, portfolio theory, and corporate finance (see Ross 2008).

Financial economics is one of the most active areas of economics. Thus, since 1991, each year, between 8% and 11% of the published research in economics belong to financial economics.¹ Such importance can also be appreciated from an institutional point of view: today, in the United States, business schools deliver as many PhDs in economics as traditional economic departments (Fourcade and Khurana 2013, p. 122).

Despite the importance of this field, it is still neglected in the history

¹To estimate the share of publications in financial economics into economics, I use the **Econlit** database that provides metadata of publications, working papers, Ph.D. dissertations, books and books reviews, and Collective Volume articles in economics. These documents are classified by research area by professionals thanks to the **JEL codes classification** of the *Journal of Economic Literature*. I start from the 1991, year of the last reform of JEL codes classifications (Cherrier 2017) until 2018. Looking at the all *publications* between 1991 and 2018, I estimate the distribution of the first category JEL codes (namely, A, B, C, D, ... Z) used in these documents. I then estimate the percentage of JEL codes “G: Financial Economics” used on the total amount of JEL codes used.

of economic thought. Figure 1 shows the distribution of research topics in

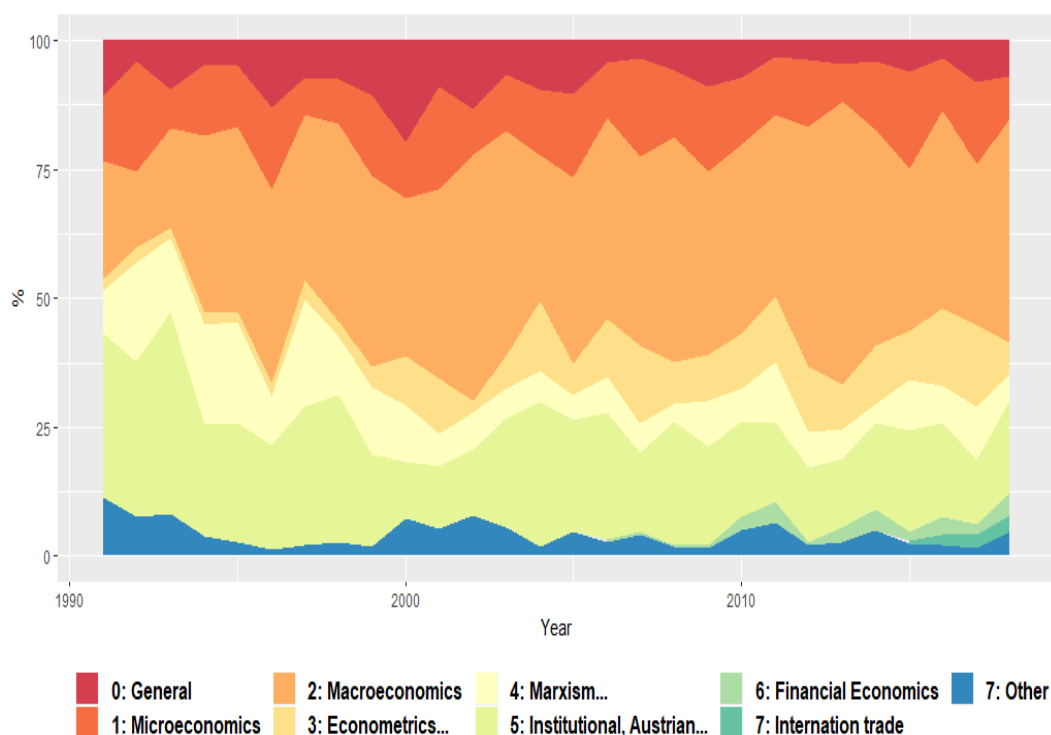


FIGURE 1: Distribution of published research in the history of recent economic thought (source: *Econlit*)

the history of *recent* economic thought.² In 2010, for example, financial economics accounted for 2.5% of the published research in the history of recent economic thought, while 36.1% of the research dealt with macroeconomics. By working on the history of financial economics, this thesis aims to understand a little known but essential element in the evolution of economic thought in the second half of the 20th century.

My aim is not, however, to study the history of financial economics separately from the rest of economic thought. On the contrary, I interpret the

²Figure 1 has been built in the same spirit than the methodology in footnote 1. The history of *recent* economic thought corresponds here to publications in history of economic thought, whose object of study date from 1925 or later. The corresponding JEL code is the second-level JEL code “B2: History of Economic Thought Since 1925”. I take the all publications classified in B2 between 1991 and 2018, and look at the distribution of third-level JEL codes belonging to this subcategories, namely B21, B22, B23, B24, B25, B26, and B29. “6: Financial economics” in the figure represents here the JEL codes “B26: financial economics”.

efficient market hypothesis as a *bridge* between financial economics and economics, that is, as a concept at the heart of the identity of financial economics, but also as the main object through which this sub-discipline dialogues with the rest of the discipline. The thesis is structured in four episodes, each of which discussing in detail some of these dialogues.

In the first episode, I examine the pioneering analyses of financial markets conducted by agricultural economists during the interwar period and their influence on the emergence of financial economics. In particular, this first episode highlights the first formulation of the efficient market hypothesis by agricultural economist Holbrook Working. Secondly, I focus on the modern development of this hypothesis during the emergence of financial economics in the 1960s. In this episode, I analyze in detail the close relationship between economists and early financial economists. The third episode studies the origins and emergence of the first critics of this hypothesis in the 1980s. In particular, I am interested in the growing relationship between financial economists and macroeconomists during this period. Finally, I provide a methodological analysis that discusses the link between market efficiency and Hayek's information theory. In this fourth episode, I attempt to explain the similarities and conceptual differences between these two theories of price formation.

This general introduction presents, in section 1, the efficient market hypothesis. Section 2 reviews the work in the history of economic thought on this hypothesis. In section 3, I present the research question and the contribution of the thesis. The historiographical framework and the delimitation of the corpus are discussed in section 4, while, section 5, presents the main outlines and results of the thesis.

0.1 The efficient market hypothesis

The efficient market hypothesis has multiple definitions, definitions that have widely evolved since its emergence in the 1960s. For presentation purpose, it is necessary to make a selection of definitions. This selection does not claim to be exhaustive, both on the theoretical and historical level.³ My purpose is not to discuss the relevance of these statements and the logical relation between these statements. It is rather to present to the readers the main statements around the efficient market hypothesis that this thesis is going to investigate.⁴

The simplest textbook definition of this hypothesis is Fama's (1970, p. 384): "market prices fully reflect all available information". This definition is usually related to three other statements, which are generally understood as implications of this definition.

First, in an efficient market, if all the available information is reflected in prices, then all the information predicting future prices changes is also contained in current prices. Any new price changes would result from new information, by definition unpredictable for individuals. Thus, in an efficient market, future prices changes are considered unpredictable. Prices are represented by a process whose successive changes are uncorrelated. For example, we can represent the price in t , P_t as the sum of P_{t-1} and a white noise ϵ_t :

$$P_t = P_{t-1} + \epsilon_t \quad (1)$$

³Section 2 discussed in greater details the origin of these statement.

⁴Since the end 1990s, the efficient market hypothesis became reframed with what is known as the "fundamental theorem of asset pricing" (Campbell 2000; Campbell 2014; Cochrane 2005). Such an issue is not analyzed in the thesis and thus not presented in this section. See Chiapello and Walter (2016) and Walter (2006, 2010) for a recent historical and methodological account.

While such representation of price changes has a long history (Walter 2013), it became increasingly popular by the end of the 1950s and the 1960s (see the review Cootner 1964; Fama 1970).

Second, if prices fully reflect all the available information then no investment strategy, at a given risk, has an “abnormal” return. The abnormality is generally defined by the following formula:

$$AR_{it} = R_{it} - R_{it}^T \quad (2)$$

Where AR_{it} is the abnormal returns of a portfolio i in t , R_{it} the observed returns, and R_{it}^T a theoretical returns which defines normality (e.g. the CAPM). If the market is efficient, the average abnormal return of the portfolio should be equal to 0. This second idea is summed up simply by the following credo: one cannot “beat the market.” Here again, while this idea has also a long history (see section 2), the establishment of modern performance measurements goes back to the 1960s (Jensen 1968; Sharpe 1966; Treynor 1965).

Third, if prices fully reflect all the information available, then it should be equal to its “fundamental value”, sometimes called the “intrinsic value.” The fundamental value is trivially what the price should be from a theoretical viewpoint. It is usually defined as the sum of the discounted expected future cash flows of the asset⁵:

$$V_t = E \left[\sum_{k=0}^{\infty} D_{t+k} \prod_{j=0}^k \frac{1}{(1 + x_{t+j})} \right] \quad (3)$$

If we assume a constant discount rate x , we can write:

⁵For a critical analysis of this concept, see Brian and Walter (2007). The definition of the fundamental value, although very popular and still widely accepted, is also the subject of recent discussions (e.g. Edmans, Goldstein, and Jiang 2012).

$$V_t = E\left[\sum_{k=0}^{\infty} \frac{D_{t+k}}{(1+x)^k}\right] \quad (4)$$

The efficiency of financial markets is expressed as the situation where the price of an asset equals its fundamental value:

$$P_t = V_t \quad (5)$$

Equation 3 might be found for instance in Shiller (1981), but the idea that asset price valuation depends of discounted asset cash flows traces back in academic works to Irving Fisher (1930) and Williams (1938). Then, Fama (1965b), Mandelbrot (1966), and Samuelson (1973b) expressed the idea that, in an efficient market, asset price should be close to fundamental value.

The efficient market hypothesis maintains a special relationship with financial economics. This notion is not just a set of theoretical statements among many others that exist in this field. Throughout its history, the efficient market hypothesis has gathered a research community, *i.e.* a group of scholars with common problems, ideas, values, and methods. It was through the issue of random price changes that a group of economists began to emerge at the end of the 1950s and which laid the foundations of a discipline that will be know as financial economics (Jovanovic 2008; Walter 1996).

The efficient market hypothesis is thus constitutive of financial economics and it has furthermore driven new developments in this field. The community around behavioral finance, which is arguably the major new research area in financial economics from the mid 1980s (Wang 2008), was built in response to the research on the efficient market hypothesis. Working on the history of the efficient market hypothesis is thus a twofold task: (a) analyzing the evolution of a concept through successive analytical transformations,

criticisms, and refinements ; (b) studying the structuring and evolution of a research community.

0.2 Origins and modern developments of the hypothesis

The section provides a short history of the efficient market hypothesis. It aims to provide a number of results by historians, which are used and discussed in this thesis. It reviews two important periods covered by the current historiography: the “pre-history” and its modern development in the 1960s.

0.2.1 The pre-history of the hypothesis

The history of economic thought on finance is not limited to the “birth” of financial economics in the 1960s. Before it became studied by financial economists, the financial markets have firstly been analyzed by their actors for centuries (Goetzmann 2016). It has also been studied by economists from a prior generation to the 1960s. This set of knowledge constitutes what I shall call the “pre-history of financial economics”. This distinction between history and pre-history only distinguishes two different sociological states of the research in finance: pre-history describes the period before the 1960s when contributions by precursors existed but this research was not yet institutionalized in an autonomous sub-field of economics, with its own concepts, theories, journals, and associations.

Historians have shown that far from being a spontaneous development in the 1960s, the efficient market hypothesis is the fruit of a much longer maturation, and of the conjunction of heterogeneous works centered around

various set of ideas: the random movement of prices (Jovanovic 2009a; Walter 1996, 2013), the investor performance (Dimand 2009; Walter 2005a), the fundamental valuation of assets (Brian and Walter 2007; Walter 2010), and the role of information in financial markets (Preda 2004; Saleuddin 2018).

The origin of these ideas originated in the popular knowledge of investors dating back at least to the end of the 19th century (Preda 2000, 2001, 2004). Such knowledge was not the fruit of purely academic research. They were chiefly essays, pamphlets, and manuals about stocks market investment. Among the most famous, the investor Jules Regnault stated (literally) in his *Calcul des chances et philosophie de la Bourse* (1863) that prices follow what will be known as the random walk process (see Jovanovic 2000). From the end of the 19th century, investors' writings show that they already understood the role of information in speculative markets, and how it was reflected in asset prices (Preda 2004).

Rather than interpreting these contributions as those of isolated "geniuses", historians view them as the fruit of a consistent community of investors seeking to provide a set of "practical answers to practical problems" (Preda 2004, p. 380). Such production of knowledge was a kind of "vernacular science" (*ibid.*) based on practices, techniques, and rationalization procedures that helped professionals to solve the daily problems they were facing.⁶

It is still unclear how economists appropriated this popular knowledge. There have always been significant interactions between the world of financial investment and the academic world. Prominent economists like John Maynard Keynes or Irving Fisher were also famous investors, and this knowledge likely entered into academics through such interactions.

⁶Recent works showed how this vernacular science already understood the principle of risk diversification, which is at the basis of the portfolio theory (Edlinger and Parent 2014; Rutterford and Sotiropoulos 2016).

Irving Fisher (1930) himself played an important role by introducing the principle of discounting in the determination of the present value of an investment—a principle that actuaries had already used for decades (Chiappello and Walter 2016, p. 166). This model of valuation was developed in his doctoral dissertation by John Burr Williams (1938). He notably applied the discounted principle to the valuation of stocks dividends. Such works have been the foundation of the fundamental value definition described in the equation 4.⁷

The idea of the random character of price changes has been modeled by the French mathematician Louis Bachelier in his doctoral dissertation (1900). By seeking to formalize the fluctuation of prices, Bachelier has laid the foundations of the Brownian motion. In the introduction of his dissertation, he famously stated one of the main insights behind the efficient market hypothesis by claiming that “the expectation of the speculator is zero”.⁸ Bachelier’s contribution remained only influential in the field of mathematics during his lifetime (Jovanovic 2012). His ideas were exported in the United States by mathematicians who conveyed it to American economists.⁹ Hence, Bachelier became known in economics only in the 1950s when an increasing number of economists have been educated to probability theory, (Jovanovic 2012).

In the first half of the 20th century, American economists already discussed the behavior of asset prices in more statistical and empirical bases. For instance, the random character of price changes are mentioned in works of the *National Bureau of Economics Research* (MacCauley 1925, p. 86; King 1930, p. 102), and at the *Cowles Commission* (Cowles and Jones 1937, p. 280).

⁷Gordon and Shapiro (1956) extended the model, known today as the “Gordon growth model” by adding a constant growth rate to dividends.

⁸“L’espérance du spéculateur est nulle” (Bachelier 1900, p. 34). See Walter (1996) for an in-depth analysis of Bachelier’s argument.

⁹For instance, Paul Samuelson recalled studying him during his math classes at Harvard (Taqqu 2001).

No statistical test supported such observations: it was only visual observations of graphs of price indexes. These preliminary findings were made possible by the massive rise of statistics in economics at the period. This development was both stimulated by the empiricism of American institutionalism (Rutherford 2011a) and the early development of econometrics (Morgan 1991).

Alfred Cowles, who founded the *Cowles Commission* in 1932, was himself deeply involved in this research program (Dimand 2009; Dimand and Veloce 2010). He first built, together with his collaborators, one of the first modern stock market indexes describing the monthly evolution of the stock market in New York from 1871 to 1937 (Cowles 1938).¹⁰ He also published a series of works attempting to measure the reliability of financial analysts' forecasting (Cowles 1933, 1944; Cowles and Jones 1937). These studies propose one of the first attempts to estimate the performances of investment funds (Walter 1999). In particular, Cowles (1933, p. 309) suggests to compare individual performance to the "general run of equities", which represents the essence of modern performance measurement (equation 2). Overall, Cowles remained highly skeptical about the expertise of financial analysts and the profitability of their forecasts.¹¹

More recent historical work has focused on the contributions of agricultural economists in the first half of the 20th century. From the 1920s to the 1940s, agricultural economics was one of the leading fields in the use and development of statistics in economics (Biddle 1999, p. 635; Fox 1986).

¹⁰See Wilson and Jones (2002) for a comprehensive historical account of Cowles' index.

¹¹Brown, Goetzmann, and Kumar (1998) point out that Cowles (1933) compared the performance of investors without taking into account the risk of each portfolio, as modern measure do. Yet, if a low-risk portfolio performs slightly worse than a high-risk portfolio, the former is a much better choice. Brown, Goetzmann, and Kumar (1998) reproduced Cowles' study using a modern performance measure and concluded in the opposite way to Cowles. Dimand and Veloce (2010) points out that investors made a similar criticism in 1933.

At the same time, the existence of agricultural commodity exchanges like the Chicago Board of Trade led agricultural economists to analyze speculative behavior. Hence, agricultural economists were at the forefront of the research on the empirical behavior of speculation, especially in futures markets. They also played a key role in the regulation of these markets (Berdell and Choi 2018; Saleuddin 2018).

Among agricultural economists, the works of Holbrook Working is arguably one the most important of the period. Working, an economist at Stanford University, is known in the history of the efficient market hypothesis for an article written in 1934 in which he suggested that wheat prices seem to behave randomly. Yet, the rest of his contribution remained overlooked—aside from agricultural economists knowledgeable about their history (Berdell and Choi 2018). Working formulated an early version of the efficient market hypothesis by linking random change to the arrival of (unpredictable) information (Working 1949a).

This collection of works and ideas remained scattered, and no research program emerged before the postwar period. It was only by the end of the 1950s that this set of heterogeneous works was picked up, rediscovered, developed, and refined in what would become financial economics.

0.2.2 Developing the modern hypothesis

Several factors explained the emergence of coherent and collective research on the efficient market hypothesis at the end of the 1950s. First, after the war, the “prehistorical” works became more easily readable to the average economists. In particular, probability theory was increasingly accepted in

economics both in theoretical and empirical research (Biddle 2017; Weintraub 1999). Hence, it became easier for economists to appreciate and develop applications of probability theory (Jovanovic 2012; Walter 1996).

Moreover, collecting data on prices and volumes became greatly facilitated by the arrival of the computer in the 1960s (Mehrling 2005, p. 88). A collective empirical research became possible because of the availability of comprehensive databases. The establishment of the Center for Research in Security Prices in 1960, hosted at the Graduate School of Business of the University of Chicago, was at the forefront of such research and still represents today one of the leading data providers on securities. Two researchers from the center, Lawrence Fisher and its director James Lorie, published in 1964 a famous study showing that an investor buying and holding an equal amount of each common stock at New-York between 1925 and 1964, would have obtained a rate of returns of 9%. Such basic fact stroke the common conception of stock returns at the time.

Another major factor was institutional. A growing demand emerged from the business community for more rigorous financial research (see Fourcade and Khurana 2013; Khurana 2007). From the mid-1950s, several philanthropic foundations (e.g. William L. Mellon, Henri Ford II, or Alfred P. Sloan) funded reforms of business schools. The latter existed since the early 20th century but did not attract any economists or other social scientists. These reforms aimed to transform business schools into leading research and educational institutions on finance, which could compete with the standards of other social sciences departments (Fourcade and Khurana 2013).

The emergence of financial economics have been interpreted by historians as the constitution of a new *scientific field* (Bourdieu 1976). According to Bourdieu, the new entrants, those trying to establish a new domain of research, are facing contradictory forces. On the one hand, they need as

new entrants to stand out from the existing fields by investing “additional, strictly scientific investments from which they cannot expect high profits, at least in the short run, since the whole logic of the system is against them” (Bourdieu 1976, p. 97). On the other, they must increase their legitimacy to existent fields (here the social sciences) by adopting criteria of scientificity, which are defined by the latter.

Post-war economics quickly became the benchmark for building a “science of finance”. Business schools recruited economists and statisticians, and research embraced the features of postwar economics, that is, highly formal and market-oriented research (Jovanovic 2008; MacKenzie 2008, p. 74). Leading economists, for example, Samuelson, Modigliani, or Stigler, were enthusiast supporters of such reforms and contributed personally, as we will see below, to this new research field.¹² Economists also entered the editorial board of existing journal (*i.e.* *Journal of Business*, or the *Journal of Finance*), and created others one (*Journal of Financial and Quantitative Analysis*).

It is important to appreciate that if business schools increasingly came closer to economic departments, they remained distinct institutions with their own purposes: educating business elites. Indeed, while the departments of economics aimed at training experts for the public sphere, business schools were asking for practically-oriented teachings. Financial economists trained in business schools developed a “practical habitus” (Fourcade and Khurana 2017, p. 362), *i.e.* a socialization that leads them “to disseminate their ideas and discoveries not only through traditional academic channels, such as journals and professional meetings but in the classroom and the wider world of practice” (Fourcade and Khurana 2017, p. 367).

The emergence of financial economics thus appears to be the fruit of

¹²Samuelson and Modigliani’s contribution to financial economics are well-known and discussed below. See Nik-Khah (2011) for the less-known but still influential role of Stigler at Chicago.

a *trade-off*: on the one hand, financial economists *adopted* the methods of economics for increasing their scientific legitimacy, and, on the other hand they *adapted* these methods to answer the demand of *practical knowledge* from business schools. In the following years, financial economics became more and more influential in the practitioners worlds (MacKenzie 2008). Economists became editors of practitioners journals, like the *Financial Analyst Journal* (see details in Mehrling 2005, pp. 68–72) and new journals close to economic research were created, like the *Journal of Portfolio Management* in 1974.

The efficient market hypothesis was the main issue around which this new community of financial economists began to develop. The increasing number of research emphasizing the random character of price changes during this period was summarized by Paul Cootner (1964) in one of the first review of the literature.

In the 1960s, Cootner was a leading figures of one of the main research group in finance, located at the Massachusetts Institute of Technology, with among others, Paul Samuelson, Franco Modigliani, Sidney Alexander, Myron Gordon, and Stewart Myers. The other important group was located at the University of Chicago around the Center For Research in Stock Prices with, notably, James Lorie, Lawrence Fisher, Harry Roberts, Merton Miller, and Eugene Fama. Fama was one of the first Ph.D. students involved in this research and will directly be hired at Chicago after completing his Ph.D. in 1964.¹³ The presence of prominent economists like Samuelson, Modigliani, and Miller illustrates the close relationship of the economics department to that of the business schools (Khurana 2007).

Progressively, the research gathered around the idea that prices follow a random walk because they respond correctly to new information (1). One

¹³See Jovanovic (2008) for a comprehensive analysis of these two groups.

of the more explicit, still literal, formulation of this idea was provided by Fama (1965b), who introduced in the same article the notion of “efficient market”.¹⁴ The same year, Samuelson (1965a) provided the first formal argument of the efficient market hypothesis by showing that investors accurately using information available would lead prices to fluctuate randomly.¹⁵ Samuelson, and, at the same time, Mandelbrot (1966), also suggested to replace the notion of random walk by the notion of martingale. Few years later, Samuelson (1973b) extended his result into the fundamental valuation framework (see Walter 2010).

Based on these contributions, economists openly doubted the effectiveness of the professional practices of the time, which will become to be known as “chartist” and “fundamentalist” analyses. Chartist analysis, also known as “technical” analysis, assumes that price fluctuations follow trends which, if correctly identified, are profitable. However, if prices fluctuate randomly, apparent trends are only illusions. Fundamentalists rather try to determine whether an asset is undervalued or overvalued regarding the firm’s fundamentals. After the publication of Lawrence Fisher and Lorie (1964), economists questioned the superiority of such a strategy in comparison to a simple *buy and hold* principle.

Financial economists developed measures of performance and documented the returns of investment funds (Jensen 1968; Sharpe 1966; Treynor 1965). They showed that most funds did not have better returns than a simple portfolio would have by passively replicating a market index. This suggests that the expenditures of funds for gathering information are, most of the time, an unnecessary cost. Instead, investors should adopt passive management focusing on long term return.

¹⁴Roberts (1967) coined the term of “efficient capital market hypothesis”, and efficient market hypothesis progressively became the standard in the literature.

¹⁵Fama (1965b) and Samuelson (1965a) are presented in details in chapter 3.

The profitability of short term speculation also became challenged by new evidence highlighting the speed of price adjustment to new information. This new literature, which will be known as “event studies”, has been popularized by Fama et al. (1969). They analyzed the adjustment of prices to stock split announcement and concluded that:

on the average the market’s judgments concerning the information implications of a split are fully reflected in the price of a share at least by the end of the split month but most probably almost immediately after the announcement date (Fama et al. 1969, p. 410).

Fama (1970) famously reviewed this research from the 1960s and framed it into three categories. Research gathered around the random walk became understood as testing the weak-form efficiency that focused on the integration of past information: if historical price series cannot be used to forecast future prices, then all the past information is integrated into prices. Fama renamed works on event studies as tests of the semi-strong form looking at the integration of public information. Finally, the strong form tests the integration of private information through funds performances. The use of private information was by definition unobservable, but might be indirectly tested by looking at the performance of the funds.

0.3 Research question and contribution of the thesis

The debates between sub-disciplines, what I shall call the *intradisciplinary* debates, are at the heart of the emergence and evolution of financial economics. To the extent that financial economics represents the sub-discipline that links

finance to economics, its history is a succession of continuous interactions with economics (e.g. Jovanovic 2008; Mehrling 2005; Walter 2010). These interactions result from two contradictory logics, both of which are necessary for the constitution of financial economics: a first logic is that of *integration* into the economic framework in order to justify its sub-disciplinary status, a second is a logic of *differentiation* with respect to economics in order to define the characteristics and identity of this sub-discipline. This double contradictory logic is found, for example, in the emergence of financial economics in the 1960s, and in the emergence of Behavioral Finance in the 1990s, both of which appropriate and distinguish themselves from the dominant framework, namely a formal framework centered on the analysis of rational agents in a competitive situation (Jovanovic 2008; Schinckus 2009).

The literature review highlighted how the efficient market hypothesis has been central in the dialogues between economics and financial economics. From the origins of this hypothesis, the first discussions were based on interactions with other emerging fields such as econometrics or agricultural economics. Its modern development in the 1960s was also the result of several intradisciplinary dialogues. One can, for example, retain the central role played at MIT and Chicago by authors such as Samuelson, Modigliani, Friedman, or Stigler. It is not surprising, moreover, that the early 1980s, when the efficient market hypothesis received a series of criticisms, was also a period marked by lively discussions on the relationship between financial economics and economics (Lucas 1978; Merton 1985; Ross 1987; Summers 1985). From this point of view, market efficiency represents a “boundary object”, both at the heart of the identity of financial economics, but also the main bridge through which financial economists and economists dialogue

with each other.¹⁶

The first choice of this thesis is to explore in detail these intradisciplinary dialogues. Rather than reading the history of market efficiency as a history specific to financial economics and its concepts, this thesis proposes an external history of the field focused on the interactions and ongoing dialogues with other subfields of economics. This approach raises important conceptual issues about the delimitation of boundaries between the subfields of economics. The issues are, on this point, similar to the existing discussions on the definition of the boundaries of economics and the question of interdisciplinarity (Mäki, Walsh, and Pinto 2017). The difficulty in apprehending inter or intradisciplinarity stems directly from the ambiguity of the very concept of discipline (Mäki 2016, p. 6). The boundary between financial economics and economics is conceptually ambiguous because financial economics and economics are objects that are difficult to define and whose characteristics evolve over time.

However, while disciplines remain hard to define analytically, they are rooted in institutional realities (such as departments, schools, and faculties, associations, specialized journals) that make it possible to identify their boundaries (Mäki 2016, p. 22). Financial economics remains a well delimited field through the system of *business schools*, which gives it autonomy both in terms of teaching and research. It is thus possible to define the work relating to financial economics and that of other sub-disciplines through the institutions in which this work is produced.

The second choice of this thesis is to analyze the intradisciplinary dialogues in the history of the efficient market hypothesis in a perspective that

¹⁶This distinction is inspired by Star and Griesemer (1989, p. 393) who defines the boundary object as “[a]n analytic concept of those scientific objects which both inhabit several intersecting social world ... The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds.

is both analytical and contextual. On the one hand, some chapters of this thesis, such as chapters 3 and 4, focus on the concepts and ideas on which economists and financial economists interact. On the other hand, chapters 1 and 2 place greater emphasis on the professional and intellectual context within which these interactions happen. These two perspectives are complementary. As Weintraub points out, making a history of thought entails retracing the evolution of thought within communities of economists, but it also means taking into account “the developmental context in which those communities thought those thoughts” (Weintraub 1999, pp. 148–149).

In this thesis, this perspective comes less from a historiographic *a priori* standpoint than from a historical necessity linked to the object under study. Insofar as the hypothesis of the efficient market is both a concept and a notion gathering a research community, making its history implies studying both the evolution of the formulations of this hypothesis and the environment in which these formulations have been made.

This work gathers four research articles, which constitute the four chapters of the thesis. The analysis carried out in this work covers a long-term period, from the 1920s to the early 1980s. The aim is not to propose a history of the efficient market hypothesis that would cover this period exhaustively and continuously. This thesis provides a history of the efficient market hypothesis around four episodes, which analyze in detail the influence, or the proximity, of this hypothesis with research from other areas.

While the history of this hypothesis cannot be reduced to the study of a few actors, this thesis highlights the individual contributions of a number of economists. It analyzes already known works, such as those of Eugene Fama or Robert Shiller, and re-evaluates other contributions, such as those of Holbrook Working, Paul Samuelson, or Thomas Sargent. Particular attention is given to the contributions of Holbrook Working that I analyze in

three chapters of the thesis.

Working was an American agricultural economist, who wrote from the 1920s to the 1960s and has been one of the first to observe the random nature of fluctuations (Working 1934) and to give an explanation of it (Working 1949a). This “precursor” of financial economics has been largely neglected by the historical analysis.¹⁷ In addition to shedding light on its contribution, this thesis analyzes its influence in the emergence of financial economics. It also offers the opportunity to examine more broadly the pioneering analyses of financial markets conducted by agricultural economists in the interwar period, and in particular, to emphasize the central role that they gave to the circulation of information.

This work contributes more broadly to methodological research on the definitional issues concerning the notion of the efficient market hypothesis (e.g. Vuillemeys 2013, 2014).¹⁸ I discuss the different interpretations of the efficient market hypothesis by analyzing the contexts, often very different, in which its formulations have been developed. This perspective is particularly explicit in Chapter 2, which discusses different historical interpretations of this hypothesis, and, in Chapter 4, which proposes a methodological analysis of the concept of information.

This thesis contributes to the history of financial economics and hopefully sheds light on its growing importance in economic thought in the second half of the 20th century (Fourcade and Khurana 2013; Mehrling 2016). To the extent that this work explores moments of interaction between financial economists and economists, it also contributes to the history of the subfields studied. For example, Chapter 3 contributes to the history of macroeconomics by analyzing the links between the rational expectations

¹⁷The following section discusses the notion of precursor in greater detail.

¹⁸See Walter (2005b) for a first methodological analysis of these issues.

hypothesis and the efficient market hypothesis.

I focus mainly on the most explicit formulations of the efficient market hypothesis and their context of enunciation. In doing so, I only marginally analyze the empirical dimension of the works studied. In many respects, the history of economic thought described in this thesis has been determined by innovations in empirical research, both in the improvement of econometric tools and in the accessibility of observational data. Such a perspective is not, however, addressed in the thesis and should be the subject of future research.

Moreover, since financial economics emerged in business schools in the United States, the intellectual history proposed in this thesis is essentially an American history. Thus, the way in which the efficient market hypothesis has been adopted, and potentially adapted to other national contexts, is also not addressed in this work (see for the French case, Jovanovic and Numa 2020).

0.4 Methodological framework and selection of the corpus

The following chapters are structured around three methodological issues: (1) the use of the notion of precursor, which concerns the analysis of Working's proposed in chapters 1 and 4; (2) the way in which the historian must study the very recent evolutions of the discipline, a problem that concerns the analyses conducted in chapters 2 and 3; (3) the delimitation of the corpus and the nature of the sources used.

0.4.1 The figure of the “precursor”

The “modern” development of the efficient market hypothesis dates back to the 1960s, the period when the analysis of financial markets became institutionalized. In fact, we consider all the economists writing before this period as “precursors” of this hypothesis. For example, Holbrook Working is interesting because his work “anticipates” the modern formulation of market efficiency.

Historians should handle carefully the notion of precursor because it is often associated with the risk of presentism, that is, the risk of crudely re-reading the past through the ideas, concepts, and issues of the present. The very notion of “market efficiency”, which was first formulated by Fama (1965b), did not exist at the time when Working was writing his main works.

Presentism is, however, an inevitable element in the history of economic thought:

Even to write a “history of economics or a “history of economic thought” is to impose a present-day classification on historical materials. Presentism is an issue of which historians need to be aware, not something we should avoid altogether (Backhouse 2001, p. 243)

Rather than vainly seeking to eliminate presentism from his or her research, the historian must, above all, be aware of this issue and remain cautious about the terms and concepts that support his analysis. For example, the precursors of the efficient market hypothesis have long been viewed as independent and isolated individuals (Bernstein 1993). However, if these authors appear isolated, it is because they have been analyzed *uniquely* through the modern ideas they have anticipated. If we reread the inter-war period

through the modern arguments of the efficient market hypothesis, Working can only be viewed as a lonely researcher since he is *by definition* one of the few to write on these questions during this period.

However, in order to properly appreciate the contributions of precursors, it is necessary to take into account the development of the environment in which these contributions were made. The analysis must include a better understanding of the problems, issues, and collective dynamics in which these precursors wrote. As Preda (2004, p. 356) argues: “The emergence of an academic theory of finance is irreducible to isolated insights. Rather, we have to do with a slow evolution of popular knowledge into an academic, formalized science” (Preda 2004, p. 356).

Through chapter 1 and chapter 4, this thesis analyzes the contribution of Working from this angle. These chapters propose to re-evaluate his work by showing the pioneering character of his contributions—particularly on the concept of information—while retracing the context in which he wrote his texts.

0.4.2 The study of contemporary theory

The evolution of economic thought after the 1970s remains a little-studied period. The historian faces *de facto* a field that is not or only slightly circumscribed by his peers. The evolution of the efficient market hypothesis after the 1970s remains little studied.¹⁹ Recent economic thought is essentially depicted, in a casual way, by economists themselves through their academic

¹⁹Research is obviously ongoing, and several recent works study this period. For example, Chiapello and Walter (2016) and Walter (2015) propose a history of the discount rate that was at the heart of the debates on the efficient market hypothesis in the 1980s. This research is still very important in the field (Cochrane 2011, 2017). Schinckus (2009, 2011) analyzes the emergence of behavioral finance. Jovanovic and Numa (2020) studies the export of this hypothesis to France in the 1980s.

writings. It is thus common for an economist writing a review of the literature to introduce it with a short note on the history of the field (e.g. Fama 1970; LeRoy 1989).

To the extent that they constitute the first historical record describing the recent evolution of the discipline, these narratives are essential for understanding this period. For example, the transformations that took place in financial economics in the 1990s, with the emergence of behavioral finance in particular, were essentially described and analyzed by economists themselves (e.g. Fama 1998; Thaler 1999).²⁰ Using the expression “the emergence of behavioral finance” is a historical thesis, produced by economists, which a historian will have to *appropriate* and *question*, in order to carry out his own analysis.

Telling a story is a rhetorical tool among others, legitimizing the position that economists hold at the time they are writing (McCloskey 1983, p. 505). These narratives can participate in the creation of myths.²¹ that historical analysis is led to criticize, reject or amend. Generally speaking, the historian comes to question the methodology behind these narratives. For example, economists essentially write stories of “winners”, ignoring the work of “losers” (Goutsmedt 2017). Yet, the history of economic thought is led to study ideas considered good as well as those considered false.

As a result, historians working on these recent periods have regularly stood in relation to, and often against, these narratives that have been described as “official”, “canonical”, or “standard” history.²² Historians of recent thought thus have an uneasy relationship with economists. While maintaining a critical distance, they also use economists and their narratives

²⁰The work of historian Christophe Schinckus (2009, 2011) represents a notable exception.

²¹See for example the work of Forder (2014) on the Phillips curve.

²²See for example, in financial economics, Gindis (2020) and Jovanovic (2008) and in macroeconomics the introductions to the theses of Goutsmedt (2017) and Sergi (2017).

to help them analyze the most recent periods.

This thesis is in line with this perspective. The history of the efficient market hypothesis after the 1970s still has many unexplored areas, which are only discussed by the actors in this history. Chapter 2 and especially Chapter 3 take as a starting point and conduct a critical analysis of the “official accounts” of economists.

0.4.3 Delimitation of the corpus and selection of sources

The size of the corpuses studied varies according to the chapters and analyses proposed. Chapters 2 and 3 focus on the intellectual trajectories of individuals. Thus, the corpuses are limited to a restricted set of texts, which are analyzed in depth. Conversely, chapters 1 and 3, which describe the trajectory of communities of researchers, rely on a much larger corpus of texts in order to describe the whole collective dynamic.

Since this thesis investigates intradisciplinary dialogues, the analysis of the texts extensively uses comparisons of corpuses affiliated to different sub-disciplines. Throughout its four chapters, this thesis puts the contributions of financial economists into perspective with those of economists, or groups of economists, which are outsiders or at the boundaries of the field.

These comparisons provide a new perspective on the writings of financial economists by highlighting the influence of economists who are outside or at the boundaries of this subfield. The analysis in chapter 3 is based on the identification of two distinct corpuses, that of the efficient market hypothesis in financial economics and that of rational expectations in macroeconomics, and proposes to study the historical meeting between these two corpuses.

The main sources used in this thesis are obviously the published writings of economists, whether they come from academic journals, books, and

collective works. This thesis also uses secondary sources such as literature reviews, textbooks, and essays. These sources allow analyzing different registers of discourse from scientific publications. Indeed, in these formats, economists focus less on the demonstration of a new argument as they would do in an academic article, but more on the synthesis of preexisting knowledge. For example, Chapter 3 uses numerous textbooks and literature reviews to understand how economists from the 1970s actually viewed the link between the efficient market hypothesis and rational expectations.

Many chapters of this thesis use literature reviews, which have been one of the popular formats of economists working on the efficient market hypothesis.²³ The importance of literature reviews can be explained for different reasons depending on the period. In the context of the emergence of the discipline in the 1960s, these literature reviews were a means of synthesizing dispersed work around a common problem (Jovanovic 2008). In the late 1970s and beyond, the extensive use of literature reviews illustrates how their validity became increasingly controversial. From this period onwards, literature reviews served to support a theoretical opinion through a synthesis of the works published in the field.

This thesis also uses archives. In particular, Chapter 2 uses Paul Samuelson's personal manuscripts, which are composed of his professional correspondence with other economists and his unpublished writings. These kinds of archives enrich the understanding of an author's thoughts. Historians can observe the author's speech in an environment other than the official publications. In particular, Samuelson's archives allow the historian to observe the research process prior to his publications, which only represent the final outcome. For example, Chapter 2 highlights an original correspondence between Samuelson and Working, which demonstrates

²³For example Cootner (1964), Fama (1970, 1991), Jensen (1978), and Shiller (1984).

Working's direct influence on Samuelson's writings.

In addition to these individual archives, this thesis also uses archival sources of institutions where agricultural economists worked during the interwar period, namely the archives of the United States Department of Agriculture and two of its agencies, the Bureau of Agricultural Economics and Grain Future Administration. These archives are essentially internal reports summarizing the work done by these respective administrations.

These archives are essential given the context of the profession of economists in the United States during the interwar period. If the professionalization of American economists began during this period (Barber 2001), a large part of American economists (especially agricultural economists) worked for government agencies. These economists published *de facto* very little. Thus, these archives were essential to the writing of Chapter 1 because they are the only sources for observing the work of economists within administrations.

Chapter 3 of this thesis also uses interviews with economists from the corpus under study (Eugene Fama, Richard Roll, and Steven Sheffrin). Interviews have become a privileged material for historians of recent thought (see Jullien 2018). They complement and enrich the historian's analysis by providing him unavailable information. For example, interviews can inform on the initial motivations that lead an economist to write an article, or on the initial reception of a working paper before its publication.²⁴

²⁴For example, by interviewing Michael Jensen, Gindis (2020) shows that the Firm Theory of Jensen and Meckling (1976) was initially very badly received by other financial economists in Chicago.

0.5 Outline and results

Chapter 1 focuses on the analysis of the work of Holbrook Working, work that can be viewed as being at the origin of the efficient market hypothesis. The chapter examines in detail the role played by agricultural economists within the U.S. Department of Agriculture in the reforms conducted in the 1920s. These reforms aimed to improve the production and dissemination of information on agricultural markets. The objective of the chapter is to show how this work provided a necessary background to Working's writings on the efficient markets hypothesis. It begins with a discussion of the growing role of agricultural economists within the U.S. Department of Agriculture. Second, the chapter examines the work of these economists who saw the state as the producer and distributor of impartial and unbiased information. In a final section, the chapter shows how Working's view, which will lead him to his formulation of the efficient market hypothesis, contrasted but was intimately linked to the USDA's research program.

Chapter 2 analyzes how Working's arguments, written in the context of the interwar period, are translated into those of financial economics that emerged in the 1960s and 1970s. The chapter compares the writings of Paul Samuelson and Eugene Fama and shows that the main element that differentiates them is their conception of expertise. Fama interpreted his work to provide practical recommendations in terms of investment strategy. Samuelson put emphasis on the expertise that was intended to be useful for policymakers. The chapter shows how this opposition was already present in their initial contributions to the efficient market hypothesis, both published in 1965. The chapter suggests that two elements are central to explain the normative positions of Fama and Samuelson: (1) the contrasting views of their respective research institutions, the University of Chicago and MIT;

(2) the respective positions of the two authors in the emerging field of financial economics. In a final section, I show that Samuelson's viewpoint echoed many of the critics of the efficient market hypothesis in the early 1980s.

Chapter 3 of this thesis looks in detail at the growing interactions between financial economists and macroeconomists in the 1970s. This chapter studies the genesis and popularization of the association between the efficient market hypothesis and the rational expectations hypothesis. In the first part, the chapter shows that, while the two concepts are developed autonomously in the 1960s, they gradually became associated in the 1970s around the work of Thomas Sargent, Franco Modigliani, and Robert Shiller on the determination of the yield curve. The chapter then examines some of the early discussions about the association, which nevertheless became a pillar of macroeconomics and finance, at the turn of the 1970s. Finally, the chapter shows how new definitions based on rational expectations became used in the early 1980s to criticize the validity of the efficient market hypothesis.

Chapter 4 provides a methodological analysis of the efficient market hypothesis. It discusses the conceptual similarities between, on the one hand, the work of Working and Fama and, on the other hand, the information theory of Friederich Von Hayek. This chapter seeks to show the existence of a conceptual filiation between Hayek and the EMH while taking into account their differences. After a presentation of the two theoretical frameworks, the second part of the chapter proposes a distinction between the epistemology and the methodology of the authors: the first is defined as the fundamental concepts of their theories, while the methodology considers how an author operationalizes his concepts. The chapter shows that, despite important methodological differences, the two theoretical frameworks share a common epistemology. In particular, both frameworks are based

on a subjective conception of the notion of information that leads them to interpret the market as an information “processor”.

Chapter 1

“The Eyes and Ears of the Agricultural Markets”:

A History of Information in Interwar Agricultural Economics

“I put on my reading list a wonderful description of the efficient markets hypothesis by Charles Conant (1904). He has a beautiful essay about speculation and markets and the function of speculation and how all these speculators, trying to make profits, create a price, not just for today; they create a price for tomorrow and a price for next year and all relevant years in the futures markets. And, then, people who are planning have all these price indicators. Its laid out very nicely around 1910. He didnt call it the “efficient markets hypothesis”; but it was a little glib too. Anyway, he never got famous for it. He was, however, a great writer. So the efficient-markets hypothesis was well known from, I think, then on, if not before. And the next thing that happened, that seemed to me was a turning point, was that the Ford Foundation gave the University of Chicago a grant to create the Center for Research in Security Prices tapes in 1960. And this is another breakthrough”

1.1 Introduction to chapter 1

The first episode of this thesis focuses on the “prehistory” of the efficient market hypothesis. It is based on a research article written in collaboration with Guillaume Noblet and entitled “ ‘The Eyes and Ears of the Agricultural Markets’: A History of Information in Interwar Agricultural Economics”.

Historians of economic thought showed that most of the ideas underpinning the efficient market hypothesis—such as the randomness of price fluctuations—had already been formulated and understood by economists and/or investors before the emergence of financial economics (Jovanovic 2009a; Walter 1996). The modern formulation of the hypothesis, which introduced the idea of the incorporation of information into prices, appears therefore as an *ex ante* explanation that has synthesized in a single research program a set of pre-existing and scattered ideas (*e.g.* Walter 1996).

While these works have shed light on the origin of the efficient market hypothesis, they have neglected the historicity of the very concept of information. Yet, it seems very unlikely that the importance of information was a spontaneous post-war development. For instance, the informational role of prices was already well-understood by Western investors by the end of the 19th century (Preda 2004). It is relatively easy to find essays, written by financial professionals of the 19th and early 20th century, that defended a vision of financial markets where prices reflect information. For instance, the U.S. American journalist Charles Arthur Conant (1904) argued that:

The publicity which prevails in stock-exchange quotations gives the holder of a security not only the direct benefit afforded by such publicity for the moment, but gives him, free of charge, the

opinion of the most competent financiers in the capitals of Europe and America. If they were dealing with him privately, instead of through organized markets, they might withhold the information which years of study and observation of railway properties and industrial enterprises have put in their possession, but when they go into the market and bid a price for securities, by that very act they give their advice free of charge. That quoted price stands as a guide to the most ignorant holder of these securities as to their value in the present and their probable value in the future. (Conant 1904, p. 90)

If it has been necessary to trace the origins of the idea that financial fluctuations are random, it seems equally essential to understand how economists gradually came to investigate the dissemination of information in financial markets.

However, it is difficult for the historian to collect materials that would provide any evidence about the circulation of ideas from the world of professional finance to academia. Likewise, it is possible that there was actually no such circulation of ideas, and that economists at the end of the 19th century already shared the same idea about information, albeit it was not explicit in their research. If professionals had conceptualized price as aggregating information, how this idea emerged in academia remains an unresolved question in current historiography.

In this chapter, I offer a preliminary analysis of this issue. I document the work of American agricultural economists during the inter-war period. The general introduction already mentioned the contributions of Holbrook Working, who formulated a version of the efficient market hypothesis in

the late 1940s (Working 1949b). From the perspective of modern financial theories, Working's contributions can be seen as those of an isolated author, finishing his career in the late 1950s just before the emergence of financial economics (Bernstein 1993). However, from a broader perspective, Working's research was part of a significant research program within economics—agricultural economics, which emerged in the United States in the 1920s.

This research program was mostly public-funded and supervised by the United States Department of Agriculture (USDA). The USDA brought together one of the most important groups of economists of the time (Fox 1986; Rutherford 2011b; Stapleford 2017). Agricultural economists were at the forefront in the development of statistics and played a leading role in the early developments of econometrics (Biddle 1999; Morgan 1991). Another research contribution made by agricultural economics, less known, was the analysis of speculation on the major agricultural exchanges. Recent historical works have notably highlighted the debates between Working and other agricultural economists on the regulation of futures markets (Berdell and Choi 2018).

The purpose of this chapter is to show how the reliability of the information owned by market participants lied at the heart of these debates. Based on their published works and archives of the U.S. administration, this chapter documents the works of agricultural economists within the U.S. government to *reform* agricultural markets by producing, editing, and disseminating information to market actors. The objective of this chapter is twofold: (1) to provide an analysis of these reforms; (2) to examine how this general context has influenced Working's later theoretical contributions.

1.2 Introduction

In 2015, the USDA celebrated the 100-year anniversary of its market-news service (Alonzo 2017). The market-news service chiefly aims at providing market participants free and unbiased information on prices on the agricultural commodities market. USDA’s first radio report in 1915 broadcasted to growers and shippers the prices of strawberries, tomatoes, cantaloupes, peaches, and pears. Today, the USDA market-news service still provides prices and other relevant information on U.S. agricultural products. The establishment of the market-news service was only one part of a larger program launched by the USDA during the interwar that aimed at improving the production and diffusion of agricultural market information. This article relates the role that agricultural economists played in this program, and more particularly their view on the information. In the history of economics, information has been studied as a concept emerging in the postwar context through the influences of several others disciplines such as early cybernetics or mathematics (Mirowski and Nik-Khah 2017). Yet, it has already been acknowledged that early U.S. agricultural economists viewed information as a key issue for improving the efficiency of agricultural markets. For instance, agricultural economists advocated early market transparency leading to the first regulation on futures exchanges in the 1920s (Berdell and Choi 2018; Saleuddin 2018). Moreover, agricultural economist Holbrook Working formulated an early (and personal) version of the efficient market hypothesis, which states that assets prices fully integrate all available information (Berdell and Choi 2018). The writings of Working and their influence on modern financial economists have already been noticed¹.

¹See for instance the relationship between Working and MIT financial economists (Delcey 2019; Jovanovic 2008).

Except for Working, other agricultural economists did not produce significant analytical contributions to information theory. While not considered as contributing to economic theory, agricultural economists were actively concerned with the informativeness of market participants. In the 1920s, in the context of the expansion of the USDA, they chiefly reformed the agricultural markets to improve the production and the circulation of information. This article investigates precisely how, through such reforms, agricultural economists shared a set of beliefs on information and how it influenced Working's contributions.

We argue that agricultural economists shared two beliefs. First, that the improvement of markets participants' information was the best way for a proper functioning of agricultural markets. Second, they thought that markets participants were ill-informed and thus that the State should produce and disseminate economic information. We want to show how these beliefs on information produced the necessary background to Working's contributions to the efficient market hypothesis. Rather than interpreting Working as an isolated pioneer of financial economics, this article aims to understand the collective dynamic preceding and surrounding his contributions. We essentially focus on the emergence of economic institutions and of the debates on information within the USDA between 1862 and the early 1930s, with an emphasis on the 1920s.

It is important to note that interwar agricultural economics was essentially public-funded. The boundaries between academia and expertise were not clear: many agricultural economists were civil servants within the USDA. They not only published scientific writings; they also built institutional devices to reform and improve the agricultural economy (such as the market-news services). Consequently, a large part of our work focuses on the role they played within this administration. The primary sources we use are

three yearly USDA’s public reports: the USDA yearbook, the report of the Chief of the Bureau of Agricultural Economics, the report of the Chief of the Grain Futures Administration², and writings from economists that worked within the USDA.

This article contributes firstly to the history of agricultural economics by shedding light on the role played by some agricultural economists on the establishment of both economic administrations and the market-news service. It also contributes to the history of information in economics. We exhibit how information was central in economists’ debates and economic policies far before the post-war era. Such result remains consistent with other findings showing that investor’s “popular knowledge” already stated that asset prices reflect information at the end of the 19th century (Preda 2004). This calls for further investigations of early economic knowledge and analyses on the informational role of markets. Finally, we contribute to the history of financial economics by enriching our understanding of Working’s contributions to financial theory.

Our argument is structured as follows. Section 1.3 relates how USDA’s interest in information arose from political concerns, and from converging interests of policymakers, farmers, and businesswo/men. The USDA launched a large economic research agenda in order to meet this demand. Section 1.4 shows the central role of agricultural economists in this research agenda. We focus on the establishment in the early 1920s of economic federal administrations, namely the Bureau of Agricultural Economics and the Grain Futures Administration. Both institutions aimed at improving the production and the diffusion of information. Sections 1.5 and 1.6 explain

²The bibliographic reference to these archives in the body of the text is respectively USDA, BAE and GFA.

the institutional devices by which agricultural economists gathered and disseminated information to market participants. It emphasizes how agricultural economists viewed the government as the producer and distributors of impartial and unbiased agricultural economic information. Section 1.5 explains the collection and the edition of information. Section 1.6 focuses on the establishment and the functioning of the market-news service. Section 1.7 investigates, in particular, the kind of efficient market hypothesis that Holbrook Working formulated. We relate how his view contrasted with (but was intimately related to) the USDA research agenda.

1.3 The growing demand for economic information of market participants (1862-1926)

Historically, providing reliable information to farmers was an important feature of USDA's agenda. When President Lincoln established the USDA in 1862, he explicitly formulated the need for U.S. agriculture to learn from science to reach such purpose. Its original mandate enjoined to promote "the general welfare of rural Americans" by "diffus[ing] among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of the word"(Wik 1988, p. 177). The Colleges of Agriculture—or "land-grant colleges"—were established the same year (Morrill Act), and experimental stations were funded in these colleges in 1887 (Hatch Act). State colleges produced research on every topic related to agriculture: farm management, biology, chemistry, etc.

From the end of the 19th century, the U.S. agricultural sector was in crisis: low prices, overproduction, monopolies. As farmers and politicians understood it, prices remained too low, and farmers could neither live with good standards nor integrate the simmering rise of the consumers society. Moreover, farmers thought that low prices were caused by traders (Santos 2008). They considered that the price of their supply was settled on agricultural exchanges, e.g, on the Chicago Board of Trade, and that they remained misinformed about market trends and their underpinnings (Wik 1988, p. 178). During the last thirty years of the 19th century, farmers progressively gathered and organized themselves at the national and local level.³ Farmers societies disseminated practical information to farmers in an effort to spread scientific knowledge. They believed that education—courses, test plots, demonstration of new methods, boys’ and girls’ clubs, etc.—and information were the key to solve the problem of low prices (Fite 1971; Scott 1971). Farmers asked for any information that would improve their knowledge on any subject related to agriculture, from weather and fertilizers to farm management. The need for improving farmers’ information on market conditions was grasped by politicians. For instance, in 1889, Secretary Jeremiah M. Rusk already reported that thousands “of letters of inquiry for information” were sent to the USDA “from all sections of the country, from all classes and conditions” (Harding 1947, p. 330).

From the 1910s, a third party will enter the ongoing equation: The business community, facing a growing need to forecast prices, became very interested in market information, particularly on agricultural statistics like prices series (Stapleford 2017). During the 1920s, a convergence will occur between

³For example, the Grange—a farmers’ union, based in the North-East—promoted popular education and made social demands against monopolies, especially transportation monopolies. In 1875, 800,000 members composed the Grange. The Grange was not a stranger in the lobbying that led to the Smith Lever Act of 1914 and to the establishment of the Farm Credit System.

businessmen' and farmers' interest in receiving market information.

The early agricultural economists were working in land-grant colleges and experiment stations—notable scientists of this era are Henry C. Taylor, George F. Warren, William J. Spillman, and Thomas N. Carver.⁴ Most of them shared Victorian-American values, and, among those, they thought that education was a tool to the enlightenment and the moral improvement of the people (McDean 1984). The legislative apparatus developed economic research that would meet these interests towards information and education. The institutionalization of economics within the USDA remained a long sequence that reached its acme under Secretary Henry C. Wallace with the establishment of the Grain Futures Administration (1921) and the Bureau of Agricultural Economics (1922). During the same decades, Agricultural Experiment Stations pursued economic research, which was officially recognized by the Purnell Act (1926). According to Secretary Henry A. Wallace, the establishment of the BAE allowed farmers to better adapt to market conditions:

It is now possible to make a comprehensive study of economic questions involved in production, marketing, and distribution of farm products, following every step of these processes. This is necessary to secure for farmers the information needed to put American agriculture upon a permanently productive and profitable basis. (USDA 1923, p. 17)

The growing demand for information lead to the development of a public funded agricultural economic research. The next section narrates how,

⁴The main land-grant colleges they worked in were Massachusetts, Iowa, Nebraska, California, Michigan, Wisconsin, New York, and Minnesota. Most of those “pionneers” of agricultural economics—some of them were considered rural social scientists—were born and raised on Mid West farms. See McDean (1984) for more details.

starting in the 1920s, agricultural economists seized upon the issue of information.

1.4 The establishment of the Bureau of Agricultural Economics and the Grain Futures Administration

Two federal administrations within the USDA—both established in 1921-22—exemplified the increasing importance of economics in agricultural research: the Bureau of Agricultural Economics (BAE) and its Graduate School, and the Grain Futures Administration (GFA).⁵

The BAE acted as the cornerstone of economics' integration in the USDA. It brought together a large group of economists or economic-oriented scholars (Fox 1986). Moreover, it mainly hired PhD agricultural economists from land-grant colleges such as the University of Wisconsin, the University of Minnesota, and Cornell University (Archives 1995). In 1922, under the impetus of Secretary Wallace and Taylor—its first director—the BAE was established by merging three preexisting institutions (Chancellier 2014; Taylor 1940; Warren 1932): the Bureau of Markets (1917-21), the Office of Farm Management and Farm Economics (1920-22) and the Bureau of Crops Estimates (1914-22). The Bureau of Markets, whose activity was integrated into the BAE, had already been commissioned by Congress to “get market information to farmers more rapidly”. The BAE then functioned as a research agency at the boundaries of economics, statistics, and planning. Planning was reinforced with the New Deal and the Agricultural Adjustment Act

⁵The BAE lasted until 1953. After being re-dispatched in others bureaus, it became the Economic Research Service in 1961. The GFA became the Commodity Exchange Administration in 1936, and eventually the Commodity Future Trading Administration in 1982.

(AAA); yet, economists from the BAE had already advocated for planning years before (see the seminal work of Kirkendall (1966)). The mandate of the Bureau explicitly aimed at disseminating economic information:

Conducted studies and disseminated information relating to agricultural production, crop estimates, marketing, finance, labor, and other agricultural problems. Served as the central planning agency for economic and statistical research in the Department of Agriculture. (Archives 1995).

Moreover, the Graduate School of the USDA⁶, was established in 1921, with the objective to answer the rising demand in statistical and economic expertise. The School mainly trained USDA civil servants. It did not offer degrees but provided courses in economics and statistics for many universities' degree.⁷ The Graduate School invited prominent statisticians such as Ronald Fisher or Jerzy Neyman. Many known figures taught economic courses, for instance on land economics or prices analysis. Notable teachers were Henry C. Taylor and economists who worked on early econometrics such as Mordecai Ezekiel, E. J. Working, Holbrook Working, Howard Tolley, W. J. Spillman, Louis Bean, and Frederick Waugh (McDean 1984; Morgan 1991; Rutherford 2011b). Like many interwar U.S. economists, agricultural economists were or have been trained by institutionalists. In particular, they shared with institutionalists their interests in empirical analysis and policy advising (Mehrling 1997; Rutherford 2011a). For instance, Taylor, Ezekiel, Tugwell or Working had been economic advisers for USDA's secretaries (Rutherford 2001, p. 182; Berdell and Choi 2018, p. 550).

⁶For the history of the Graduate School, see Rutherford (2011b).

⁷Such as Columbia, Cornell, Yale, Harvard, Johns Hopkins, Chicago, California, Michigan, New York, Illinois, Iowa (Rutherford 2011b, p. 423).

The second federal agency, the Grain Futures Administration (GFA), was established in 1921 (Grain Futures Act, 1922) and clustered the farmers' demand for the regulation of futures markets. The U.S. futures exchanges had been controversial for years, although no attempt for regulation had been made before the end of World War 1 (Santos 2008). Since a part of the public viewed the futures markets as gambling, which led to artificial increasing of prices at the expense of farmers, the GFA was tasked with preventing the manipulations of prices which led to excessive fluctuations:

The transactions and prices of grain on such boards of trade are susceptible to speculation, manipulation, and control, and sudden or unreasonable fluctuations in the prices thereof frequently occur as a result of such speculation, manipulation, or control, which are detrimental to the producer or the consumer ...and render regulation imperative for the protection of such commerce and the national public interest therein. (Grain Futures Act, 1922, in Berdell and Choi 2018, p. 541)

Yet, the GFA remained a small agency within the USDA compared to the BAE. In terms of budget, the GFA regular expenditure was \$100,000-200,000 in the 1920s and the 1930s, to be compared to the BAE's expenditure that added up to millions (see USDA's yearbooks, *e.g.* USDA 1926, p. 98). Nonetheless, it was one of the earliest attempts to study and to regulate modern exchanges (Saleuddin 2018). In the 1920s, the GFA did not have any real coercion power on futures exchanges and thus focused mostly on "information gathering" on futures markets (Saleuddin 2018, p. 162). Economists within the GFA mainly sought to prevent "the dissemination of false or misleading market information." (GFA 1924, p. 3). They pursued this objective, helped by the other USDA agencies and notably the BAE, in order

to check the accuracy of published statements on market conditions (GFA 1924, p. 26). The GFA tried to measure how ill-informed trading activities influenced strongly spot and futures price movements driving them away from agricultural fundamentals (Berdell and Choi 2018, p. 540). Hence, if the GFA was mainly concerned by market regulation, it was also a pioneer research institution on financial activities, collecting and analyzing data on speculative activities in agricultural markets (see 1.5).

The BAE's and the GFA's mandates centered around the production and the diffusion of economic information. BAE's and GFA's economists obviously thought that producing information and making it available would improve the efficiency of the agricultural economy. Within these administrations, the nature of daily work was a hybrid of economic research and policymaking. They were particularly concerned with improving farmers' economic conditions. A large part of their discussions on information was neither theoretical nor empirical, but practical. Rather than analyze agricultural markets, they wanted to reform them by producing and editing information for market participants.

1.5 Producing and editing information

The USDA did not only collect information on markets, but also on a variety of others subjects as long as it would help the market participants. For that, they promoted a plurality of empirical methods like cost accounting, surveys, geographical methods. They notably promoted experimental work from the 1920s. Experiment stations and the BAE worked on joint experiments in rural sociology, agricultural engineering, soil and fertilizers, animal and dairy husbandry, and so on. By 1930, 7,000 experimental

projects were active in the US, of which 1/8 was devoted to agricultural economics (USDA 1930). Following the setting up of new protocols (e.g., Call, Green, and Swanson 1925), agricultural economists notably used and discussed statistical theory such as significance tests using samples and field experiments (Elliott 1929; Fisher 1925; Grimes 1929; Wilson 1929). Within the Bureau of Crop Estimates and then the BAE, early attempts at random sampling to conduct surveys were made; likewise, surveys were used for price forecasting (Didier 2009).

In a nutshell, the USDA was an important and innovative actor in the development of the U.S. statistics in the 1920s and the 1930s (Didier 2009; Rutherford 2011b). A large part of this statistical work relied on market information. The goal was to help market participants to better adapt to economic conditions. Taylor stated that the BAE's purpose was to "serve as a sort of barometer of the agricultural industry" (BAE 1924, p. 2). The relationship between market participants and agricultural economists was not a unilateral relationship in which the uninformed agents learned from the expert economists. To increase market participants' information but also its control on the agricultural economy, the USDA needed to improve its knowledge (Didier 2009; Saleuddin 2018). In fact, the State and the economists did not know much more about the agricultural sector's economy than the market participants. For futures markets, simple information like prices level or trades volume did not exist or were kept private by traders (Saleuddin 2018, p. 281). Before any dissemination of information, the work of the economists was twofold. First, they collected data to *produce* information on the agricultural economy. Second, they *edited* that information for the practical use of market participants.

Historically, the USDA already collected data, mostly the annual production and monthly prices (e.g. USDA 1907, p. 542). From the 1910s, county

agents were in charge of locally collecting data for the Federal State. They notably interviewed farmers to fill out forms with price data that were sent to the Bureau of Statistics (Didier 2009, pp. 27–36). From 1913, the Bureau of Statistics was dispatched over other Bureaus (USDA 1914, p. 14). The Bureau of Markets, and then from 1921 the BAE, became in charge of collecting statistics on the agricultural economy. Statistics on prices and supplies progressively improved, mainly by increasing the range of goods and the periodicity of prices data. The BAE was also in charge of providing analysis of these data such as forecasts, that the Bureau of Crops Estimates (1914-1922) previously provided. Alongside this statistical work, the BAE made efforts to improve the grades and the standardization of agricultural products (BAE 1923, p. 7). This issue, discussed by the BAE during all the decade, was viewed as a mean to improve information coordination between market participants (Lenfant 2017, p. 17).

Some agricultural economists also used records from private actors, dealers, or specialized newspapers. For instance, in one of his first publications, Working collected data on the historical prices of potatoes thanks to newspapers and private dealers (Working 1922, pp. 11–12). Moreover, before the 1920s, most market participants, academics, and policy-makers did not know much about agricultural exchanges, especially futures exchanges. As a consequence, one of the main tasks of the GFA in the 1920s was to build a legal environment imposing more transparency on futures exchanges, like the Chicago Board of Trade (Saleuddin 2018, p. 165). The Grain Futures Act (1922) imposed traders to report daily or weekly information such as their net position and the number of contracts traded on the period, the quantity of goods received, or delivered (Saleuddin 2018, p. 165). For achieving such transparency, the GFA collected crucial data on futures exchanges that were necessary to understand and analyze these markets. Thereby, in 1923 the

GFA delivered their first studies about futures markets, on the prices movement, on the volume exchanged, and the features of futures traders (GFA 1924).

While they thought they were helping all market participants, the work of BAE's economists mainly targeted farmers. The BAE handed down several types of information to them like historical prices, forecasts, factors influencing prices, general agricultural economic research, farm management advises (Lininger 1929). Economic information took many forms: exhibits, posters, charts, models, moving pictures, addresses, radio talks, correspondences, press releases. These forms needed strong editorial work beforehand and the editing of such information was at the heart of many discussions on the expertise of agricultural economists: should data be sent raw or should the information be sorted by economists to facilitate the reading? Should economists only hand in data or should they interpret them and suggest forecasts? Some articles from agricultural economists directly discussed the editing of information during the 1920s (Cooper 1929; Estabrook 1923; Hart 1929; Lininger 1929; Williams 1929). Professor Lininger, an agricultural economist from Pennsylvania State College, summarized the issue as follows:

From the great mass of information available, it is possible to glean something like answers to the four abiding questions of the farmer: "What, when, where, and how shall I sell, in order to obtain the highest net price?" In other words, what do all these statistics and expert calculations mean to the farmer himself. (Lininger 1929, p. 348)

Estabrook (1923)—former chief of the Bureau of Crops estimates and associate chief of the BAE—stated that farmers should use crop reports as

material to make their forecasts, and that information should not be sorted by the USDA. He argued that even though the problem was complex farmers were able to compare today's data (either local, national, or world market conditions) with past data or averages (Estabrook 1923)⁸. Answering to Estabrook in the *Journal of Farm Economics*, Williams—a farmer stockman—stated that “they get nothing out of past movements of prices unless they can be made to see the relationship between this past movement and futures one” (Williams 1929, p. 86). Moreover, according to him, the farmers knew what kind of information they wanted and agricultural economists should edit it as requested.

On top of discussions on the collection of information, editing was subject to arguments that in the end reflected different conceptions of expertise. Another important and related issue that faced agricultural economists was the means of diffusing the information.

1.6 Diffusing information countrywide: The example of the market news service

The editing of information depended crucially on the technological support through which it was diffused. In the early 20th century, news might take days to reach the more isolated part of the country. In the 1910s, the USDA already mailed bulletins to inform farmers on weather, marketing, and management. However, these bulletins were long to produce and they reached with difficulty the farmers. Even when they did, the USDA acknowledged

⁸The simple rule was then the following: “If [the crop report indicates] more, prices are not likely to advance and may not be maintained. If less, prices are likely to advance or at least to be maintained”.

that the interpretation and application of the information was hard (USDA 1915, pp. 32–34). Hence, improving the diffusion of information was needed.

The USDA used a variety of means for diffusing the information. They worked with experiment stations’ extension services established by the Smith Lever Act (1914). Extension services aimed at “diffusing among the people of the United States useful and practical information ... in cooperation with the United States Department of Agriculture” (United States 2017, §341). The issue of diffusing market information existed before the arrival of economists inside the USDA. In 1914, the Bureau of the Secretary established an “Office of Information”, primarily to facilitate the diffusion of USDA information to newspapers. In the following year, the market-news service was established by the Bureau of Markets (USDA 1915, p. 30). In order to serve the war effort, the market-news services aimed at building a national network to diffuse information quickly countrywide. The service was composed of a central office in Washington and local offices, also called “market stations”. The market stations managed the collection and the diffusion of information at a local level. After the war, it had more than 30 permanent local offices (USDA 1919), but suffered from budget constraints the following years. However, from the mid-1920s, the BAE refunded the service allowing it to reach 50 permanent local offices in the mid-1930s. The market-news’ reports primarily focused on a few fruits and vegetables. In the 1930s, it eventually covered all the other agricultural products (BAE 1931, p. 5). The USDA worked also to collect and diffuse information on the agricultural conditions of other countries against which U.S. farmers might compete with (USDA 1927, pp. 57–58). In the early 1930s, the USDA had offices in London, Berlin, Marseille, Shanghai, Belgrade, Buenos Aires, Pretoria, and Sydney.

The market-news service used several means for diffusing information

to farmers. USDA's reports were sent to local offices and then mailed to the market participants. Economists mostly used newspapers, which remain over the period the medium with the largest audience. In particular, the USDA wrote daily or weekly columns to be published in newspapers willing to diffuse them. The market-news service also provided the agriogram, a radio broadcast. The BAE telegraphed ready-for-use reports to be broadcasted by local offices and other partners such as chambers of commerce, private radios, state colleges' extension services, and college radios (USDA 1927, p. 625). In the early 1920s, the radio network was mostly established in the North and the East of the country. Other regions (*e.g.* Nebraska, Kansas, South Dakota, Iowa, Oklahoma) were too distant with regards to the existing telegraph and radio network at the time. In the following years, the radio network expanded to central and western regions. The USDA claimed in 1926 that they broadcasted their reports in more than 80 radio stations (USDA 1927, p. 624). The USDA also advocated the use of radio in the farms. The results of their surveys showed an estimate of 145,000 sets on farms in 1923, 365,000 in 1924, while in 1925 the number estimated was 553,000.

It has already been noted that the USDA was an enthusiastic supporter of new communication technologies (Craig 2001; Wik 1988). Market conditions' and especially prices' regular changes pushed the BAE to acknowledge the relevancy of diffusing promptly these changes. For the agricultural economists inside the USDA, the radio was viewed as the best mean for diffusing information since it allowed to communicate *directly* with the farmers, *i.e.* without intermediaries. In 1923, W. A. Wheeler, in charge of the Market News Service of the USDA, promoted radio as " the only means of giving [farmers] quickly and at small cost the economic information necessary in the proper conduct of the farm business." (Wheeler 1923, p. 214).

If BAE's economists primarily worked for the benefit of farmers, it also served other market participants such as trading agencies (e.g. BAE 1926, p. 39, 1928, p. 53). Through market-news services and the others mean of diffusing information, economists viewed the BAE as the producer and the distributor of accurate information on the agricultural economy to all parties. Chief-economists of the BAE repeatedly emphasized the "unbiased" character of information they provided (BAE 1925, p. 3, 1926, p. 27, 1933, p. 13). One of the more explicit advocates of BAE's informational role was the economist Nils Olsen, chief between 1928 and 1935. He notably viewed the market-new service as an "unbiased, impartial, accurate source of information", the "eyes and ears of the agricultural markets", providing "facts in a world of rumors" (BAE 1933, p. 13). Olsen did not hesitate to claim that farmers, thanks to the radio, were "better advised than many individuals actually trading on the market" (BAE 1934, p. 7) or that the market news service was comparable in "speed and precision ... to that supplied by the ticker service in the financial world" (BAE 1933, p. 13).⁹

Inside the USDA, the GFA was the only administration interested by financial activities and this is through this institution that the discussion on information became theoretical.

1.7 Making things theoretical: The debates between the GFA and Working .

In a retrospective work of the first fifteen years of the GFA's activities, two economists in the GFA¹⁰ stated that:

⁹See Preda (2006) for a historical account on the introduction of ticker service.

¹⁰Joseph W. T. Duvel, chief of the GFA, wrote most of its reports with George W. Hoffman, an economist consultant of the GFA, who was also Professor of Insurance at the Wharton School. According to Berdell and Choi (2018, p. 543), GFA's views though have been mostly

A perfectly informed market is one in which all the participants are armed with full knowledge of past and current trade conditions. A perfectly competitive market is one entirely free from control of any sort. It is not difficult to argue that present-day markets are far from this ideal. (Hoffman and Duvel 1941, p. 70)

As soon as 1924, the GFA emphasized the danger of spurious information disseminated through private telegraph service (GFA 1924, p. 3). Following the USDA's agenda, it was clear for the GFA that improving the efficiency of future markets rested on the accuracy of information circulating through markets. For them, traders were mostly misinformed. The GFA thought that the excessive speculation from small but numerous ill-informed traders was one of the greatest threats to futures markets' stability (Berdell and Choi 2018, p. 543). From GFA's standpoint, the limitation of futures trading volume was the best way to reduce price volatility. The different reports in the 1920s and the 1930s systematically suggested limiting futures trading (*e.g.* Duvel and Hoffman 1928). In 1936, the Commodity Exchange Act reinforced GFA's power and imposed limits on open positions and daily trading (Berdell and Choi 2018, p. 551).

Conversely to the BAE, GFA's interest in information also led to academic publications. Indeed, the GFA aimed not only at preventing the circulation of misleading information, but also at measuring its effect on futures prices. GFA's economists discussed these issues in economic articles published in the *Journal of Farm economics* (Hoffman 1937; Mehl 1934, 1940). They remained convinced that futures prices departed from fundamentals and that futures traders remained mostly ill-informed. A session on futures

influenced by Paul Melh—an agricultural economist recruited in 1924 at GFA's Chicago office.

markets during the 1936 annual conference of the American Farm Economic Association discussed the capacity of future prices to forecast future conditions. George Hoffman from the GFA argued that past economists gave too much credit to the ability of futures traders to "display a superior knowledge" (Hoffman 1937, p. 308). Traders were poorly informed, and futures prices' fluctuations remained "a very random and uncertain affair" (Hoffman 1937, p. 308). Not all agricultural economists shared this view, even within the GFA, and some theoretical and empirical challenges emerged in the 1930s (Berdell and Choi 2018, p. 553).

Probably the most important figure supporting a contrasted stance was Holbrook Working. Working (1895-1985) wrote a Ph.D in Agricultural Economics at the University of Wisconsin in 1921. He then taught at Cornell University and the University of Minnesota before joining the Food Research Institute (FRI) at the University of Stanford, where he remained until his retirement. The FRI had been established thanks to the major support of Herbert Hoover (Secretary of Commerce between 1921 and 1928 and 31st U.S. President between 1928 and 1932).¹¹ The FRI was a rare example of a private institution conducting agricultural economic research (the Social Science Research Council funded by the Rockefeller Foundation was another example).

Working was in the room during Hoffman's presentation at the 1936 Annual Conference, and, if he agreed on the importance of information for futures trading, he suggested that

[current] prices, as they are determined in modern speculative markets are not so haphazard and imperfect as one may

¹¹Hoover strongly promoted the use of statistics and economics for conducting policies on commerce and agriculture; see Barber (1989)

judge from too restricted a view of the information and trading habit of individual speculators. (Working 1937, p. 310)

Already in 1922, Working suggested that traders must be well informed to find arbitrage opportunities. This was the case for geographical arbitrage—*i.e.* across local markets—as well as time arbitrage—*i.e.* between present and future prices (Working 1922, p. 6). Working did not consider that this view was antagonistic with the work of the USDA and the GFA, with whom he had a close working relationship (Berdell and Choi 2018). Working repeatedly suggested that market participants were more informed than what agricultural economists claimed. It was nonetheless only an assumption since he lacked empirical evidence. As he reminded in a letter to Paul Samuelson¹², he and the FRI supported this view since the 1930s without having “possibilities for objective testing of the validity of our impressions.”¹³ While Working’s theoretical contributions came later, the influence of USDA’s program was already visible in his earlier works. In one of his first articles, Working already acknowledged the role of BAE’s market news service in informing market participants. Moreover, he already suggested empirical consequences on the price spread:

The market news service of the United States Department of Agriculture has done much to make it easy for dealers to keep informed regarding prices and supplies in other markets ... The result is that prices in all the markets of the country are very closely related. (Working 1922, p. 6)

¹²Samuelson had been a prominent contributor to the research program on the efficient market hypothesis in the 1960s (Samuelson 1965a) and was in touch with Working in the early 1960s (Delcey 2019).

¹³Letter to Samuelson, May 2, 1961. Samuelson’s manuscripts, *Rubinstein Library*, Duke University.

In the late 1940s¹⁴, Working solved this issue—and gave a similar formulation to the efficient market hypothesis—by linking his view on information with the difficulty to forecast prices changes. This difficulty had already been acknowledged by U.S. scholars from at least the 1920s, and notably by NBER scholars (King 1930; MacCauley 1925), by Holbrook Working (Working 1934) and Alfred Cowles (Cowles 1933, 1944; Cowles and Jones 1937). While these works raised doubts on the superiority of forecasts made by professionals, Working (1949a) explicitly recommended a reinterpretation of Cowles' article by explaining that an "ideal market" speculators "would have taken full account of the information which permitted the successful prediction of the price" (Working 1949a, p. 159). Thus, "apparent imperfection of professional forecasting, therefore, may be evidence of perfection of the market. The failures of stock market forecasters ... reflect credit on the market" (Working 1949a, p. 159).¹⁵ Lately, Working interpreted trading activities as "a sort of informal division of labor in their use of available information" (Working 1958, p. 194). Trading appeared as a way to disperse scattered information and the market as the place where information is continuously processed.

¹⁴In the 1940s, most of Working's works (1942, 1948, 1949b, 1953) did not directly discuss the issue of information. During this period, he notably developed his famous concept of "price of storage" (Working 1949b). A presentation of his theory can be found in Working (1953).

¹⁵Chapter 4 presents in more detail the arguments of Working.

1.8 Conclusive remarks

While Working and GFA's economists disagreed on the accuracy of traders' information, they shared the view that information was central in the determination of future prices. Although the legacy of GFA's analysis to economic analysis has already been noted (Berdell and Choi 2018; Saleuddin 2018), we show that investigating the broader interest that USDA's economists had for information brings new insights on the history of economic analysis. Disagreements between Working and USDA's economists on the accuracy of market participants' information also emphasize the *common* belief that information was essential for the functioning of markets.

It is also interesting to note that this common belief was firstly embodied in policy-oriented rather than in academic contributions. The development of an information theory has been the last step of the story. Early economic policies led to a research program aiming at collecting and disseminating information. Then, some agricultural economists have formulated analytical arguments on the accuracy of market participants' information, and its relation to price volatility. GFA's and Working's contrasted stances can only be appreciated thanks to the prior efforts of USDA's economists to collect and distribute market information.

1.9 Conclusion to chapter 1

This chapter has reviewed the work of agricultural economists in the interwar period and their contributions to the economic analysis of financial markets. The chapter documented the construction in the 1920s of a research program within USDA to improve the production and dissemination of agricultural market information. Although Working did not work directly

on this research program, we argue that he was close to GFA's economists in charge of the regulation of agricultural futures markets.

This chapter has mainly offered a history of information. It describes how the question of information owned by agents, which was initially a political issue for the USDA, became a theoretical object in Working's hands. There is obviously room for further works to understand this period and the peculiar community that was agricultural economists. For instance, the intellectual influence of these agricultural economists, and in particular the place of American institutionalism, has been only briefly mentioned in this chapter.

This work contributes to the history of the efficient market hypothesis in two ways. First, it emphasizes the legacy of interwar agricultural economists on the analysis of futures markets. Agricultural economics was at the forefront of the research on speculative behaviors, both on the collection of data, the analysis of this data, and the regulation of futures markets. The central role of information was a collective belief shared by the majority of economists within the USDA. Their works are still visible today through the institutional devices and regulatory agencies they helped to establish, such as the Market-News Service or the Commodity Futures Trading Commission.

Second, this chapter sheds light on Working's contributions. Working recognized the reliability of investor information as early as the 1920s and 1930s that led him to formulate a version of the efficient market hypothesis in the late 1940s. His theory accounted for his observations on the randomness of financial fluctuations, and the results of other precursors such as Cowles on investors' poor performance. The chapter examines the research context in which Working has evolved. While his contributions remain original for the time, this chapter illustrated how Working's research was part of

a more general community of scholars interested in the information owned by market participants. Despite its disagreements with GFA's economists, Working had a deep respect for their work. In 1962, Working paid tribute to the data collection work that the GFA had carried out. He notably praised Duvel, the chief of the GFA, that "gave research a prominent place in the work of that regulatory body" (Working 1962, p. 434).

Working's 1962 article was one of his latest publications, in which he synthesized the research on futures markets over the previous decades. Working also discussed more recent works, such as those of Cootner (1962) or Samuelson (1957), which led to the modern development of the efficient market hypothesis. The next chapter analyses this period.

Chapter 2

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

“Lucas argues that economists will never develop models that will forecast "sudden falls in the value of financial assets, like the declines that followed the failure of Lehman Brothers in September. The reason is the efficient markets' theory, which teaches that the prices of financial assets impound the best information about their value. But Lucas's detour into efficient-market theory misses the point. The criticism (my criticism, anyway) of macroeconomists and financial economists is not that they failed to predict that the collapse of Lehman Brothers would lead to a fall in stock prices (they were already falling), but that they disbelieved in asset bubbles. (Eugene Fama, whom Lucas relies on for his remarks on the efficient-markets theory, has been explicit in his disbelief.) So they were not alert to signs that the rise in housing prices in the early 2000s was a bubble phenomenon.”

2.1 Introduction to chapter 2

This second episode studies the development of the modern formulation of the efficient market hypothesis in the 1960s and the 1970s. It is based on an article entitled “Samuelson vs Fama on the Efficient Market Hypothesis: The Point of View of Expertise”, published in *Æconomia* (Delcey 2019).

The post-war period is characterized by a profound change in U.S. economics. From the pluralism of the interwar period dominated by the old American institutionalism, the discipline gradually became mathematical and market-oriented towards the analysis of rational agents in competition (Morgan and Rutherford 1998). Moreover, the scope of economics has also evolved. To paraphrase Cherrier (2017, p. 554), U.S. economics entered the war as a science of production, oriented on the analysis of supply and its determinants, and emerged from it as a science of decision, focused on the choice of agents and their expectations.

At the same time, economic research on financial markets became more popular among economists and became professionalized within the U.S. business schools. This process of "scientization" of finance is notably characterized by the emergence of financial economics in U.S. business schools. In the general introduction (see section 0.2), I described this emergence as the outcome of a *trade-off* from business schools. On one side, teaching and research within business schools needed to be practical-oriented and easily applicable by their students who were the future businessmen. On the other side, they needed a scientific legitimacy that required the adoption of more formal and abstract methods (Fourcade and Khurana 2013).¹

¹Initially, the business schools were not specifically oriented towards economics but rather the whole range of social sciences. For example, research and teaching at the Graduate School of Industrial Administration (GSIA) at the Carnegie-Mellon Institute was characterized by its multidisciplinary nature. It was within the GSIA that Franco Modigliani and

Finance, as an object of study, was far from being legitimate among economists at that time. Some issues, which today are naturally considered as belonging to economics, were not at that time. The best illustration of this point was Harry Markovitz's recollection of a comment made by Milton Friedman during his Ph.D.'s defense in 1954. While Markovitz's Ph.D provided the foundation of what will be known as the modern portfolio theory, Friedman was skeptical about the thesis topic:

I've read your dissertation and can't find any mistakes in it. There is just one problem: this is not a dissertation in economics. We cannot award you a Ph.D. in economics for a dissertation that is not economics. It's not math, it's nor economics, it's not even business administration (quoted in Bernstein 1993, p. 60)

This legitimacy was gradually built thanks to a collaboration between the business schools and the economics departments of elite U.S. universities. Economists became involved in the management of schools and in the teaching and the training of graduate and doctoral students. It led to a first generation of financial economists.

This chapter focuses in particular on the evolution of economic expertise in the efficient markets hypothesis history. While Working and the GFA's economists are mainly interested in market regulation issues, this chapter shows how the research within the business school became primarily interested in practical issues. It contributes to describe the impact of financial economics on economics that "reorienting it away from its 'public purpose' missions and increasingly toward the needs and concerns of private firms and market" (Fourcade and Khurana 2013, p. 155).

Merton Miller, two future Nobel Prize winners, developed their famous theorem on the financial structure of firms (Modigliani and Miller 1958). Several other Nobel laureates such as Henri Simons, Lars Peter Hansen, Robert Lucas, Edward Prescott or Finn Kydland then taught or studied at the GSIA.

This chapter examines the development of the efficient market hypothesis in the light of these different transformations of the discipline. I put my focus on the interactions between economists on the one hand, and a new generation of financial economists from business schools on the other. The chapter offers a case study of this question. It compares the intellectual trajectories of Samuelson and Fama. These two authors independently developed the modern formulations of this hypothesis in 1965, and remained important players in this research program in the 1970s. In the 1960s, Samuelson was already an important character of post-war economics anchored at the MIT, while Fama was one of the leading figures in the new generation of financial economists at the University of Chicago.

This comparison thus makes it possible to observe how the efficient market research program was developed and refined in the context of the U.S. economics in the 1960s and 1970s. This chapter also investigates the legacy of Working. By analyzing an original correspondence between Samuelson and Working, it studies the direct influence of this precursor on the modern development of the efficient market hypothesis.

2.2 Introduction

The Efficient Market Hypothesis (now EMH in this chapter) 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 (Challe 2008; Vuillemeys 2013; Walter 2006). However, except for (Jovanovic 2008), historians have not investigated the emergence of this polysemy. Besides its polysemy, the EMH also carries multiple normative recommendations (Brisset 2018; Charron 2017). Indeed, the EMH has

been guiding both investors' practices (MacKenzie 2008) and policy making (LeRoy 1989, pp. 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,b) 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).²

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.*

²Apart from Fama and Samuelson, there is a substantial set of contributors to the development of the EMH in the 1960s (a few examples are Cootner (1964), Roberts (1959), and Working (1949b)). Furthermore, there are many other formal definitions of the EMH than those of Samuelson and Fama (see for instance Black (1986), Jensen (1978), Malkiel (1989), and 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 (2009a) and Walter (2013).

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.³

We first investigate the papers they both published in 1965. As mentioned previously (Bernstein 1993; Guerrien and Gun 2011; Merton 2006), 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 contributions as an answer to the questions he had raised in the 1960s and 1970s.

³This distinction is inspired by Mehrling's view (Mehrling 2005, p. 193) 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.

2.3 Fama and Samuelson's EMH: the 1965 pioneered contributions

2.3.1 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, prices behavior was represented by a random walk process.⁴ Fama investigated the issue empirically by testing the independence of changes in stock prices.⁵ 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 1965b, p. 90)

⁴See Jovanovic (2008) and Walter (2013) for a history of the random walk model in finance.

⁵It should be noted that the independence was later discarded as being too restrictive. Other tests, abusively called "random walk tests", focused on the uncorrelation in price changes (Campbell, Lo, and MacKinlay 1997). Fama's thesis also discussed the relevancy of the Alpha-Stable distribution compared to the Gaussian distribution.

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 1965b, p. 36).⁶ Fama 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 1965b, p. 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

⁶The 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 Todd in 1934 (Bernstein 1993). According to Graham and Todd, 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. 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 discounted expected dividend of companies. For a recent account see Brian and Walter (2007).

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 1965b, p. 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.

2.3.2 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 made him hesitate to publish it before 1965.⁷ In this article, Samuelson challenged the relevance of random walk to describe prices behavior in 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

⁷Merton (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)

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, p. 42)

Samuelson suggested replacing the random walk by another stochastic process, the martingale.⁸ Samuelson applied the martingale to futures prices on the commodities market.⁹

We note P_{t+T} an estimation in t of the spot price in T of a commodity. Assume that P_{t+T} is representable by a given distribution law. Now suppose a futures market for the same commodity. The price of the discounted futures contract at time t is noted $Y_{t,T}$, 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 $t + T$:

$$P_{t+T} = Y_{t,T} \quad (2.1)$$

But before the $t+T$ period, no one knows P_{t+T} with certainty. Thus, Samuelson proposed an assumption he calls “Mathematically Excepted Price

⁸That same year, Benoit Mandelbrot also described financial fluctuations by the martingale process (Mandelbrot 1966).

⁹A future is a financial contract that allows buying or selling an asset, such as commodities, at a predetermined date and quantity.

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:

$$Y_{t,T} = E[P_{t+T}|I_t] \quad (2.2)$$

Samuelson extended the arbitrage argument to uncertainty¹⁰ considering that, because of competition, investors evaluate $Y_{t,T}$ by the expected value of the random variable P_{t+T} conditionally to the market information $I_t = (P_t, P_{t-1}, \dots)$. 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 1965a, p. 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 law¹¹, a property of probability theory independent of his model, Samuelson concluded that (3) implies that the sequence $Y_{t,T}$ follows a martingale:

¹⁰This 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.

¹¹The iterative exception law can be written formally as follow: $[X|I_1] = E[E[X|I_2]|I_1]$ if and only if I_1 is a subset of I_2 (see Campbell, Lo, and MacKinlay (1997) and LeRoy (1989)). The Samuelson model says that $Y_{t,T} = E[P_{t+T}|I_t]$ so that $Y_{t+1,T-1} = E[P_{t+T}|I_{t+1}]$. Thus, using the iterative exception law, $E[Y_{t+1,T-1}|I_t] = E[E[P_{t+T}|I_{t+1}]|I_t] = E[P_{t+T}|I_t] = Y_{t,T}$

$$E[(Y_{t+1,T-1})|I_t] = Y_{t,T} \quad (2.3)$$

If a 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.

2.3.3 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 2008). Both models have also been interpreted as early developments of rational expectations in finance (see Hoover and Young (2013) and Merton (2006)). This should not belittle the strong differences between the two contributions. First, Fama and Samuelson adopted a different methodology (Jovanovic 2008; Mehrling 2005): 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: prices were characterized 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 (LeRoy 1989, pp. 1590–1591). If a future price can be interpreted as

an estimation of the expected spot price, 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.¹² 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, p. 47) and (Fama 1965b, p. 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, p. 59)

¹²While Samuelson's model gives an example of a market composed of well-informed individuals possibly implying that price follow a martingale, but it is only true under the assumption of a zero discount rate. LeRoy (1973) and Lucas (1978) later showed that the link between martingales and efficiency is not systematic.

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, p. 59)

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; Guerrien and Gun 2011; Merton 2006), 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 investigate 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 1965a, p. 48)

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

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 1965a, p. 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. 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.

2.4 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.¹³ The research at Chicago University was traditionally empirical and pro-market: the government was “the natural enemy of the market” (Mehrling 2005, p. 193). 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 2005, p. 191). 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

¹³Even 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).

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 2013, 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. In Chicago, the CGSB's reform was led by Wilson A. Wallis, dean of the CGSB between 1958 and 1962, and a close friend of Milton Friedman and George Stigler, with whom he had participated in the constitution of the Mont Pèlerin Society (Fourcade and Khurana 2013, 2017). The CGSB hired the economist Merton Miller to lead the research in finance: Miller was to be Fama's Ph.D. advisor, and was a firm pro-market advocate (Mehrling 2005, p. 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 Krueger 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 (Cootner 1964; Modigliani and Miller 1958).

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 2005). 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 character of price changes on the commodities market (Working 1934), and who has suggested an explanation close to the modern formulation of the EMH (Working 1949a, 1958).¹⁴ Samuelson himself had been in contact with Working when he was developing his martingale model.¹⁵ Samuelson was

¹⁴See Berdell and Choi (2018) for a recent account of Holbrook Working's contributions to financial economics.

¹⁵Hendrick 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

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 closer 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, a remark he shared 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.¹⁶

Houthakker to Samuelson, February 12th 1953). Houthakker also suggested to Mandelbrot to work on cotton prices and then stock prices in 1961 (Mandelbrot 1963, p. 394).

¹⁶"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)

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

2.5 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, p. 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 2005, p. 195).¹⁷ 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 2005, p. 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 implications on practices. Fama, as one of the

¹⁷“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 2005, p. 193)

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, p. 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 2005, p. 193). 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, pp. 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 U.S. 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).

2.6 From the 1965 papers to the EMH controversy in the 1980s

Beyond the 1965 papers, the above section 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 early opposition.

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.¹⁸ Beyond further contributions to the EMH¹⁹, Fama participated in the research program on the measurement of fund performance (Fama 1972a) which shows that actively managed mutual funds exhibit poor performance (Jensen 1968; Sharpe 1966; Treynor 1965). 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 1994). 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).²⁰ Samuelson was still concerned by policy making issues in his discussions of the EMH (Samuelson 1965a, p. 48, 1973a, p. 22, 1989, p. 9). In a 1973 review of mathematical tools used in finance, for instance, he emphasized the unresolved question of the social optimality of price behavior in speculative markets, mentioning Working and Keynes as holding

¹⁸For 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.

¹⁹For instance Fama (1970) and Fama et al. (1969).

²⁰The Chicago School of Business has been renamed Chicago Booth School of Business in honor of a recent donation from Booth (Guth 2008).

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, p. 3)

In the 1980s, the EMH was challenged in many respects.²¹ 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 (Poterba and Summers 1988; Summers 1986).²² 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:

[V]irtually 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, p. 634)

²¹Of course, the EMH had been criticized before, especially toward the end of the 1970s (Grossman and Stiglitz 1976; LeRoy 1976; Modigliani and Cohn 1979). However, these contributions suggested a reformulation, rather than radically challenging the EMH.

²²Among other research 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 (De Bondt and Thaler 1985) and early experimental finance (Smith, Suchanek, and Williams 1988).

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 timevarying expected returns” (Fama 1991, p. 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 related (Fama and French 1988).²³ 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.* (we emphasize Fama 1991, p. 1610)

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.

²³Fama’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).

Samuelson's view was later supported by Shiller who proposed an empirical test of Samuelson's distinction (Jung and Shiller 2005).²⁴ Samuelson remained strongly convinced that in terms of micro efficiency, the EMH was the best model for guiding investment strategy.²⁵ 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.

2.7 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 regarding 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

²⁴If Samuelson states that he has "always" used this distinction (S-ARC, letter from Samuelson to Siegel, August 1991), he used it frequently only from the 1990s onwards.

²⁵In this perspective, he has been very skeptical about promoters of market timing.

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 underline 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, p. 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.

2.8 Conclusion to chapter 2

This chapter has examined the modern development of the efficient market hypothesis in the 1960s and 1970s. By comparing Fama and Samuelson's views, my objective has been to shed light on the differences in methodology, ideology, and expertise among the economists involved in the modern development of the hypothesis. The work of Fama and Samuelson can be viewed as two distinct developments of Working's insights discussed in Chapter 1. On the one hand, Fama extended the statistical and empirical work carried out by Working on the randomness of price fluctuations and their practical implications. On the other hand, Samuelson developed Working's preliminary models of agents' expectations and perpetuated Working's more nuanced view on market imperfections.

Probably the most striking evolution between Working's analyses and those of financial economics has been the transformation of the expertise associated with the efficient market hypothesis. While Working represented a figure of the political expert, directly advising and working with government agencies such as the GFA, financial economists lost interest in these political issues. For example, Fama, who is a figure of Chicago's economists, is far from defending an explicitly pro-market view *à la* Friedman. In his contributions to the efficient market hypothesis, he remained extremely discreet on political questions (Klein 2018).

This result obviously does not imply that the influence of this hypothesis was solely limited to the world of practice.²⁶ It rather implies that the definition of expertise used in this chapter deserves to be extended to properly explain how financial economists' ideas are transmitted and potentially

²⁶For instance, the efficient market hypothesis redefined the financial fraud (Jovanovic 2018) and market regulation (Walter 2010).

amended within the public sphere. For instance, while the hypothesis of financial market efficiency is regularly associated with the process of financial deregulation, we still know very little about how this hypothesis has been transmitted, if at all, to the regulators. Beyond the explicit recommendations that financial economists made, it is necessary to study other channels through which they disseminated their ideas (Hirschman and Berman 2014; Maas, Medema, and Guidi 2019).

The last part of this chapter showed the emergence of a series of works coming from *outsiders* of the field that questioned the scope of this hypothesis. The third episode of this thesis examines the development of this research.

Chapter 3

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

Before rational expectations, a lot of people were formulating distributed lag models of expectations with a lot of free parameters. It was easy to rationalize these. Now, rational expectations just imposed that every free parameter you throw into the model is going to give you a testable hypothesis. [...] Sargent wrote a paper about the Fisher hypothesis on inflation expectations and interest rates, that the interest rate is driven by the expectation of all these future prices, which wasn't as tight as a term-structure test, and it had seemed to look pretty good for Fisher. But Sargent showed that when you impose all these restrictions implied by rational expectations, it just fails. This had a very big effect ... it seemed like, all of a sudden, instead of macro being a thing where we could write down any damn model and claim that it was consistent with the data, it turned into a field in which anything that you wrote was going to get rejected right away. So the way people were doing their testing and estimation changed a lot with rational expectations.

3.1 Introduction to chapter 3

This third episode analyses the genesis of the association between the efficient market hypothesis and rational expectations hypothesis in the 1970s and the early 1980s. This chapter is based on a working paper, entitled “The Efficient Market Hypothesis and Rational Expectations. How Did They Meet and Live (Happily?) Ever After ?” written in collaboration with Francesco Sergi.

The early 1980s are characterized by an increasing number of discussions on the status of financial economics in the discipline : (e.g. Merton 1985; Ross 1987; Summers 1985). These debates were the result of several tensions between economists and financial economists caused by a growing dissatisfaction in the discipline with the efficient market hypothesis, and with the related research agenda.

The criticisms attacked the efficient market on different but related issues. First, a growing number of studies questioned the empirical validity of this hypothesis (see the review of Jensen 1978). It is important to note that at the time, economists perceived this hypothesis as being extremely robust from an empirical point of view. This reputation had been built through the replication of tests on random walk, event studies, and fund performances. Hence, even facing the growing refutations of this hypothesis, economists were therefore far from discarding it. For instance, Jensen (1978, p. 95) famously stated that “there is no other proposition in economics which has more solid empirical evidence supporting it than the Efficient Market Hypothesis”. An illustrative example of the reputation acquired by this hypothesis was the conclusion of a study by Modigliani and Cohn (1979). In the latter, the authors argue that investors suffered from “money illusion”

and systematically undervalued equities in the 1960s and the 1970s.¹ In the conclusion of the article, the authors conceded that they had struggled to recognize the implications of their analysis, which directly questioned the efficiency of the stock market:

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 [*i.e.* the money illusion] 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, my emphasis)

A second criticism was theoretical. As mentioned in chapter 2, several works highlighted the dissonance between the ambitious questions related to the efficient market hypothesis and the answers actually provided by existing work (*e.g.* Grossman and Shiller 1980; Shiller 1981; Summers 1986). They were based on a number of distinct but broadly similar arguments: the efficient market hypothesis research program had little to say about the actual determinants of asset values.

A third and related criticism was methodological. Several economists pointed out the lack of rigor of the existing formulations of the efficient market hypothesis (Grossman and Stiglitz 1980; Lucas 1978).² A illustration of such complaints were the opening words of an article by Grossman and

¹In other words, they did not take into account the devaluation of returns caused by inflation.

²The chapter discusses further these contributions.

Shiller (1980, p. 222) on the determinants of stock prices, which attacked the fuzzy character of the “information”:

The most familiar interpretation for the large and unpredictable swings that characterize common stock price indices is that price changes represent the efficient discounting of “new information.”

It is remarkable given the popularity of this interpretation that it has never been established what this information is about.

(Grossman and Shiller 1980, p. 222)

The outcome of these criticisms has been the decline in popularity (albeit clearly not the disappearance) of the efficient market research program and the emergence of behavioral economics. The purpose of this chapter is *not* to study these further transformations of financial economics. It is rather to understand the origins of these initial criticisms. The conclusion of chapter 2 partially answered this issue. I suggested that these criticisms were motivated by the desire of *outsiders* to financial economics to reform and reorient the efficient market research program.

One manifestation of these increasing interactions between financial economics and economics has been the use of the rational expectations hypothesis, coming from macroeconomics, to redefine the efficient market hypothesis. This chapter explores the genesis and the popularization of the association between these two hypotheses. In studying the history of this association, my purpose is twofold. Firstly, it aims to study the interplay between two distinct research programs: (1) on the one hand the efficient market hypothesis ; (2) on the other hand macroeconomic research on rational expectations. Second, and in particular, it aims to understand how the popularization of this association led to restructuring the efficient market hypothesis research program in the early 1980s.

3.2 Introduction

Today, rational expectations and the efficient market hypothesis are associated, insofar as it is argued 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 a “common model”). For instance, the very popular financial economics textbook by Frederic Mishkin’s associates the two concepts as follows:³ (i) rational expectations are expectations “identical to optimal forecast (the best guess of the future) using all available information” (Mishkin 2016);⁴ (ii) asset prices should reflect expectations on future returns (*e.g.*, for stocks, the expected discounted sum of future dividends Mishkin 2016, p. 190).⁵ Therefore, market participants will converge towards an “equilibrium price” reflecting the optimal forecasting, since all prices reflecting non-optimal forecasts on returns (*i.e.* non-rational expectations) would lead to over-pricing or under-pricing of assets—*i.e.* the current price would imply higher or lower future return than that implied by “the best guess” (Mishkin 2016, pp. 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 their common origins are found in several self-produced historical narratives, *i.e.*

³A similar line of reasoning can be found in other popular finance textbooks (*e.g.* Burton, Nesiba, and Brown 2010) and in some macroeconomics textbooks (*e.g.* Burda and Wyplosz 2013).

⁴This also echoes one of Muth (1961, p. 361)’s justification for his rational expectations assumption: “information is scarce, and the economic system generally does not waste it”.

⁵This is also sometimes called the “fundamental value” or “intrinsic value”.

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 scholarship 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.⁶ The purpose of this paper is precisely to start filling this gap. Our investigation of the origins and early development of the association between rational expectations and the efficient market hypothesis should then be seen as one illustrative example of the emergence, during the 1970s, of stronger relationships between finance and macroeconomics.

Our investigation starts with an assessment of self-produced narratives

⁶An early exception is Hoover (1988, chap. 5). Hoover argues that Fama (1980) has provided an influential basis for the extension of new classical macroeconomics to finance, money, and banking. Young (2014) and Mehrling (2005) also provide similar insights on the dialogue between new classical macroeconomics and financial economists: Fischer Black—one of the pioneers of the 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).

about the origins of the association, based on historical literature and evidence (section 1). We conclude that the two concepts are more likely to be characterized as independent developments, stemming from distinct research programs. We then uncover the first instance of the association between the two concepts (section 2). We argue that Sargent (1972b) 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 to the redefinition of the efficient market hypothesis as the equilibrium outcome of rational expectations models—first by Fama (1975), then by Fama (1976b,c), and finally by Lucas (1978). These theoretical refinements represented the concluding step of a long process (which had started in the 1950s; Jovanovic (2008)), aiming at anchoring the efficient market hypothesis (and finance) into an “equilibrium discipline” proper to the field of economics.

Section 3 illustrates how the association between rational expectations and the efficient market hypothesis rapidly gained traction in the mid-1970s. The association was stabilized and took its contemporary form, both in macroeconomics and in finance. Moreover, the use of rational expectations equilibrium models favoured further developments and discussions about the definition of efficient financial markets, particularly in finance. We scrutinize two representative examples of this development: Shiller (1979, 1981) empirical test of the efficient market hypothesis, which paved the way to the literature in behavioral finance about “market valuation” ; Grossman

and Stiglitz (1980) theoretical model, which fostered the development of a literature on the informational structure of financial markets.

3.3 Self-produced Narratives and Historical Evidence

This section argues that is not trivial to identify the actual origins of the association between rational expectations and the efficient market hypothesis. We discuss some examples of self-produced narratives about the origins of the association, which are drawn from four types of contemporary (from the 2000s and 2010s) materials: (i) dictionaries (notably *The New Palgrave Dictionary of Economics*); (ii) textbooks in macroeconomics and in finance; (iii) literature reviews and surveys on the efficient market hypothesis;⁷ (iv) personal memories (interviews or autobiographies). The materials selected here are illustrative of “stabilized” or “consensual” knowledge, which play a key role in structuring, showcasing and reproducing the state of a field.⁸ From the analysis of these materials, we identify 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 provides a critical assessment based on historical literature. We point out that some claims about the origin of an association in the 1960s seems incompatible with (or at least very unlikely in light of) the available evidence.

⁷Literature 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 counterattacks (e.g. Malkiel 2003).

⁸We follow here the approach taken by similar historiographical work on “self-produced” or “standard” or “canonical” narratives (see for instance, for finance, Jovanovic (2008), and for macroeconomics, Duarte and Lima (2012) and Sergi (2020).

3.3.1 Samuelson (1965) as a Precursor of Muth (1961)

In his account of Samuelson's contribution to finance, Robert Merton (2006) claims that Samuelson (1965a)'s early formulation of the efficient market hypothesis could be seen as using (implicitly) rational expectations *à la* Muth.⁹

The historical literature on the history of rational expectations has already identified several potential "precursors" to Muth.¹⁰ Keuzenkamp (1991) discusses Jan Tinbergen (1933)'s use of expectations that would be "rational, *i.e.* consistent with the economic relationships".¹¹ Besides, Keuzenkamp refers to a wide set of authors addressing the issue of expectations and allegedly having come close to Muth's formulation: nevertheless, Keuzenkamp's list does not mention any financial economist (although Keuzenkamp refers loosely to the interest on expectations by "market analysts"). Darity, Leeson, and Young (2004) also highlight several patterns of research on expectations in the 1950s, patterns that ultimately converged, notably, in a collective volume edited by Holt et al. (1960). Young and co-authors briefly discuss also Feller (1957)'s model of speculation on perishable commodities, which featured expectations that "as in Muth ... are the predictions of the model itself" (Darity, Leeson, and Young 2004, p. 20). However, they are reluctant to consider this as entirely comparable with Muth's rational expectations,

⁹Moreover, Merton also argues that Samuelson had been disseminating the ideas of his 1965's article during the decade preceding its publication, through several talks, including one 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, p. 14). However, Samuelson claimed that he had no influence on Muth (Letter to Bernstein, 01/02/1991. Correspondence with Peter Bernstein, Box 16, 1948-2009. Paul A. Samuelson Papers, 1933-2010 and Undated. David M. Rubenstein Rare Book and Manuscript Library, Duke University).

¹⁰Research on "precursors" of rational expectations is still ongoing. Recent scholarship points out for instance the hypothesis of "ideal expectations" made by Holbrook Working (1949a, 1958)—see Berdell and Choi (2018).

¹¹Young (2014, 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)).

since, they argue, Samuelson rather relied on the (already existing) idea of “perfect foresight”, *i.e.* a form of certainty equivalence (*ibid.*). Other authors are reluctant to identify any “precursors” to Muth: as suggested by Hoover and Young (2013, p. 19), although several economists “came close” to this concept before 1961, nevertheless they “never quite capture Muth’s definition”.¹²

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. So far, available historical evidence has not highlighted any connection between finance and Muth’s own work. Darity, Leeson, and Young (2004, chap. 2 and 3) provided a rich scrutiny of all the research programs connected with Muth.¹³ 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 with this research network on expectations (Darity, Leeson, and Young 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 contradicted by other self-narratives (see section 1.4).

¹²Lucas also strongly objects 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” (Hoover and Young 2013).

¹³This 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.

3.3.2 The Efficient Market Hypothesis and its Influence on Rational Expectations Macroeconomics

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 (1965b) and other early works on the efficient market hypothesis (Ross 2008, p. 6). 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 (Ross 2008: 6)

Ross’ claim depicts a plausible chronology: 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, *New Palgrave* entries (e.g. Fischer 2008; Sargent 2008) and textbook (e.g. Blanchard 2016) do not mention any connection with finance. If there was an influence or inspiration, it is either neglected or forgotten: not only by macroeconomists but also by historical scholarship investigating the methodological and theoretical turn in macroeconomics set in motion by Lucas and Sargent (e.g. De Vroey 2016; Duarte and Lima 2012; Hoover 1988). Even the

contributions scrutinizing more closely the originating sources of Lucas and co-authors' work (see *e.g.* Da Silva 2017; Louçã 2004) do not uncover any influence of the efficient market hypothesis.¹⁴

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 development of economics, capable of influencing the discipline as a whole as well as 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, p. 34).

3.3.3 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, p. 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,

¹⁴Similarly, Sent (1998a) reports "ten stories" (or, "hypothesis") that she encountered in her investigation about the raise of rational expectations in macroeconomics: again, none of these is connected to the efficient market hypothesis or to finance.

as two “parallel developments” resulting from Muth’s work: “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, p. 195)¹⁵ 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 (Mishkin 2016: 195)

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.¹⁶ Notably, self-produced narratives arising from autobiographical accounts are contrasted on this point. While Lucas and Fama are skeptical of this connection (*cf. infra*, 1.4), Richard Roll claims that he 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” (Sent 1998b, chap. 1, fn. 7). However, historians have not uncovered any concrete element (citations, references or archives) supporting this connection, although it could be a possibility. Roll (*pers. comm.*, February 20, 2020) convincingly argues that financial economists at University of Chicago were not citing Muth’s theoretical ideas because, in the 1960s, they

¹⁵The 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” (Mishkin 2016, p. 195). Other textbooks follow the same presentation (*e.g.* Howells and Bain 2010, p. 573; Burton, Nesiba, and Brown 2010, p. 146).

¹⁶Jovanovic (2009a, p. 70) mentions for instance that Fama (1970) had been influenced by Muth (1961), although no clear explanation is provided.

were rather concerned with empirical testing of the efficient market hypothesis. This hypothesis is consistent with the current historiography about the reception of Muth's ideas. According to Darity, Leeson, and Young (2004), 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 and in Chicago. However, despite this awareness about Muth's work, the idea of rational expectations was far from being fully appreciated as a breakthrough.¹⁷ All along the 1960s, rational expectations were thus "a solution in search of a problem" (Darity, Leeson, and Young 2004, p. xi): applications of Muth's idea remained scarce, until new classical macroeconomics somehow vindicated Muth by making of him a "father figure".

3.3.4 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". This latter account is consistent with the absence (so far) of available historical evidence (citation, mention, . . .) on a connection between ideas, authors, or research programs in the 1960s.

Hoover and Young (2013, p. 22) directly asked Lucas: "When rational

¹⁷Several explanations are provided for what is, in retrospect, a surprising neglect or lack of reaction: see Darity, Leeson, and Young (2004, chap. 4-5), Sent (2002) but also Lucas's own account (Hoover and Young 2013)

expectations and the efficient market hypothesis were first connected?" Lucas's answer rather relied 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 Hoover and Young (2013, p. 11181)¹⁸

The later 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 (Roll, pers. comm., February 20, 2020; see also Sent (1998b, chap. 1, fn. 7). Sargent mentioned as well that he became aware of the work of Fama and Mandelbrot, when he met Roll at the end of the 1960s (Sargent in Sent (1998b, p. 167); Sargent (1996, pp. 17–18).

3.3.5 Rational Expectations Macroeconomics and its Influence on the Efficient Market Hypothesis

A fifth set of narratives argues that rational expectations in macroeconomics have been responsible for the blossom of the efficient market hypothesis. Robert Hall (1996, p. 42) claims that Lucas (1978)'s asset pricing model "gave structural content to the relationships alluded to in the finance literature".

¹⁸Fama confirmed Lucas's narrative (pers. comm., February 14, 2020), while Roll remains sceptical (pers. comm., February 20, 2020).

More specifically, it is Lucas's model based on rational expectations that reframed the efficient market hypothesis in general equilibrium terms:

[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 (Lucas 1978, pp. 41–42).

Stanley Fischer presents a similar 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, p. 18).¹⁹

In his entry "Efficient market hypothesis", Andrew Lo subscribes to the same narrative. After the "landmark" papers by Samuelson (1965a) and Fama (1965b), it is only "a decade later" (Lo 2008, p. 3) that rational expectations came to be associated to the efficient market hypothesis. Lo views 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 towards a full-fledged "theory of efficient markets".

The main line of this narrative (rational expectations contributed in substantiating an equilibrium concept for the efficient market hypothesis) is not

¹⁹Note 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.

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.* Jovanovic (2008) and Walter (1996)).²⁰ Therefore, 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.

3.4 The Origins and Early Development of the Association between Efficient Market Hypothesis and Rational Expectations

The discussion of alternative narratives suggests that rational expectations 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 purpose

²⁰For 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 in the U.S. and became firmly established, thanks to the work of Fama, Samuelson and others. Historians note that this breakthrough was not only analytical but also material and institutional—notably through 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, largely supported the emergence of econometrics. 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 2017).

of this section is precisely to complete and clarify how the two concepts were originally associated and how this association grown stronger.

We start (2.1) by presenting Sargent's "Rational Expectations and the Term Structure of Interest Rates" 1972(1972a) and Modigliani and Shiller (1973)'s reply to Sargent. These, to our best knowledge, are the first published articles explicitly discussing and associating rational expectations and the efficient market hypothesis.²¹ We then discuss (2.2) how this debate on the term structure rapidly found an echo in Fama (1975)'s and how this led him to reformulate the efficient market hypothesis as a rational expectations equilibrium—a reformulation which he achieved in his *Foundations of Finance* 1976. Finally, we discuss how this reformulation was taken to a further stage when Lucas (1978) disentangled the idea of efficient markets from any statistical characterization (2.3).

3.4.1 The Origins: Sargent, Modigliani, Shiller, and the Term Structure of Interest Rates

Sargent (1972b) contributed 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), Hicks (1939), and

²¹This is not to say that there were no other works whatsoever that mentioned explicitly (though incidentally) this association. Nor we argue that some unpublished works might have preceded Sargent's article. In a footnote to his 1972 seminal 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) Similarly, Laffer and Zecher (1976), which followed a line of argument very close to Sargent (1972b)'s, was probably completed in 1971 or 1972 at University of Chicago, although it was published only 4-5 years later (we would like to thank Edward Nelson, who pointed this out to us).

Lutz (1940).²² In the 1960s, the debate was reinvigorated by the blossoming of econometric testing of these theories (see in particular Hamburger and Latta (1969), Meiselman (1962), Modigliani and Sutch (1966, 1969), and Wood (1964). The main contention of the 1960s debate was the explanatory power of the so-called “expectations theory” of the term structure. The expectations theory simply states that, for 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-term 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.²³ Modigliani and Sutch also concluded, from their empirical estimations, that the expectations theory alone did not satisfactorily explain the data, while the fit of the model was considerably improved by adding an additional “risk premium” term. Sargent was not the first to investigate the term structure within the framework of efficient market hypothesis. This issue was first discussed by Roll in his PhD dissertation *The Behaviour of Interest Rates: An Application of the Efficient Market Model to U.S. Treasury Bills* (Roll 1968), which stimulated

²²See Brillant (2019) for a historical perspective on these contributions.

²³Meiselman (1962) suggested that expectations are formed through a learning process from past errors; Kane and Malkiel (1967) used questionnaires to measure directly expectations. However, they also concluded that their measurements supported Modigliani and Sutch’s hypothesis of adaptive expectations.

Sargent's research interest in this topic (Sent 1998b, pp. 33–34).

In his 1972 paper, Sargent suggested 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 1972b, p. 74)²⁴

For Sargent, the two “hypotheses” (the expectation theory of the term structure on the one hand, and rational expectations on the other hand) had one single implication, *i.e.* that the bond market was “efficient”. Following the many examples developed in the previous decade by the literature on the efficient market hypothesis, it was straightforward to test this outcome: in short, both hypotheses would be corroborated if forward interest rates were proven to follow a martingale.²⁵

Sargent followed the same argument than Samuelson (1965)'s model about the relation between spot and futures prices in commodities market. The spot one-period interest rate R_t could be represented by a probability

²⁴Sargent credited, in a footnote, (Roll 1968) and (Fama 1970) for devising the expression “efficient market”. It could also be argued, although this was not explicit in the article, that Sargent was inspired by 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.

²⁵Sargent (1972b, p. 75) credited Samuelson (1965a) for the martingale model, and Roll (1968) as the first having tried to test the distribution of interest rates—indeed, the efficient market hypothesis was mostly tested, along the 1960s, on stock market data.

distribution. The expectation theory implies that the current forward interest rate for a future period (that we note F_t^{t+j} , a forward interest rate determined at t , for a bond maturing at $t + j$) should be related to the expectations of the spot interest rate in this future period R_{t+j} . If we then assume that expectations about R_t are rational, then the expected value of the spot interest rate should be equal to the forward interest rate, conditionally to the available information I_t :

$$F_t^{t+j} = E [R_{t+j}|I_t] \quad (3.1)$$

It results from this equation and the iterative expectations law (see Campbell, Lo, and MacKinlay 1997) that that the F_t^{t+j} is a martingale:

$$E [F_{t+1}^{t+j}|I_t] = F_t^{t+j} \quad (3.2)$$

However, Sargent's estimations rejected this martingale property, and therefore the efficiency of the bond market. Nevertheless, Sargent was 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 clarified how he did 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 were "arbitrary", *i.e.* they did not rely on any theoretical justification (Sargent 1972b, p. 94). Abandoning rational expectations was equally unacceptable: to Sargent, this would entail violating the non-arbitrage condition (embedded in the expectations theory), since "non-optimal" (*i.e.* non-rational) expectations would result in unexploited profit opportunities (*ibid.*).

Shiller (1973b) wrote a first comment about Sargent (1972b); then came a

longer answer by Modigliani and Shiller (1973).²⁶ First, Shiller and Modigliani acknowledged that the discussion could be framed as a test of the “efficiency” of the bond market, following the literature in finance. Secondly, they accepted the idea that, in the context of an efficient market, expectations should be “optimal forecasts” or “best guesses”. However, Modigliani and Shiller considered that “extrapolative expectations” *did abide by this definition* (i.e. that expectations based on a weighted sum of past rates did minimize the prediction error for future rates).²⁷ Sargent’s negative result about the martingale, they argued, indicated precisely the importance of *past* rates (Modigliani and Shiller 1973, p. 29). Second, they suggested that past inflation rates represented a relevant variable to predict long-term interest rates. This argument was already formulated in Shiller Shiller (1973b, p. 16) and was inspired by Modigliani and others’ work for the FRB-MIT-Penn Econometric Model (Acosta and Rubin 2019, pp. 478–479).

²⁶It was natural to Shiller to enter in this debate, since his PhD dissertation was on the “Rational Expectations and the Structure of Interest Rates” (1969-1972, under Modigliani’s supervision at MIT) and Sargent was his colleague at University of Minnesota from 1972 on. Moreover, it is important to note that Shiller (1973b) and Modigliani and Shiller (1973) mostly relied on two ideas developed in Shiller (1972)’s dissertation.

²⁷In Shiller dissertation, the main model represented the interest rate for the n-period (long run interest rate) as equivalent to a linear combination of the future one-period rates, which are “forecasted on the basis of any subset of the forecasting variables used by the market plus an error term”. This meant that the relation forecasted by the econometrician could rely only on a subset of what was used by actual market participants. Typically, such subset would include only past one-period interest rates (Shiller 1972, pp. 36–39). Despite this asymmetry between the econometricians and market participants, the forecast obtained was proven to be “optimal” (in a least-square sense; Shiller 1972a.: 12-14). The idea that there was an asymmetry between the information used by the econometrician and the information used by economic agents was obviously in contrast with the usual definition of rational expectations in Muth and in new classical macroeconomics. However, Shiller did not discuss this latter issue in his dissertation (which, for instance, contained no citation of Muth’s paper).

3.4.2 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 1975).

Sargent also indirectly replied to Shiller and Modigliani's arguments in "Interest Rates and Prices in the Long Run: A Study of the Gibson Paradox" (Sargent 1973). The main point of contention between Sargent and Modigliani-Shiller was the role of inflation in the determination of long-term interest rates.²⁸ First, Sargent argued that inflation rates (or inflation levels) were not a relevant variable for predicting interest rates. Such relation, as estimated by Modigliani-Shiller, relied on the idea that inflation rates causally determined interest rates: for Sargent, on the contrary, causality was "two-way", hence the two variables were "mutually determined" (Sargent 1973, p. 447), as he had already argued in previous work (Sargent 1969, 1972a). Second, Sargent supported again that past interest rates do not follow "naive extrapolations of past rates" à la Modigliani-Shiller.²⁹ As a conclusion, Sargent followed a line of argument built around the idea of "efficient market": past inflation rates should not contain any relevant information about future rates. the expected inflation rate should be already incorporated in the current nominal interest rate (Sargent 1973, p. 447).

Fama entered the debate on the term structure, first with "Short-Term

²⁸The so-called "Gibson paradox" points precisely the empirical positive correlation between the price level and the interest rate contradicting the predictions of the quantity theory of money.

²⁹To make his point, Sargent criticized the older explanation of the Gibson Paradox based on Fisher (1930), which served as underlying base for Shiller (1972, 1973b) and Modigliani and Shiller (1973).

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 was to investigate to what extent current interest rates (spot and forward) could be econometrically predicted by past inflation rates and past interest rates, which would be “inconsistent with a well-functioning or efficient’ market” (Fama 1975, p. 269).

Nevertheless, we argue that the importance of 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 (see *e.g.* Jovanovic 2008). However, in these (and subsequent) contributions, the definition of the equilibrium concept underlying an efficient market was rather elusive. Fama (1965b, p. 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” (Fama 1965b, p. 36). In further refinements, Fama (1970, p. 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). 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).³⁰ In Fama (1975, pp. 270–271), the notion of “best estimate” on future returns was reformulated for the first time following Muth’s definition of rational

³⁰Fama (1976a) also used this new formulation to answer LeRoy (1976)’s criticism of Fama (1970)’s definition of the efficient market hypothesis.

expectations. The “best estimate” of future real interest rates was the mathematical expected value given all the available information, and it was interpreted as market participants use the correct conditional distribution to form their expectations’.³¹ As in Sargent (1972b, 1973), this implied that past inflation and past interest rates had no predictive power on current interest rates, which can be tested empirically by proving that interest rates follow a martingale.

3.4.3 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 set his article as a contribution to finance and to the literature on the efficient market hypothesis. In this respect, he connected both his result and his assumptions to Fama *and* Muth:³²

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, p. 1429)

In his model, Lucas discussed the dynamic properties of 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

³¹ However, Fama did not explicitly refer to Muth; nor did he use the term “rational expectations”.

³² Like Sargent (1972b), Lucas (1978, 1444, fn. 10) also explicitly referred to Samuelson (1965a)’s formulation of the efficient market hypothesis as a martingale. Lucas also referred to LeRoy (1973)’s refinement of Samuelson’s model.

“claims on part of the output”, which is produced exogenously (*i.e.* with no inputs) by one among a large number of heterogeneous firms. Households (which were assumed identical) can purchase assets in a “competitive stock market”. The problem set by Lucas was thus to determine the price sequence for assets and the produced good, assuming that such prices were market clearing prices (*i.e.* the prices for which, at each period, households consume all the current output of the economy and they hold all the existing assets). Lucas’s result was that the equilibrium asset prices might either follow a martingale process, or they might not. In other words, the statistical characteristics of a sequence of prices was not a *sufficient* condition to draw inference on “efficiency” of markets:

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 characteristic (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, 1944, Lucas’s emphasis)

A more explicit claim about the *intentions* of the paper was to be found few lines later, where Lucas clarified 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, p. 1944)

The bottom line of Lucas’s paper was therefore that efficient markets were rather characterized by the equilibrium nature of asset prices (based

on rational expectations) than by any particular form of their statistical distribution.³³ We can therefore interpret Lucas's methodological ambition as pushing finance further towards 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 (Jovanovic 2008, see *e.g.*) of "anchoring" the efficient market hypothesis, as a field of research, into a theoretical "rigorous" concept of equilibrium" and into a practice of mathematical modelling.

3.5 Stabilization of the Association and Challenges to the Efficient Market Hypothesis

The previous section illustrated how the association between the efficient market hypothesis and rational expectations had originated and developed. Starting from 1975, several new applications of the association to other topics flourished—for instance, applications to the determination of the exchange rate (Dornbusch 1976; Fama 1984; Niehans 1975). Surveys (*e.g.* Jensen 1978; Kantor 1979), books (*e.g.* Mishkin 1983; Sheffrin 1983) on both rational expectations and the efficient market hypothesis started to routinely associate the two concepts. One example is Steven Sheffrin's *Rational Expectations* (1983), a detailed exposition of the rational expectations literature, in which the efficient market hypothesis was viewed as an application of rational expectations to financial issues.³⁴ Sheffrin's exposition already matched

³³Similar arguments were raised later by Sims (1980)'s working paper "Martingale-Like Behavior of Prices."

³⁴Sheffrin argues that by the time he was writing his book, the association "was widespread. We often would talk about using regression models for rational predictors, so that the error terms in prediction were orthogonal to the regressors. For efficient markets,

Hypothesis

with the modern textbook presentation of the association between the two concepts (cf. Introduction).

The association remained very much in the background of new classical macroeconomics, which implicitly or explicitly assumed efficient financial markets until very recently (*e.g.* Vines and Wills 2018). Conversely, the association has been at the centre of new research programs in the field of finance. In this section, we discuss two examples of these new developments: Shiller's test of volatility and the Grossman-Stiglitz paradox. A shared and somehow paradoxical characteristic of these works is that they did not *reject* the association of the two concepts *per se*; conversely, they *embraced* it in order to criticize standard formulations of the efficient market hypothesis. Thus, these new research programs also contributed to further popularize the association between rational expectations and the efficient market hypothesis.

From the perspective of the broader dialogue between (macro)economics and finance, the research programs discussed below are also representative of the moving boundary between the two fields (Ross 1987; Summers 1985). These research programs were mostly raised by outsiders to financial economics; that is, scholars mostly trained in economics departments in the 1970s, and not in finance departments in business schools (Fourcade and Khurana 2013). Moreover, these scholars used more intensively theoretical models to address topics in finance (in particular, though not exclusively, rational expectations equilibrium models to address market efficiency). Although sophisticated empirical analysis remained highly fashionable in finance, this shift towards a more formal and theoretical approach echoed Lucas (1978)'s methodological ambition.

the regressors' would include publically available information. We realized that rational expectations was a deeper, model based concept but some of its immediate implications applied to efficient markets." (Sheffrin, pers. comm., February 14, 2020)

3.5.1 Shiller and the “Anomalies” of the Efficient Market

Hypothesis

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). The formulation of efficient market hypothesis based on rational expectations became the benchmark, against which “anomalies” of market efficiency were detected (see for instance, Jensen 1978: 95).³⁵

The perhaps most illustrative 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” (Shiller 1979) and “Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?” (Shiller 1981).³⁶

Shiller’s methodology for testing the efficiency of the bond market was original, insofar it did not start, as in the past literature, from a statistical assessment of the random character of the interest rate. Conversely, Shiller began with developing a simple class of linear rational expectations models of the long-term interest rate. As such, the current (t) long-term interest rate (R) for a bond maturing at time (n) (R_t^n) should be equal to the present expected value of the sum of one-period interest rate (r_t) :

$$R_t^n = \frac{1 - \gamma}{1 - \gamma^n} \sum_K^{\gamma^K} E_t(r_{t+K}) \quad (3.3)$$

with γ the inverse of the discount factor.³⁷ Shiller notes then that long-term

³⁵Note 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 with tests about “above-average profitability” (Summers 1986, pp. 591–592) or “excessive volatility” (cf. Shiller *infra*).

³⁶For the stock market, (Porter 1981) provided similar results to Shiller’s (1981).

³⁷The original version of the model also included a constant liquidity premium, which was omitted here for sake of simplicity. As the reader will note, the core of Shiller’s formalisation was simply a rational expectations version of the expectations theory of the term structure, precisely as suggested by Sargent (1972b).

Hypothesis

interest rates, as defined by the above equation, could be computed using observed short-term interest rates (r_t^*) and assuming a value of $\gamma = 0.98$. Such “ex-post rational rates” are:

$$R_t^{n*} = \frac{1 - \gamma}{1 - \gamma^n} \sum_K^{n-1} \gamma^K (r_{t+K}^*) \quad (3.4)$$

When comparing the series of ex-post rational rates above with the actual (observed) series of long-term interest rates for 1966-1977, the discrepancy between the two plots became apparent: the actual rates were much more volatile than the ex-post rates predicted by the rational expectations model (Shiller 1979, Figure 1 and Figure 2). This disqualified an explanation of long-term rates as the “averaging implicit in rational expectations models” of short-term rates (Shiller 1979, p. 1192). Although the integration of “new information” into expectations could eventually justify the observed volatility, Shiller argued that it was unlikely that such “new information” would appear that often, and that long-term rates seemed rather “disturbed by transient effects unrelated with expectations” (Shiller 1979, p. 1214).

Shiller’s paper ended with a statistical analysis of the discrepancy between the ex-post rates and observed rates. Notably, Shiller introduced for the first time a set of zero-covariance restrictions on observed long-term and short-term rates, in order to test the efficiency. These restrictions were violated by data. This casted further doubt on the efficiency of the bond market, since non-null covariance implied “forecastability” of rates, contradicting the efficient market hypothesis.

Shiller (1981) extended this reasoning to the volatility of stock prices: he highlighted how the observed volatility of these prices seems inconsistent with a rational expectations model which expressed the equilibrium price

of stocks as their expected returns (measured as the ex-post observed dividends). As for bonds, the excess volatility of the observed stock prices was combined with a violation of zero-variance restrictions, therefore implying the existence of profit opportunities (Shiller 1981, pp. 423–424).

Several other contributions (*e.g.* De Bondt and Thaler 1985; Poterba and Summers 1988; Summers 1986) followed up on Shiller’s idea—although with different angles.³⁸ With respect to 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. For instance, Shiller used the association to address the same issue of term structure of interest rates he addressed without the association ten years before. However, on the other hand, based on these tests, these works 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, p. 424). Price valuation became indeed the central issue for the rise of behavioral finance (De Bondt and Thaler 1985; Shiller 1984). This entailed, precisely, the development of several explanations of asset prices determination, all relying on assumptions about individual behavior that clearly departed from the optimizing rationality implicit in the

³⁸Summers and Poterba focused on the mean-reversion phenomenon, as further evidence of possible misvaluation of assets prices. De Bondt and Thaler focused on market “over-reaction” (*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 (1586 Fama 1991; Shiller 2003, pp. 84–90).

rational expectations hypothesis.

3.5.2 Grossman and Stiglitz's Paradox

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. A different research path result from a more theoretical and logical criticism. One example is the literature on "rational bubbles" (Blanchard 1979; Blanchard and Watson 1982; Tirole 1982, 1985). Like the new research program on price valuation, the literature on rational bubbles illustrated that, within rational expectations models, asset prices' could depart from their efficient price—although this literature was rather interested in rigorously formalizing bubbles than in supporting or criticizing a particular assumption on rationality (Tirole 1985, p. 1180).

Another example of this line of theoretical or logical criticism is the new literature in finance which used rational expectations as a benchmark to model and discuss the circulation of information in financial markets. The seminal paper for this line of research was Grossman and Stiglitz's "On the Impossibility of Informationally Efficient Markets" (1980), famously rebranded the "Grossman-Stiglitz paradox".³⁹ The model developed by Grossman and Stiglitz relied explicitly on Lucas (1972) incomplete information model (a seminal model for new classical macroeconomics) in which expectations are formed rationally in the sense of Muth. Grossman and Stiglitz used Lucas's model to investigate if efficient prices (*i.e.* "prices reflecting all available information") were a property of a rational expectations equilibrium model (Grossman and Stiglitz 1980, p. 383).

³⁹Note that the paper draws on the authors' previous work on the role of information in determining market equilibrium (*e.g.* Grossman and Stiglitz 1976).

Grossman and Stiglitz's model described a market featuring two types of individuals: "informed traders", who have acquired, at a fixed cost, information on the future returns of a financial asset; and "uninformed traders", who have decided not to pay for information. The latter, from observing the asset price on the financial market, can only *infer* (with no cost whatsoever) information about future returns. However, this inference is not perfect: even if the asset price reflects some of the information about information about future returns (acquired by informed trader), the price also reflects noise generated from a stochastic component.⁴⁰ Market participants will acquire information only if its marginal cost is less than its expected utility, that is, the profits they are expecting from the financial asset. The equilibrium (*i.e.* the absence of profits opportunities) occurs when the expected utility of the informed traders equals the expected utility of the uninformed traders. If the expected utility of informed traders is greater than those of uninformed traders, then some of the uninformed traders switch to the informed traders group. If the population of informed traders increases, their expected utility decreases since (a) the relative gains of informed traders on uninformed traders decrease. Furthermore, (b) if the population of informed traders increases, an information has greater impact on price (relatively to noise) and then more information is available to the uninformed.

After proving the existence of an equilibrium of this economy, Grossman and Stiglitz investigated notably the case where the price "fully reflect all information" as defined by the efficient market hypothesis. Their model showed that, if the price "fully reflect[s] all information" and information is costly, then the market collapses. Indeed, since the price reveals all the information, informed traders would stop paying for this information. Since all

⁴⁰In the Lucas (1972)'s analogue model, agents observing individual prices could not distinguish changes in relative prices from changes in nominal prices.

traders behave identically, they should then all become uninformed; however, if all agents are uninformed, there is then a profit opportunity for those that would decide to purchase information. Hence, Grossman and Stiglitz showed that freely available information is not only a *sufficient* condition for the efficient market hypothesis to hold, but that it is a *necessary* condition. However, if the information is freely available, then, the authors argued, financial markets and competitive prices become purposeless, since their role should be precisely to convey information.

Grossman and Stiglitz did not aim at challenging the efficient market hypothesis, although they did want to redefine it under less restrictive conditions (incorporating inefficiency and costly information). Their attempt to redefine the efficient market hypothesis is of much interest to the conclusions of our paper, insofar as it was based on a rational expectations model. This contributed to the development of a new literature analyzing the information transmission in financial markets: see, for instance, the no-trade theorems (Tirole 1982) (Milgrom and Stokey 1982; Tirole 1982), the noise traders (Black 1986; De Long et al. 1990), and the issue of information aggregation (Hellwig 1980; Diamond and Verrecchia 1982; Admati 1985; Kyle 1985). In this literature, the efficient market hypothesis was not taken as a theory subject to empirical test, but rather as a premise since these works analyze the idea that price incorporates information.

3.6 Conclusive remarks

This article investigated the theoretical origins and early development of the association between rational expectations and the efficient market hypothesis. The history of the association illustrated the moving boundary

between macroeconomics and finance. The contributions we have scrutinized certainly showed a stronger relationship between the two fields that emerged throughout the 1970s, though further research should characterize more precisely this relationship.

Beyond the analytical aspects of the association, some scholars used it to make a point about economic policy. For instance, (Mishkin 1978, 1983) relied on the literature on the efficient market hypothesis to support the new classical proposition about “policy ineffectiveness” and the new classical critique of large-scale macroeconomic models (Lucas, 1976):

efficient-markets theory implies that the macro-econometric models currently used for policy analysis and forecasting are deficient in a fundamental way. (Mishkin 1978, p. 709)

Moreover, Mishkin argued that large-scale macroeconomic models assumed that monetary policy affecting money supply will thus affect the short-term interest, which, in turn, will affect long-term interest rate (through term structure). Henceforth, if the bond market was efficient, predictable monetary policy would have no effect on interest rates, since the information about current and future expected monetary policy would be already incorporated in current rates. Following Lucas (1972), Mishkin claimed that discretionary monetary policies were then ineffective or counterproductive.⁴¹

It should be noted that not everyone agreed about the way the relationship between macroeconomics and finance led to this kind of conclusion on economic policy. Modigliani picked up directly on Mishkin (1978)’s use of the efficient market literature, which he bluntly rejected as “unwarranted”

⁴¹In a similar vein but in a different context, Lucas used examples from the efficient market literature to illustrate his position on economic policy, during a speech given in March 1977 and organized by Mitchell, Hutchins Inc., a Wall-Street-based financial firm (Box 39, Folder Mitchell, Hutchins Conference. Robert E. Lucas Papers, 1960-2011 and undated. David M. Rubenstein Rare Book and Manuscript Library, Duke University).

and “based on confusion” (Mishkin 1978, p. 757). The case of Samuelson is another illustrative example of this disagreement. Samuelson (1965b)’s theoretical work on efficient markets (rather than Fama 1965) constituted the backbone of the rational expectations models of asset markets developed by Sargent (1972b) and Lucas (1978). However, Samuelson strongly rejected any association between his formulation of the efficient market hypothesis and rational expectations supported by new classical macroeconomics (Boianovsky 2020).⁴² Samuelson considered that those ideas were relevant only to financial issues, and even more particularly to the assessment of actual investment strategies (Delcey 2019). These two examples illustrate how the disagreements about the association were entangled with more than theoretical issues, and notably with economic policy issues.

These debates might be related to the asymmetrical influence of the association on, respectively, finance and macroeconomics. As we have shown in section 3, the association between rational expectations and the efficient market hypothesis had driven fruitful research programs in the field of finance, in particular by questioning the conditions under which financial markets might be deficient. We suggested that, by contrast, the influence of the association on macroeconomics research appears as less fruitful. Macroeconomics seems to have implicitly relied on the efficient market hypothesis to describe the functioning of financial markets and their impact on macroeconomic variables, at least until the very recent discussions about financial stability following the great financial crisis.

⁴²“It is a mistake, albeit a common one, to believe that the hundreds-of-thousand bit of evidence that bear out market microefficiency thereby lend credence to the macroefficiency arguments that go under the fancy title of the School of Rational Expectations (the “new Classical School” of Robert Lucas and Thomas Sargent [...])” (“The Morning After”, speech at NYU, 20 October 1987. Speech and Interviews Series, Box 121, Paul A. Samuelson Papers, 1933-2010 and Undated. David M. Rubenstein Rare Book and Manuscript Library, Duke University).

3.7 Conclusion to chapter 3

In this third episode of the history of efficient market, I have studied the transformations of this research program in the 1970s and early 1980s. This chapter has traced the origin and popularization of the association between the efficient market hypothesis and the rational expectations hypothesis.

The contribution of this chapter is twofold. First, it suggests that the two hypotheses were developed independently in the 1960s. It is indeed difficult in the present state to document the influence of one of the research programs on the other at that time. This first result, far from being definitive, calls rather for further research on the question. For instance, while section 1 of this chapter does not point to any precise interaction between Samuelson (1965a) and Muth (1961), both articles use a no arbitrage argument to justify their rational expectations models: departure from their model would imply profit opportunities that speculators may exploited. Both arguments, besides being similar, use the argument at the heart of modern financial theory: no arbitrage (Mehrling 2016). There is room for further work for understanding the increasing used of arbitrage arguments in economics.⁴³

In addition, I highlighted the important influence of macroeconomics on the research agenda of the efficient market hypothesis. The contributions of Shiller (1979, 1981) and Grossman and Stiglitz (1980) that reformulates the efficient market hypothesis are two important examples. If these contributions challenged the efficient market hypothesis, they were using rational expectations models inspired by the new classical macroeconomists (Lucas 1978; Sargent 1973). This chapter certainly does not account exhaustively the important evolution of this period. For instance, this chapter has ignored a

⁴³Moreover, it can be noted that both applied their models to describe price movements in agricultural markets: Samuelson's, as we already saw in chapter 2, following Working's view and Muth discussing the Cobweb theorem (Ezekiel 1938).

set of fundamental contributions in asset pricing at that time (e.g. Harrison and Kreps 1979; Harrison and Pliska 1981; Ross 1976; Ross 1978).⁴⁴ Moreover, the analysis ended before the emergence of behavioral finance, and thus has ignored the study of this clash between the efficient market and this new research program. On this matter, I showed the redefinition of the hypothesis around the notion of rationality, which will be at the heart of this opposition. Since then, departures of price behavior from rational expectations became a new way to define informational inefficiency.

⁴⁴See Chiapello and Walter (2016) and Walter (2015) for a recent account and its link to the efficient market research program.

Chapter 4

When Efficient Market Hypothesis Meets Hayek on Information: Beyond a Methodological Reading

Science is a continuation of common sense, and it continues the common-sense expedient of swelling ontology to simplify theory.

(Quine 1951, p. 45)

If market efficiency, in Fama's sense, had been only an empirical proposition, i.e. the formulation of a contingent property, it would certainly not have had the posterity it has had. What has made the efficient market hypothesis such an innovative and widely used tool is not what it states about the contingent prices observed in a market, but the interpretation of the prices it allows.

(Vuillemeys 2013, 35, my translation)

4.1 Introduction to chapter 4

This fourth episode offers a methodological examination of the efficient market hypothesis and its links with Hayek's information theory. It is based on an article written with Nathanaël Colin-Jaeger, entitled "When efficient market hypothesis meets Hayek on information: beyond a methodological reading" published in the *Journal of Economic Methodology* (Colin-Jaeger and Delcey 2020).

Since the emergence of behavioral finance, the efficient market hypothesis is less and less viewed as a testable hypothesis. Indeed, rather than a conflict between two theories, this opposition is better understood as an opposition between two research communities who come together around common assumptions, theories, methods. This underscores another ambivalence in the concept of market efficiency. Apart from having many formulations, the very scientific function of this concept is not very well defined. For some scholars, the concept is viewed as a hypothesis that should be tested by the data, for others as a paradigm that needs to be replaced (Fama 1998; Shiller 2003; Thaler 1999).

Works in methodology of economics already tried to clarify such issue. Market efficiency has been characterized as a *scientific research programs* in the spirit of Lakatos (Challe 2008; Schinckus 2009; Vuillemeys 2013). Lakatos (1976, p. 241) defines a research program as a network of scholars gathered around a *hard core*, that is, a set of premises that scientists consider to be irrefutable but which encourages to work on set of auxiliary hypotheses, which he calls the *protective belt*.

From this perspective, stating that "prices fully reflect all available information" is not an hypothesis that might be submitted to empirical testing. It is rather an assumption belonging to the *hard core* that allows financial

economists to define, implicitly or explicitly, prices as entities reflecting information (see in particular Vuillemeys 2013). Hundreds of empirical studies have been conducted on the basis of this definition. For example, in Chapter 3, I mentioned an article by Fama (1975) which associates the efficient market hypothesis with rational expectations. Another fundamental innovation from this article is Fama's interpretation of interest rates. Whereas econometric research of that time interpreted the nominal interest rate as the variable to be explained by the expected inflation rate, Fama proposes to interpret the nominal interest rate as the *explanatory* variable for predicting future inflation rate.

Such approach is only possible if the interest rate observed on the markets is interpreted as a price incorporating all available information (on the real interest rate and expected inflation).¹ This new interpretation of the interest rate was not discussed in depth by Fama, who focused on econometric issues, as did the numerous works adopting his approach (Mishkin 1990; Campbell 2014, p. 16). This example underlines a feature of the efficient market hypothesis that is often overlooked, namely that beyond *explaining* the formation of asset prices by information, this concept offers, first of all, a new *definition* of price. From this point of view, the idea that "prices fully reflect all available information", is *not* a testable hypothesis, but rather a fundamental assumption that allows the development of other hypotheses, which are in turn submitted to empirical verification.

This chapter proposes to study this interpretation of the price in greater details. Because information is central to this research program, it is common for economists to compare the efficient market hypothesis with Hayek's

¹Vuillemeys (2013, p. 42) gives the example of studies that estimate probabilities of default from the price of *Credit Default Swap* (CDS). Here again, such a study is only possible if and only if one assumes that the CDS price reflects information on the quality of the borrowers.

work on information (e.g. Grossman and Stiglitz 1976; Vives 2008). The latter is notably the author of a theory in which markets are interpreted as an institution whose social role is to aggregate the dispersed information of individuals in a price system. Hayek is not only known for formulating this interpretation of the award, but also for having discussed its conceptual foundations and implications. The objective of this chapter is to analyze the consistency of the efficient market hypothesis with Hayek's theoretical framework. The purpose of this comparison is, above all, methodological. This chapter does not intend to discuss the historical interactions between Hayek and financial economists or precursors such as Working. By making the efficient market hypothesis interact with Hayek's theory, my ambition here is to discuss the definitions of concepts associated with this hypothesis like the definition of price, market, and information.

4.2 Introduction

One of the most important tenets of neoliberalism² is defined as the fact that the market "posits to be an information processor more powerful than any human brain" (Mirowski and Nik-Khah 2017, p. 54). Therefore, neoliberalism is deeply linked with the concept of information.

In this perspective many authors underline that Hayek introduced a shift in economics and politics with the introduction of the notion of information (Grossman and Stiglitz 1976; Hirshleifer 1973; Mirowski and Plehwe 2009; Vives and Wills 2018; Vives 2014), and draw a comparison with other theories, especially Efficient Market Hypothesis (EMH) in financial economics, which use information in order to characterize assets prices formation. The

²The term is highly controversial in the scholarship. However, we do not intend to use it negatively here, contrary to the major tendency in the late publications (Boas and Gans-Morse 2009), but above all descriptively.

comparison, between Hayek and EMH, appears to be of the utmost importance since finance is also one of the main elements defining neoliberalism (Cahill and Konings 2017; Fourcade Gourinchas and Babb 2002; Krippner 2005; Lévy and Duménil 2014).

In this paper, we compare Hayek's theory of price and the work of Eugene Fama and Holbrook Working pioneer contributions on EMH.³ The comparison is, at first sight, relevant: the concept of information is central in the works of Hayek, Working, and Fama, where information is the set of all relevant data for the action of individuals. EMH's theorists and Hayek use the system of prices as the way to centralize information while there can be no central planning by an individual. It could then be said that the theory of efficiency formulated by Fama (Fama 1965a,b, 1970), when prices incorporate all the relevant information, is a restatement of the theory of price we can find in the work of Hayek. One may also point out the similarities in terms of consequences: Hayek and Fama defend the deregulation of the market.

While this intention appears considerable in its consequences little attention has been paid to the testing of this comparison. Most assimilations remain superficial, non-systematic or underdeveloped. For example, Vivès, in his classical book on information and learning in markets, just asserts that: "Hayek's ideas are the basis for the rational expectations models that explain how rational agents make optimal inferences from prices, and other public statistics, about the relevant parameters about which they are uncertain" (Vives 2008, p. 2) is raised by those who see Hayek as the inspiration of everything that is often vaguely called neoliberal.

But these sorts of assimilations, that draw a direct and an unquestioned

³It is difficult to reduce the Efficient Market Hypothesis to only few names given the number of contributions to this research program (Jovanovic 2008). The introduction of Section 3 justifies our choice to select Fama and Working's works.

line between Hayek and the more recent models using rational expectations, raise several issues. For instance, Hayek, as a systematic author, developed a particular social philosophy and philosophy of economics. How can we compare him with authors who do not have the same range of analysis and a different methodology? It is well accepted now that a lot of similarities between Hayek and other authors, for example, authors from the Chicago School, are mostly superficial (Butos 1985; Hoover 1992; Mougeot 2009; Zijp 1990).

Boettke and O'Donnell (2013) highlighted the particularity of Hayek's position as a representative of the Austrian tradition, which highly differs from the position of the American school—which is Fama's school⁴—especially on the question of formalization. Some authors on this subject even wrote about two different paradigms (Audier 2013), highlighting the very particular position of Hayek in the economic field.

Our aim in this paper is to develop the comparison between Hayek's theory and the development of EMH in finance—through the works of Working and Fama—in order to justify the lineage between these prices theories while taking into consideration their important differences. The concept of information initially called knowledge in the work of Hayek will be the central theme of our analysis.

This comparison raises several problematic issues. For instance, it is well-known that the respective position of the selected authors evolved through time (see for instance Vestuti (2004) for Hayek and Berdell and Choi (2018) for Working). We will thus compare one formulation of Hayek and of the EMH. Hayek's position is formulated in several articles from 1935 to 1946, the EMH position is the standard view in the literature. This main focus

⁴We use these distinctions between schools following other scholars, such as Caré (2016), that provided a typology of schools in economics.

on analytical matters to the detriment of historical acuity calls for further investigations, see Section 4.1 on this problem.

The thesis of this article is thus to show how bridges can be built between Hayek's theory of information and the concept of information that we find in the works of Fama and Working. We then acknowledge the literature that emphasizes the importance of the effective differences between Hayek and other corpuses, but we show that the similarities are hidden beyond methodological differences, often not noticed by the authors defending the continuity between Hayek's and EMH's views. Indeed, these authors share the same conception of information, broader than scientific knowledge, which leads them to the same conception of market and competition. This involves, as we will showcase, a formulation of efficiency that can be compared between Hayek and Fama. While the lineage between Hayek and Fama is sometimes taken as a self-evident fact in the literature, or criticized because the authors do not share enough in terms in methodology, we will show that this opposition can be overcome with a proper analysis of what these theories share analytically. Thus, we challenge the thesis of Boettke and O'Donnell (2013), for instance, who claim that formalist economics, especially the economics of information, missed Hayek's point because of the assumptions made for formalization. We show in this paper that if there are important differences between Hayek and EMH theorists on the assumptions made, the lineage between Hayek and EMH is more profound.

In order to overcome this problem, we propose an original distinction between methodology and epistemology to show that Hayek and EMH share important core conceptions. Epistemology encapsulates the common core of the theories, that is to say, the same conception of agent's information that implies a specific understanding of the functions and nature of the market

and competition. Methodology refers to the differences in terms of operationalization between the two conceptions. See section 4 and 5 for more specifications.

Hence our main result is to highlight a common *Weltanschauung* (Mirowski, 2009, p. 112) or World Reason (Cahill and Konings 2017; Dardot and Laval 2020; Konings 2018), namely a common representation of the world, especially of the market and its role, between Hayek and EMH. Another contribution of our paper is to refocus the historical and methodological literature about finance on the conception of information, rather than on the stochastic process underlying EMH's formulations⁵. Obviously, if our core conception is warranted, our paper highlights the importance of financial economics for an understanding of neoliberalism.

Section 2 is dedicated to a reconstruction of Hayek's philosophy in two subsections. The first one highlights the importance of information as a core concept. We then underline the consequences of this starting point, namely a new conception of market and competition. Section 3 develops the positions of Working and Fama. The sub-section on Working concentrates on his theory of information, while the sub-section on Fama will pay particular attention to the formulation and efficiency and the transformation of the concepts of market and competition that stem from this starting point. Section 4 defends our comparison between the two corpuses with our distinction between epistemology and methodology. Finally, section 5 provides a systematic comparison on three issues: a subjective view of information which leads to the symmetry of the observed and the observer, a specific conception of market and competition and a formulation of informational efficiency in Hayek's work.

⁵On this issue, see the history of random walk in finance by Jovanovic (2009b) and Walter (2013).

4.3 Hayek, the introduction of information as a core concept

Hayek is rightly acknowledged as one of the masterminds of the liberal and economic thought and has a great influence both theoretically and organizationally (Dostaler 2001; Mirowski and Plehwe 2009). Hayek distinguishes himself in many ways from the economic mainstream (Boettke and O'Donnell 2013; Dostaler 2001; Vestuti 2004), the neoclassical theory, which is represented when he writes by the general equilibrium program, even though it is not fully developed until 1954 and the work of Arrow and Debreu. But it is highly debatable to say that his work did not have a decisive influence on the productions and the theoretical mutations of the discipline. Thus, Robert Lucas explicitly represented himself as a continuator of Hayek (Laidler 1982, p. ix), regarding the status given to the concept of information by Lucas.

Hayek develops in a systematic way a subjectivist epistemology based upon the statement of the division of information, which implies some major modifications for the understanding of concepts such as market, competition and prices, relatively to the conception which Hayek sees as hegemonic in economics, the general equilibrium analysis and its theory of pure and perfect competition (Hayek 1948a). This introduction by Hayek of the concept of information, especially in the text of 1944, that is to say, "The Use of Knowledge in Society", will leave a mark on the whole discipline of economics, being one of the top 20 articles with the most citations of the *American Economic Review*.⁶

⁶We will use the terms knowledge and information as synonyms here, following Hayek himself and the habit taken by translators to translate knowledge by information (Mirowski

4.3.1 An economics of information

Hayek's theory is based upon a subjectivist position regarding information (Hayek 1952, p. 31), correlative to his individualism that we can sum up in the following way: there are only individuals, and they are the only entity that can be said to possess information. This position is well developed in the articles of Individualism and Economic Order (1948) and in *The Counter-Revolution of Science* (1953). Hayek's subjectivism is more developed than the one we traditionally find in marginalism for the theory of value or in the Austrian perspective, for example in Menger position during the *Methodenstreit* or in Bohm-Bawerk's work on the interest rates. Indeed, Birner (2006) distinguishes between four connected meanings of subjectivism in Hayek's view: the facts of the social sciences are the opinions and desires of the agents (i), information is divided and heterogeneous (ii), it is also limited and local, and thus human reason must concede to the wisdom incorporated in the social rules (iii) and the fact that the agents and the theorists can understand the actions of other people only because their minds work in the same manner (iv). All of these meanings stem from his position in theoretical psychology. Hayek (1979, pp. 199–200) underlines the importance of his book *Sensory Order* for his philosophy of social sciences and his theory of information. In order to understand Hayek's views one as to start with this thesis, we will then see that his whole theory can be reconstructed from there (Birner 2006; Butos 1997).

How can we reconcile the fact that the information I possess is subjective with the subjective information of others, and thus how a world made of individuals following their own interest based on their local information

and Nik-Khah 2017, p. 66). For more details about Hayek's use of information and knowledge and the distinction that one can draw between the two concepts Khalil (2002) and Boettke and O'Donnell (2013).

can be in order? Some scholars consider that this thesis introduces a shift in Hayek's scientific production (Butos 1985; Caldwell 1984, 1988; Hutchison 1981). If the main discovery of Adam Smith is the division of labor, illustrated with the example of the fabric of pin in the beginning of the *Wealth of Nations*, the great discovery of Hayek in economics is the division of information, that is to say, the fact that knowledge is shared among the different members of society and cannot be centralized by one particular entity or person. Economics is then just not the realm of material exchanges but of cognitive exchanges too. Hayek develops this theory in the context of the controversy on the scientific possibility of economic planning led by Mises with his book *Der Sozialismus* written in 1922 from an article of 1920, which constitutes the background of these theoretical analyses. Hayek defines his problem in the following way:

The problem which we pretend to solve is how the spontaneous interaction of a number of people, each possessing only bits of knowledge, brings about a state of affairs in which prices correspond to costs, etc., and which could be brought about by deliberate direction only by somebody who possessed the combined knowledge of all those individuals. (Hayek, [1937] 1948, pp. 5051)

Or, with another formulation by Hayek: how can the combination of fragments of information existing in different minds bring about results which, if they were to be brought about deliberately, would require a knowledge of all the information on the part of the directing mind which no single person can possess? (Hayek 1937, p. 54). Information in this frame refers to the present and future information the individuals have or will have of

prices, but also to the use that any individual can make of any good he possesses. This type of information is not only scientific knowledge but also all relevant information for the agents: how to use something, the quantities, and all the specific information given in a time and place. This information is then said non-homogenous because it cannot be reduced to one specific type, because individuals possess specific information, from their subjective history. This type of local and private information is for Hayek even more important than the scientific knowledge in order to understand the possibility of social coordination because most individuals rely primarily on this wider type of information for their actions. The definition of information is very large and can actually include almost everything, from the scientific knowledge available at a certain time to the very specific transformation of contexts and immediate circumstances.

Every individual possesses information, beliefs, and desires that are his own. The major consequence is that nobody can know it all, because information is for the main part subjective. The division of information is then a starting point in order to explain economic and political phenomena, and not an element to explain, an explanans and not an explanandum. Agents are thus cognitively limited, and this is why they follow social rules, or behavioral norms, that civilization created in order to promote cooperation. Here is a notable difference between Hayek and other economists: rationality is always socially bounded for Hayek.

The situation on the market is then for Hayek a situation of cognitive fragmentation: everyone possesses information but it is difficult to centralize all the information, especially in an intentional mechanism of regulation. The individuals do what they can in order to fulfill their goals, using information they possess. The original division of information introduces a clear rupture with the neoclassical model: the problem is not the one of general

equilibrium, but to make the best of the available information. It is thus impossible for Hayek that a figure such as the auctioneer exists, equalizing the offer and demand functions.

We will, however, see that the focus upon the cognitive aspects of the coordination implies a new conception of the economic concepts of market and competition. We will follow Hayek's criticism of what he perceives as the standard view when he writes in the 1930s and the 1940s.⁷

4.3.2 Hayek's conception of market and competition

The market is the device of coordination in Hayek's theory. Hayek will in his later work, especially *Law, Legislation, and Liberty*, define this concept as a specific spontaneous order. The notion of order is not solely political but refers to all the situations of great complexity where it is impossible to assess the situation with universal laws (Hayek 1953). The order exists in distinction with the organization, where the complexity—namely the fragmentation of information—is reducible enough to make planning possible, such as in a small business or a family. In comparison the order is the consequence of an irreducible complexity: nor the scientist neither the planner can produce a correct nomology of the situation. The definition of the market as an order ensues from the interactions of the individuals in a spontaneous, that is to say non-intentional, process. This process is the process of competition:

Competition is thus, like experimentation in science, first and foremost a discovery procedure ... Competition must be seen as a process in which people acquire and communicate knowledge;

⁷The main point here is not to characterize precisely the general equilibrium program (see Cot and Lallement 2006; Weintraub 1993, 2002).

to treat it as if all this knowledge were available to any one person at the outset is to make nonsense of it. (Hayek 1979, p. 68)

Competition is a procedure of research for individuals. The market is not the place where an offer and a demand encounter but a processor of information since prices works as signals for the agents, giving them objective information for their actions (Bourdeau 2014). His conception of competition is a dynamic one: it is an endless process of trade during which information is shared and spread. According to Hayek, competition and market in the general equilibrium theory are too static. According to Hayek, competition in general equilibrium is a given *market structure* where some conditions are fulfilled: atomicity, homogeneity, transparency, mobility of production factors and free access to the market. The individuals are price-takers and have the same information in virtue of transparency. Hayek may also have in mind the theory of Chamberlain, published in 1933, *The theory of monopolistic competition*, where the standards requirements for pure and perfect competition are not fulfilled. In this theory there are a lot of producers on the market but the products are heterogeneous, which implies some information asymmetry and a rupture with the atomicity condition. However, this distinction is not important in Hayek's perspective because it is still too static. What Hayek criticizes is less the specificity of the five requirements for competition than its core conception as not well suited in order to take the dynamic substance of the economic process. Perfect competition, where every individual has all the information available is described as a way to dodge the real question because of its static characteristics. Perfect competition indeed takes for given what is the result of a competitive process:

In other words, the description of competitive equilibrium does

not even attempt to say that, if we find such and such conditions, such and such consequences will follow, but confines itself to defining conditions in which its conclusions are already implicitly contained and which may conceivably exist but of which it does not tell us how they can ever be brought about. (Hayek, [1946] 1948, p. 94)

Competition is then more of an epistemic process than an outcome. This epistemic dimension, in the sense that the agents in competition gather the information, changes the way we conceive competition itself. It is now seen as a process of rivalry and not anymore as a market structure. Competition is the general answer to the radical ignorance in which individuals are imprisoned. New information is discovered only because individuals are in competition. On this matter, Hayek underlines the entrepreneurial process of competition (Kirzner 1988). The two meanings of competition clearly appear here: competition as market structure is a situation when the market can equalize the offer and demand function; competition as rivalry in Hayek's work is not of the same kind, closer to the usual meaning of competition (Berthonnet 2014). Thus, competition is defined as a tool in order to select good expectations or even rationality. Rationality is consequently not a hypothesis but the result of competition, which selects the most efficient expectations. This theoretical result is defended with an evolutionist approach in Hayek (1979), stating that competition results in the selection of rational behaviors and efficient rules, eliminating as a consequence the individuals that are less adapted (Hayek 1979, p. 75). This dynamic assures for Hayek a better allocation of resources because the competition adapts to different situations: the price thus incorporates new information available and conveys them. This consequence is not totally unfamiliar for who

knows the definition of efficiency proposed by Fama in his articles of 1965a (see section 2). The prices are therefore of central importance:

The sum of information reflected or precipitated in the prices is wholly the product of competition, or at least of the openness of the market to anyone who has relevant information about some source of demand or supply for the good in question. Competition operates as a discovery procedure not only by giving anyone who has the opportunity to exploit special circumstances the possibility to do so profitably, but also by conveying to the other parties the information that there is some such opportunity. It is by this conveying of information in coded form that the competitive efforts of the market game secure the utilization of widely dispersed knowledge. (Hayek 1979, p. 117)

Prices are a device of social coordination, incorporating the information of the entrepreneurial process in which individuals try to exploit “special circumstances” and opportunities, answering to the problem Hayek asked from a subjectivist position. Hayek tends to restore the “invisible hand” of the market via the price system, which incorporates new information during the perpetual process of competition and can then convey a form of objective information. In a social order, which we distinguished before from an organization, the prices become one of the only solutions for economic coordination.

Thereby Hayek answers his question: how can an order exist without anyone organizing it? The market, as a spontaneous order, is a central element of the answer. It can transform the subjective information of individuals in information objectivized by the prices. The dynamic aspect of the market, led by entrepreneurs who try to take advantage of opportunities is

not ignored but this dynamic process is one of adaptation: the entrepreneurs show opportunities to the other who can imitate them and then stabilize the whole. This integration of the concept of information, that appears more and more often in Hayek's work, becomes preponderant in *Law, Legislation and Liberty* and transforms the concepts of market and competition. Competition is a process of discovery and learning.

If Hayek retains the idea of equilibrium from the walraso-paretian theory it is to explain the possibility of a tendency towards equilibrium (Arena 1999; Caldwell 1988). The pure market of the theory is criticized because it is highly tautological—two agents that know everything is in equilibrium only because we define equilibrium this way—and is begging the question of the discovery of the information itself. In his later work he abandons the notion of equilibrium for the one of order: the equilibrium supposes a static state where the information has been discovered already, while the conception of the competition and market of Hayek is highly dynamic. Hayek thereby transformed the concepts of competition and market to question about the possibility of coordination between the individuals that have subjective information. These transformations are epistemological, regarding not only the concepts that Hayek uses and his position towards the general equilibrium tradition but also his broader representation of the social world. We showed that this representation is determined by his conception of the division of information. This vision is encompassed in the fact that no one can beat the market because it incorporates all the relevant information. Hayek introduces consequently a fundamental symmetry between the observer, the planner, the scientist, the politician, and the observed, the acting individual. Because of his epistemological position, defining information as subjective and heterogeneous there is no possibility of disengaged central view. This acknowledgment laid the foundations of the Hayekian world where only

unintentional processes such as evolution (Hayek 1976) or competition can lead us. The result is that prices incorporate all relevant information and are the mean of coordination.

Mirowski and Plehwe (2009) attributes a dominant version of the concept of the market to Hayek, who, according to him, transformed the ontology⁸ of the concept:

Perhaps the dominant version at MPS (Mont-Pélerin Society) emanated from Hayek himself, wherein “the market” is posited to be an information processor more powerful than any human brain, but essentially patterned on brain/computation metaphors . . . From this perspective, prices in an efficient market “contain all relevant information” and therefore cannot be predicted by mere mortals. In this version, the market always surpasses the state’s ability to process information, and this constitutes the kernel of the argument for the necessary failure of socialism. (Mirowski and Plehwe 2009, p. 435)

Here we can observe that the conception of the market which is said to be dominant in the Mont-Pélerin Society is the Hayekian version of a market that contains all relevant information and thus is an information processor which is impossible to beat by a ruler or a mere mortal. This definition, and what it implies on the problem of social coordination, is what the authors called the first tenet of neoliberalism. We will see that this definition shares a lot with the definition of EMH. Can we then rightly speak of a common neoliberal world vision?

Before we compare Hayek’s epistemology with EMH we have, however, considering the importance of the concepts of market and competition in

⁸The term “ontology” appears in Mirowski’s article. However, we will not focus on the ontological dimension of the shift.

our analysis, to refine two features of the market and competition that stem from the evolution of Hayek's views on the nature of subjective information.

4.3.3 Two features of the market and competition

Our analysis identified two core characteristics in Hayek's epistemology of the market: the market is an information conveyer, and it is an information creator.⁹ The second characteristic is often overlooked, especially because it is explicated by Hayek after "The Use of Knowledge in Society", which is his work that had more influence on economics. Indeed, if neoclassic economics broadly accepted the role of prices as information conveyer (Boettke and O'Donnell 2013) the market has not been understood as a "creative process" (Buchanan and Vanberg 1991) in the mainstream literature. It is worth noting that if there is a difference between communicating and creating there is no contradiction: the market as a process discovers information possessed by the individuals and conveys it, and create, by the process of competition new opportunities and then new information during the process. The two features are two faces of a unique process if we understand that the interactions between individuals in market situations cause new interactions and then new opportunities for the individuals, that will act and then modify, through competition, the information to communicate. However, Hayek's thinking certainly evolved during the 1950", because of the influence of philosophy, especially Ryle, and of M. Polanyi (Ouz 2010). This evolution encourages him to propose a philosophical conception of the

⁹In our formulation "the market" is the subject but one may remember that the market is the unintentional consequence of the intentional actions of the individuals, thus it does not exist or act in its own rights. The market is not an individual. In Hayek's individualism we can always describe the institution of the market as the result of choices made by individuals in a competitive environment. When we use the expression "the market" we always have to keep in mind that it does not make anything, but that the market is our linguistic term for naming the consequences of the intentional actions of the individuals.

socio-economic order as a whole. He underlined more and more not only the incapacity of the planner to centralize the information, as he did during the Socialist Calculation debate, but the tacit dimension of the information the individuals possess, that is to say the fact that most information the individuals have is in fact inarticulate. Hayek thus has a dispositional account of information as being incorporated. The specification about what kind of information is at stake in the market modifies the concepts of competition and market too: the market discovers things that could not be discovered without it, and competition is the condition of the emergence of new information. This is because the information possessed by the individuals is incomplete and subjective that we live under the realm of social rules. If, as Hayek put it earlier, the market is only communicating information that is pre-existing then planning is not logically impossible but only technically. Whereas if we recognize the creativity of the market process planning cannot even be accomplished by an omnipotent and benevolent god because only competition can reveal the inarticulate information and create new opportunities through the process (Buchanan and Vanberg 1991). The market reveals indeed the inadequacy of individual dispositions and forces them to adjust their preferences (Boettke and O'Donnell 2013, p. 313). Can we identify these two features in the conception of the market in the work of EMH theorists?

4.4 When the efficient market hypothesis meets Hayek.

A market is informational efficient if all information available about assets prices are integrated into current assets prices, which is indeed a formulation close to the one we find in Hayek. The EMH represents a keystone of financial economics in many aspects. From a historical perspective, the information efficiency has been one the key research program in the constitution of modern financial economics in the 1960s (Jovanovic 2008). It still represents today the central framework in financial economics to describe the financial markets (Vuillemeys 2013, 2014). Many subfields in financial economics have been dedicated to developing the implication of this hypothesis, and many other central contributions to financial economics claim a direct link with the EMH. It should be noted that the EMH is not only a theory of information among others that we decided to compare to Hayek. Our focus on EMH is also motivated by its importance on the historical constitution and his analytical centrality in the financial field.

Conversely to Hayek's theory, the EMH has been developed by a set of heterogeneous researchers. The comparison with Hayek's theory requires then to avoid these heterogeneities to focus on the key ideas behind the informational efficiency. We choose to present the contributions of Holbrook Working and Eugene Fama. Our focus on Eugene Fama is obvious since his contributions are considered as the more systematic exposure of informational efficiency. Holbrook Working, however, is known only by the specialists of the field as a pre-theoretician of EMH who introduces the issue of information for analyzing speculative markets (see chapter 1, and Berdell

and Choi 2018). However, Working exposes with more clarity the problematic that lays behind efficiency. We begin our account by presenting these intuitions. It consists mainly in introducing the role of expectations and the role of dispersal information in the determination of assets prices which are going to be commonplace in financial literature. We then display the more theoretical and formal formulation of EMH given by Fama which becomes the standard view in the literature.

4.4.1 Holbrook Working: information and forecasting.

The issue about the use of information in finance has been discussed openly by the first Anglo-Saxon researches on finance in the 1930s. The studies of Alfred Cowles questioning the forecasting skills of forecasters are an illustrative example (Cowles 1933, 1944; Cowles and Jones 1937). Cowles shows that forecasts' forecasters were not better than a random strategy. Based on Cowles' studies, economists believe in the objective prediction of economic science, whereas traders were attacked for the unscientific character of their forecast (Dimand 2009; Dimand and Veloce 2010). The question is then similar to Hayek's problem, in other words, the question of the centralization of information. In 1934, Working publishes a well-known article in which he notices the random character of assets prices changes (Working 1934). The informational issue rises naturally from this finding. Like Cowles, it questions the forecast of traders and thereby the information used by traders to forecast. Working puts in the same line the issue about the information possessed by traders and the knowledge of economic theory. If random fluctuations question the forecasters' forecasting, why should it not question the economic science too? In the 1930s, even he does not have yet a systematic view on the issue, Working already defends the accuracy of practical men's

information about forecasting, for instance, in this wheat prices study, he suggests that businessmen have likely a more accurate view about wheat market tendencies than any economic theorists:

Ask a number of intelligent businessmen of long experience with wheat prices to state the tendencies they believe to exist, and you will get much more general agreement with the propositions here stated that will be obtained from economic theorists.
(Working 1935, p. 425)

In this quote, Working suggests that the subjective information possessed by experienced businessmen may have more accuracy than the objective knowledge produced by current economic theory.¹⁰ Still in the 1930s, and while the mainstream research viewed speculators as ill-informed agents¹¹, Working suggests the importance of trader's information on price formation: "prices are not so haphazard and imperfect as one may judge from too restricted a view of the information and trading habits of individual speculators" (Working 1937, p. 310).

Working (1949a) follows and reinforces the same trend by acknowledging that "perhaps the absence of recognized scientific significance of "traders' information reflects inadequacy of our perception rather than absence of real significance" (Working 1949a, p. 150). In short, maybe traders' expectations make sense: it reflects the incapacity of economic theory to understand the expectations of traders and the information they use, namely not only scientific information but local and contingent information. Working suggests then that Cowles' finding should be reinterpreted:

¹⁰Here the knowledge produced by the theory is similar to the "scientific knowledge" we discussed in the previous section.

¹¹See Berdell and Choi (2018) for a recent account of Holbrook Working's view on information in the 1930s, in particular, his contrasted view with the Grain Future Administration on speculation.

Some years ago, Alfred Cowles made a critical study of the economic expectations recorded by professional stockmarket forecasters. The main conclusion which emerged was that these expectations had characteristics substantially identical with those of random guesses. We shall see before we finish that such an observation is not necessarily evidence of poor forecasting. (Working 1949a, pp. 150–151)

In order to show that, he makes a logical distinction between two kinds of expectations errors. First of all, errors can result from unpredictable factors, independent from the agents, what Working calls “necessary errors”. It results then that the second kind of errors which may occur results from predictable factors, dependent on the agents, what Working calls “objectionable errors”. In an “ideal market” (Working 1949a, p. 160), expectations should be subject only to necessary errors, errors that result from unpredictable events. Assets prices fluctuations of such a market will be entirely unpredictable:

Ideal market expectations would have taken full account of the information which permitted successful prediction of the price change . . . An interesting consequence of this proposition is that, given an ideal futures market in which market expectations exhibited only necessary error, it would be impossible for any professional forecaster to predict price changes successfully. (Working 1949a, p. 160)

Working then links this finding to his own observations about the random character of financial fluctuations: “Changes which are completely unpredictable are, by definition, random changes” (Working 1949a, p. 160).

The crucial point we want to emphasize here is that Working's contribution is not only theoretical, but it is also mainly a transformation of the relationship between the observer and the observed on the information possessed. From an overhanging position, the observer symmetrizes his cognitive capacity with the observed. Beyond the construction of a theory of expectations, he highlights the significance of the subjective character of information of investors by suggesting that traders' expectations should be taken more seriously than it was:

Apparent imperfection of professional forecasting, therefore, may be evidence of perfection of the market. The failures of stock market forecasters, to which we referred earlier, reflect credit on the market (Working 1949a, p. 160)

In this respect, whereas the researchers of his time were looking for an objective model of forecasting, Working reverses the logic by modeling the subjective foreseeing of agents. It leads then to focus, not anymore on what kinds of information are relevant, but on how agents use information inaccessible to the theoretician: "Anticipating events requires *special information and special skills*. While some traders seek to predict crop developments, others seek to predict changes in general business prospects" (we emphasize Working 1949a, p. 194). If Working gives an example of what relevant information is, he does not aim at defining objectively the content of information. Like in Hayek's theory, information is what is useful for agents' decisions, that is here, the price changes predictions.

Moreover, noting that "the amount of pertinent information potentially available to traders in the most modern market is far beyond what anyone trader can both acquire and use to good effect" (Working 1958, p. 158), Working gives the intuition of the—Hayekian like—division of information:

Circumstance and inclination lead different traders to seek out and use different sorts of available information; and if at any time some sort of available and useful information is being generally neglected, someone is likely soon to discover that that neglect offers him a profitable field to exploit. In short, traders are forced and induced to engage in a sort of informal division of labor in their use of available information. (Working 1958, p. 158)

It is particularly interesting that we find in Hayek's writing the same defense of traders' subjective knowledge (Hayek 1948a, pp. 80–81).¹² Working uses the same argument as Hayek, who underlined the entrepreneurial process of the market. Both arguments share the same structure and the same emphasis on the necessity of local information but also the same figure in order to make the market process work, that is to say, one of the entrepreneur/traders. Working does not only develop a representation of informational market, he has also a conception of information as subjective information, that is, local knowledge of traders. We thus find in Working's writing the two features of the market and competition that we identified in our analysis of Hayek's epistemology. The market prices reflect available information and competition is a process of discovery through the actions and expectations of the individuals. However, Working does not develop explicitly the modern notion of efficiency even if, retrospectively, he has developed its main intuitions (Berdell and Choi 2018; Jovanovic 2008).¹³ The

¹²“or the arbitrageur who gains from local differences of commodity prices, are all performing eminently useful functions based on special knowledge of circumstances of the fleeting moment not know to others. It is a curious fact that this sort of knowledge should today be generally regarded with a kind of contempt, and that anyone who by such knowledge gains an advantage over somebody better equipped with theoretical or technical knowledge is thought to have acted almost disreputably” (we emphasize Hayek 1948a, pp. 80–81).

¹³Lately, Working has been in contact with important contributors of EMH such as Paul Samuelson (Delcey and Sergi 2019).

EMH will be developed in the 1960s during the emergence of the financial economics field. We focus now on the work of Eugene Fama, which has developed the most famous formulation of EMH.

4.4.2 Fama and the efficient market hypothesis

Fama introduces the concept of “efficient market” in 1965 (Fama 1965a,b). In the 1960s, the issues of Cowles, Working, and others on the unpredictability of prices changes become the main research program of the emerging financial economics (Jovanovic 2008; Walter 2013). Regarding the multiplication of empirical studies showing the nearly random character of price changes, the scholars raise doubts on the possibility of a strategy of investment able to beat systematically the market. The problem of division of information underlined by Hayek was raised identically by early financial economists but in different context: is there an agent or a group of agents able to centralize information better than the market (here in order to make forecasting)? Fama answers with a clear no to this question by formulating, and corroborating empirically, the notion of “efficient market”. In his definition, Fama draws the representation of an informational competitive market:

In an efficient market, competition among the many intelligent participants leads to a situation where, at any point in time, actual prices of individual securities already reflect the effects of information based both on events that have already occurred and on events which, as of now, the market expects to take place in the future. In other words, in an efficient market at any point in time the actual price of a security will be a good estimate of its intrinsic value. (Fama 1965b, p. 77)

This first definition describes a financial market where the competition leads, first of all, to the integration of all information in the prices of the assets, and, secondly, to the equalization of assets prices to the intrinsic value. Although Fama considers the two aspects as synonym, he will give up this second aspect in his following writings to focus on the first part of the definition. Similarly, to Hayek and Working, Fama does not characterize the notion of information by its content, it is a definition based on what is useful for making price changes expectations.

What appears already in this first definition is a particular conception of competition: it is a process which leads a set of subjective information to be centralized objectively in a system of prices. The market appears as a processor of information (Mirowski and Nik-Khah 2017; Mirowski and Plehwe 2009), and prices as the result of this competition process. This conception of market prices is particularly apparent in his review of empirical literature (Fama 1970). After he defines an efficient market as a market in which “prices always ‘fully reflect’ available information” (Fama 1970, p. 383), Fama distinguishes his famous three tests of EMH: weak, semi-strong, and strong. The weak form tests if the market prices integrate all past information, the semi-strong form adds the current public information, and finally the strong form tests also the current private information (Fama 1970, p. 388). Beyond this classification of empirical tests, it appears as a classification of the capacity of the market to fill its role given by Fama, that is, to integrate information in asset prices. The similarity between Hayek and the EMH is then multi-dimensional. Written in the same period, answering to the same issue about centralized information, the two theories defend a new representation of the market as an informational processor.

Can we end the comparison so easily? There are strong differences between the efficiency of Fama and the efficiency¹⁴ of Hayek's theory of prices. Until now, we passed over many analytical differences between the two approaches. The formulation of EMH by Fama (1976a,c) will illustrate this issue. A market is efficient if and only if:

$$f(P_t|\Theta_{t-1}) = f_m(P_t|\Theta_{t-1}^m)$$

where P_t where P_t is the vector of the price at time t , Θ_{t-1} the set of information available at time $t-1$, Θ_{t-1}^m is the set of information used by the market, $f_m(P_t|\Theta_{t-1})$ is the true density function implied by Θ_{t-1} , $f_m(P_t|\Theta_{t-1}^m)$ is the market assessed density function for Θ_{t-1}^m (see Fama 1976c, p. 143). This formulation means that a market is efficient when the aggregate subjective information of individuals $f_m(P_t|\Theta_{t-1}^m)$ equals to the a priori objective information $f(P_t|\Theta_{t-1})$.

In short, a market is efficient if the market expects rationally the prices (see chapter 3 and Delcey and Sergi 2019, on the relation between EMH and rational expectations). Fama specifies that by saying "the market" does something is just a "convenient way of summarizing the decisions of individual investors and the way these decisions interact to determine prices" (Fama 1976c, p. 135). This formulation avoids entirely the heterogeneity between individuals and then the role of subjective and local information, a fundamental aspect of the Hayekian theory we highlighted in the first part. Secondly the rationality that Fama refers to is absolutely unfamiliar with the conceptions of Hayek. Indeed, Fama (1976c, p. 143) uses the word in relation to the rational expectations, while the expectations of Hayek cannot be said

¹⁴Our use of the term efficiency here for Hayek is anachronic and partly incorrect: Hayek never formulated a theory of EMH. We use the same term here in order to facilitate the comparison. See section 5 for a theory of efficiency for Hayek.

rational (Botos 1997). Moreover, Fama talks about market which “assesses probability distributions” implied by $f_m(P_t|\Theta_{t-1}^m)$ he supposes two implicit assumptions:

this can only be a completely accurate view of the world if all the individual participants in the market (a) have the same information and (b) agree on its implications for the joint distribution of future prices. (Fama 1976a, p. 167)

Beyond the central aspect given to information by each approach, the assumed cognitive abilities of individuals are however fundamentally different. Fama assumes that information is the same for everyone. It leads him to fall under one of the main critics Hayek made to general equilibrium, that is, to dodge, by assuming a homogeneity, the real question of how a market composed by different individuals is ordered. Can we then identify clearly the lineage between the two theories? The next section of our paper discusses this issue.

4.5 The problem of comparisons

We will at first clarify the difficulties that we encounter when we want to propose a systematic comparison between Hayek, Fama, and Working. Indeed, we showed that these authors shared similar conceptions on information, markets, and competition. But a cautious reading of the texts of these different authors also shows very different orientations and propositions. The thesis of a lineage between Hayek and EMH needs thus a more systematic demonstration. We will justify our interpretation with a distinction between methodology and epistemology, insisting on the fact that most differences lay in the realm of methodology.

4.5.1 Hayek and mainstream economics

We do not propose to go as far as David Laidler (1982) went with Lucas, Sargent and other economists of the new classical economics and say that Fama and Working are Hayekians. Indeed, Hayek has been compared already with a lot of economists, and one must not confuse comparison with identification. Furthermore, neither Working nor Fama referred to Hayek as an inspiration to their work explicitly.¹⁵ First of all, the context in which Hayek writes is very different from the context that gives rise to financial economics and efficiency. Hayek reacts to historical and political problems, such as the World War, the rise of totalitarianism and, last but not least, the problem of economic planning. In order to understand his work, one has to investigate the crisis of the twentieth century. He is not strictly speaking an economist after the Second World War, but belongs to social sciences departments and focus on much larger problems of political philosophy, eager to spread a revigorated liberalism with the Mont-Pélerin Society (Audier 2013; Burgin 2012; Mirowski and Plehwe 2009). Working and Fama did not join the Mont-Pélerin Society. If Fama expressed openly his libertarianism in a few occasions, he remained particularly reserved on political and ideological public issues (Nik-Khah 2011, p. 376; Klein 2018). They are concerned by scientific issues, mainly, finding explanations of prices fluctuations in speculative markets and testing them empirically. From that perspective, the closeness of EMH with the formal language of economics, mainly the general equilibrium and econometrics methods, has played a key role in the emergence and the legitimation of financial economics as a subfield of

¹⁵If we except the fact that Fama describes himself in an interview in the New York Times in 2013, October 26, as “an extreme libertarian” and as a reader of Hayek’s *Road to Serfdom*. Some chronological conjectures can be proposed in order to link Hayek with Working too, notably the fact that the 1949 and 1958 articles of Working, written after the 1944 article of Hayek which had a lot of success, seem to borrow some conceptions to Hayek’s theory.

economics (Brisset 2018; Fourcade and Khurana 2017; Jovanovic 2008). It is assured consequently that Hayek and EMH theorists do not share the same representation of the agents, Hayek being more interested in a general description of human action, while Working and Fama follow the modeling trends after the Second World War.

Consequently, and secondly, the scope of Hayek's theory is much broader than the scope of Working or Fama's work: Hayek is interested in philosophical problems of social coordination, to elaborate a theory of social norms and their evolution, and to develop a theory of human conduct, many problems that do not appear in the work of EMH theorists. There are some differences in terms of problematic: the "Hayek problem" (Zijp 1990) is the very general one of inter-individual coordination, while the problems that give rise to the financial economics are related to the more specific issue about the performances of the investors.

Finally, on many important issues, Hayek and EMH theorists distinguish themselves considerably. The assumptions on the individuals are clearly unlike. For instance, Audier (2013) argued that the representation of the individuals in Hayek and in the Chicago School are radically different, the first developing a theory of rule-following, the second holding on homoecomicus. The same can be said for the concept of expectations that Hayek, Working and Fama use. For Hayek the expectations are not rational, as Butos (1997) showed with a precise reading of Hayek's book *Sensory order*, but local, related to the limited information the agents possess and consequently heterogenous, closer to a tacit disposition than an intentional view while in Fama's work the expectations are homogenous and explicit. Consequently, some scholars, for example Boettke and O'Donnell (2013) expressed that the Hayek's position is, because of its insistence on subjective and dynamic processes, doomed to be misunderstood by formalist economists.

Nevertheless, one may acknowledge the historical convergence between Hayek and Chicago, where Fama completed his Ph.D. with Merton Miller at the Graduate School of Business of Chicago in the early 1960s. Recent works (Horn, Mirowski, and Stapleford 2011; Mirowski and Plehwe 2009) have shown in particular that Hayek had a profound influence on economists such as Stigler (1961) and Friedman (2009)¹⁶ who, in turn, have participated to the emergence of the Graduate School of Business, led at the time by their friend, and members of the MPS, Warren Wallis (see Fourcade and Khurana 2017; Horn, Mirowski, and Stapleford 2011). If the methodology of Chicago economics and thus of Fama differs from Hayek's methodology, it is difficult however to refute that Hayek's ideas have not infused the imagination of Chicago theorists, including financial economists.

Still, as reminded by Caldwell (2011) the fact that Hayek plays a key role in the foundation of the Chicago School does not itself shed light on the general issue of neoliberalism. Is the lineage between Hayek and EMH leading to an understanding of neoliberalism as a common conception of the role of the market condemned to be an oversimplification?

4.5.2 Methodology and epistemology: survey and definitions

We characterized the similarities and the differences highlighted as respectively epistemological and methodological. Epistemology and methodology are broad terms variously defined in the philosophy of science literature.¹⁷

¹⁶Stigler and Friedman, both members of the Mont-Pèlerin Society, quote Hayek in their respective works, and pay specific attention to the "epistemic turn" (Boettke 2018, p. 232) impelled by Hayek in economics.

¹⁷Many writings of famous methodologists or philosophers of economics define methodology in a various way. See McCloskey (1998), Rosenberg (1992, p. 10) or Blaug (1992, p. xii) for various definitions. Epistemology usually refers to the philosophy of science, and especially to the criterion that are used by authors such as Popper, Kuhn, Lakatos or Feyerabend, for example in order to distinguish science and pseudo-science.

The term epistemology here is not related to the theory of science the authors defend but to the core concepts or their theories.¹⁸ Methodology is then defined as the way the authors operationalized their epistemology, as we defined, in the field of scientific production. The history of financial economics encounters the same problem of the division of information than Hayek and develops the same answers: subjectivism for the information, the symmetry between the observed and the observer with the impossibility to centralize information, which gives birth to the same modification, beyond methodological differences, in the concept of market and competition. We called this epistemology in order to underline the fact that the authors share the same vision of information possessed by the agents. Information becomes the core concept for inter-individual coordination, that is allowed by the operations of the market. Indeed, individuals in the market convey and create information, the competition allows efficiency and the agents react accordingly to the prices. We ought then to distinguish between epistemology, relative to the fact that both theories have a common representation of information possessed by agents, and methodology, relative to the scientific way the authors realize these theses. That being said methodological differences can be really important and decisive differences and give birth to radically different theories. Hacking (1983) shows for example that the bottom-up approach founded upon the practices of the day-to-day scientist was crucial in order to understand the long-run diversification of theories. Our thesis is that the differences between Hayek and the corpus we studied in the theory of efficiency, especially Fama, are mostly methodological. For example, the use of rational expectations by Fama, that contrast with

¹⁸We borrow this mode of thinking to Lakatos and Musgrave (1970). Nevertheless, we do not use this distinction as a normative distinction in order to assess programs of research.

Hayek's vision of the individuals, is not a behavioral assumption. It is explicitly for Fama a mean to study the finality of the process of competition: the price. Thus, the differences in terms of methodology are highlighted by a common background, which is composed of common epistemological problems. As Hacking (1983, p. 5) shows with Popper and Carnap the differences appear sometimes greater than they are when there is a common ground upon which they become commensurable.

4.5.3 Formalization as a methodological difference

We already showcased some differences in the context of the two corpus writings and on the scope of the two respective approaches. These differences are crucial since they imply significant analytical differences. Hayek is reacting directly to the political philosophy behind the general equilibrium problem, his answer shares the same level of generality: a description of the economic system that he tries to spread outside the scientific field. Embodied in the rise of early econometrics, Working and Fama emphasize the necessity to test empirically a rigorous model. From his first articles on EMH (Fama 1965a,b), Fama's model becomes formal (Fama 1970, 1976a,c). The information becomes a given mathematical set, and the representations of agents about the future become the same given law of distribution for everyone. Thus, radical ignorance is replaced with a probability law. The fundamental dynamic aspect of Hayek implied by the crucial heterogeneity between agents and radical ignorance disappears.

In the same vein, Fama's efficiency (Fama 1965b, p. 76) assumes that information is "almost freely available" what has been seen as contradictory

with the Hayek's theory in which costly information is central. If the information is freely available and reflected in prices, the incentives for a competition on information disappear (see Grossman and Stiglitz 1976, 1980).¹⁹ Hayek indeed, as soon as 1935, in an article on the socialist calculation debate called "Socialist Calculation: The Nature and History of the Problem", noticed that what made planning impossible was the fact that information was not free but costly at an individual level. This is because the information is costly that the market possesses asymmetries of information.

In Fama (1970), efficiency of the market is thought, in Hayek's words, as a static feature of market in which "prices always fully reflect" available information", while Hayek insists on the dynamic and never-ending process of discovery of information which "be completely missed by any theory which treats these data as constant" (Hayek 1948a, p. 106).

Are those differences decisive? Fama (1976a,c) adopts a formal formulation which contrasts de facto with Hayek's one. In particular, by assuming a probability law for the "market" common to every market participant, Fama ignores the role of local and subjective information. However, Fama does not defend his model as describing ontological features of the world. On the contrary, when Fama discusses the realism of his model he tends to approach Hayek's theory by arguing that he has in mind individuals with heterogeneous opinions:

Strictly speaking, this implies that investors have monolithic opinions about available information and act singlemindedly to ensure that their assessments are properly reflected in current prices.

What we really have in mind, however, is a market where there is

¹⁹Fama acknowledges, after Grossman and Stiglitz's article, that information should be costly (1975 Fama 1991).

indeed disagreement among traders but where the force of common judgments is sufficient to produce an orderly adjustment of prices to new information. (Fama 1976c, p. 168)

What Fama does have in mind is a dynamic process with heterogeneous agents, in which efficiency of the market is produced through the interactions of the individuals. Indeed, prices are the result of “common judgments” produced by the process of competition, that is the agreement among individuals upon the value of an asset. In this perspective the price is the end of a process of opinion formation as Hayek highlights (Hayek 1948a).²⁰ Fama investigates the testability of an informational efficient market, the finality of the dynamic processes described by Hayek. In order to do so he has to use methodological devices for the formalization. The differences in terms of scope then imply a difference in terms of methodologies: Fama wants to test his model in the mainstream and formal framework emerging after the Second World War. When Fama explains the purpose of his model he moves towards a more Hayekian position because his model describes the state of the market resulting from a Hayekian competition process.

4.6 A common core

4.6.1 The same epistemology: information and symmetry

The view of the market as informational processors can be seen as the keystone of Hayek’s theory and the EMH: the two theoretical approaches start

²⁰“Competition is essentially a process of the formation of opinion (). It creates the views people have about what is best and cheapest, and it is because of it that people know at least as much about possibilities and opportunities as they in fact do’(Hayek, [1946] 1948, p. 106).

from the understanding of the difficulty to centralize information (by governmental or financial professional entities). This difficulty leads Hayek as well as Working and Fama to emphasize the role of local and subjective information, which cannot be fully taken into account. We already saw that both Hayek and Working, before any theoretical analysis, try first of all to reevaluate the subjective information of specialized agents, intrinsically personal and therefore, intangible for economic sciences. The notion of information appears as the objective description of this unattainable knowledge, that is, an objective description of an unopened black box. In Hayek and EMH theories, there are not attempts to describe with precision the content of the information used by agents.²¹ The notion of information is only described by its finality: agents use the information they need to achieve an economic action. They had the correct information if this action is actually achieved. The theory does not and cannot discuss the content of the local and subjective information used by agents since it is defined as impossible to centralize by a theoretician.

Another way to underline this epistemological similarity is the introduction by both approaches of symmetry²² between the observer and the observed. This symmetry is implied both in the work of Hayek and in

²¹Hayek provides only some examples on this subject, especially in his texts of the debate on the possibility of economic calculation under socialism. For example, Hayek ([1935]1948, p. 154):

The information which the central planning authority would need would also have to include a complete description of all the relevant technical properties of every one of these goods, including costs of movement to any other place where it might possibly be used with greater advantage, cost of eventual repair or changes, etc. ([1935]1948, p. 154)

Fama also provides some examples, that is to say any information related to the earnings of the company “which in turn are related to economic and political factors” (Fama 1965b, p. 36).

²²Sent (1998a) justly showed, on her work on Sargent, that symmetry was the consequence of a specific conception of information, not possessed solely by the expert, the government or the observer but also by the agents.

the works of Fama and Working, as a consequence of their position on the information. Hayek introduces symmetry between the observer and the observed, because of the impossibility to centralize all the information, as we showed above. The impossibility to centralize deprives the scientist, or the policymaker, of his prominent situation. We have seen that the problem gives rise to the questioning, by Working, of the scientific knowledge. In an informationally efficient market, information is integrated into the prices, which makes the prediction impossible for an individual, even for the most talented scientist.

4.6.2 Market and competition

By underlying the issue of information, both theories offer a new conception of what is the market and what role it fulfills. The market described by both theories fills a new role: to centralize this subjective information in a price system and to discover new information through the process of competition. The market usual main role is to coordinate the supply and the demand, it is from now on to coordinate the agents in their research of information. The shift is noticeable: the question is not only one of the allocation of resources but of cognitive coordination. Hayek explicitly formulates this:

The mere fact that there is one price for any commodity—or rather that local prices are connected in a manner determined by the cost of transport, etc.—brings about the solution which (it is just conceptually possible) might have been arrived at by one single mind possessing all the information which is in fact dispersed among all the people involved in the process. (Hayek 1945, p. 526)

Hayek described this as a “marvel” (Hayek 1945, p. 526): the functioning of the market, with prices coordinating the individuals and their actions, takes the role of the central institution of our society. Hayek’s conception of the market has been linked explicitly to EMH by Grossman and Stiglitz (1976, p. 249): “Still a third important and related observation is that prices, in our model, are serving two functions: not only are they being used to clear markets in a conventional way, but they convey information.”

In the same vein, the role of the competition changes. Competition appears as an impersonal mechanism that selects and discovers relevant information, or more specifically, selects the relevant economic action using relevantly the current information. Competition is, therefore, a dynamic process, a process that leads information to be discovered, shared, and spread. In this perspective we shall not underestimate the importance of the entrepreneurial action of the individual, highlighted by Hayek as well as by Working. Their role is to use unseen opportunities and then discover new information. Thus, we see here that EMH adopts the first feature of the market as information conveyer, but also the second feature of the market as a creative process. Of course, the former consideration does not mean that this role of competition has been invented fully by Hayek or EMH. In the history of EMH for instance, it is particularly usual for instance to find these intuitions in many others and preliminary works, of the period or even before.²³ However, EMH and Hayek’s theory appear as a systemizing analysis of this market conception. It does not mean that the idea that the market coordinates the supply and demand disappears entirely from these frameworks. It is easy to separate agent seeking information between suppliers and demanders, but these concepts become a minor aspect relative to

²³See for instance the discussions in (Kendall 1953). See also (Jovanovic and Schinckus 2017; Walter 1996) for the early contributions which formulates intuitively the informal efficiency.

the main problem of the coordination of scattered information.²⁴

4.6.3 Informational efficiency in Hayekian theory?

Because the authors share common ground on the division of information throughout society and a similar definition of information, we can formulate a theory of efficiency in Hayek's work. As we have seen the first formulation of Fama (1965b) efficiency as the fact that prices reflect all available information. This intuition is developed by Hayek in 1945, especially in "The Use of Knowledge in Society", as many authors noticed (e.g Vives 2008). Hayek takes the example of evolution in a market, a new opportunity, the disappearance of a source of supply. All the individuals do not have to know everything (what caused the disappearance of the source of supply), indeed if just some people know the cause of the change the information will spread because they will turn their investments to substitutes and then modify the price of the good, which thus reflects the new situation of the market (Hayek 1948b, pp. 85–86). The prices in Hayek's terms allow the formulation of a criterion of efficiency: we don't have to know everything since the prices reflect the information and are enough to take our decisions. Economics of information has for consequence an economy of information. The theory of Hayek states that prices will reflect all the available information in a free market, assuming that there is no rigidity that would make it work less efficiently.²⁵

The most extreme version of EMH assumes that prices reflect fully all available information while Hayek defends a weaker version, we may call it

²⁴Working (1958) has a hybrid status and mixes his analysis of information with the classic concepts of supply and demand.

²⁵The term "efficient" appears in Hayek's work, in order to say that the free market is more efficient than the socialist society. The price system is then defined as "efficient" by Hayek in the same passage, see (Hayek 1948b, pp. 85–86).

a conception of the market as powerful since the market is said to integrate information better than any individual or institution separately.

4.7 Concluding remarks

The first result of this paper is to deny the claim that EMH is Hayekian and conversely. The methods, the contexts, and the scopes are too different, beyond the fact that neither Working nor Fama explicitly refers to Hayek as a source of theoretical inspiration. However, highlighting fundamental differences between both approaches does not imply that there are perfectly orthogonal. Considering the many aspects of their analytical proximity; the problem of centralized information, the importance of subjective and local information that leads to the representation of a market as an informational processor.

A common epistemology thus remains, which seeks to describe a market in which subjective information of individuals is ordered in an objective system of price. Individuals are thought of as entrepreneurs with special information. We can then find the same conception of market and competition, as information conveyer and information creator, in both theories. In a nutshell we can identify four tenets: individuals have dispersed information; market can coordinate the individual plans through competition; the market is efficient. In this perspective most of the differences are the consequence of a difference of perspective: Fama studies the end of the process that Hayek describes.

We used in order to encapsulate this idea the concept of epistemology. The similarity is labeled as epistemological in distinction with methodology. The literature underlying the differences between Hayek and other thinkers is acknowledged but, because of its main focus on methodological aspects,

not considerate relevant on the epistemological level that is our main concern. These results underline the importance of the mutation introduced by Hayek in economics, as proposed by authors such as Mirowski (2007, 2009) or Cahill and Konings (2017).

The epistemological similarity we emphasize raises also historical issues. If we aim at comparing analytically two sets of a priori independent corpuses, it is clear that the proximity between the two approaches questions the potential inter-influence between the authors. Following chapter 1, there is still a lot to be done to understand how the concept of information became central in financial economics. Even if any direct link can be built between Hayek's theory and EMH, it raises a more important issue about how these two apparently independent theoretical innovations, written nearly at the same period, share so much. In other words, they are maybe two different ends of a same set of causes, and therefore, they are just reflecting a more general and deeper change at this period. This brings us back to the question of the possible *Weltanschauung* shared by the authors of the period, that some scholars labelled neoliberalism (Burgin 2012; Cahill and Konings 2017; Mirowski and Plehwe 2009).

4.7.1 Conclusion to chapter 4

This chapter has provided a methodological comparison of Hayek's information theory and Working and Fama's formulations of the market efficiency hypothesis. After a presentation of the two frameworks, the chapter has highlighted a common epistemology between the authors.

This epistemology is characterized by four premises: (a) The agent uses the subjective information it possesses to act and anticipate; (b) competition is a process of discovery and selection of the information possessed by

the agents; (c) the price resulting from this competition represents the only objective knowledge about the dispersed and subjective information of the agents; (d) the function of the market is thus to aggregate and centralize the dispersed information of the agents. Its role is not only to allow a material exchange between goods, the market also allows a cognitive exchange.

The comparison proposed in this chapter aimed to address methodological issues, but it obviously raises historical questions. For example, Hayek (and generally speaking the Austrian school) is a strong influence of the information theories that emerged after the war, and more generally, the conception of the market as “information processor” (Mirowski and Nik-Khah 2017). Through the figure of Working, this chapter also highlights parallel thoughts from a distinct tradition rooted in the agricultural economics. There is certainly room for further historical investigations on the “knowledge on the information” produced in the first half of the 20th.

The main message of this chapter remains, however, a methodological one. Comparing the efficient market hypothesis with Hayek’s theory shed light on the characteristics of the efficient market research program. The former cannot be reduced to a set of, even various, testable hypotheses. This research program is also composed of more fundamental hypotheses about the very nature of price and market. Throughout its history, the efficient market research program has not only explained phenomena occurring in financial markets, but it has also given a meaning and a function to these markets. Beyond its empirical solidity, this aspect may also explain the still current popularity of this concept.

Chapter 5

General conclusion

This thesis offered a history of the hypothesis of efficient market hypothesis through four episodes of interactions between financial economics and economics. Chapter 1 analyzed interwar agricultural economics as early financial economics. After describing the growing role of agricultural economists in the USDA, I focused on the practical work of those economists within administrations that viewed the state as the producer and distributor of unbiased and impartial information. In the final section, the chapter documented how Working's efficient market hypothesis development was intimately linked to the USDA's research agenda. While Working's defense of well-informed speculators remained rather marginal at that time, it seems that some U.S. economists widely acknowledged the central role of information. Apart from Working, the USDA's research on financial markets did not lead to purely academic contributions. However, their work and their thoughts on information are still visible today through the institutional devices they have effectively created, such as the Market-News Service or the Commodity Futures Trading Commission.

Chapter 2 explored how Working's arguments, written in the context of

the interwar period, were translated and developed during the emergence of financial economics in the 1960s. The chapter drew the intellectual trajectories of Paul Samuelson and Eugene Fama in the 1960s and 1970s. I showed that the main element that differentiated them is their conception of expertise. Fama was interpreting his work to provide practical recommendations in terms of investment strategy. On the contrary, Samuelson's research aimed to be useful for policymakers. In the first section, the chapter showed that this opposition was already visible in their initial 1965's contributions. The second part of the chapter provided explanations of their contrasted stances by emphasizing the institutional environments of each author. Despite the refinements of their views, I show in a final section that this opposition became more explicit in the early 1980s when the hypothesis became increasingly criticized. This comparison of the intellectual trajectories of Samuelson and Fama highlights a fundamental duality that runs through the history of the efficient market hypothesis. This hypothesis has historically been developed both by economists whispering to the "the prince" and by financial economists interested in the production of applied and practical knowledge for investors and managers.

Chapter 3 investigated the growing interactions between financial economists and macroeconomists in the 1970s. This chapter studied the genesis and perpetuation of the association between the efficient market hypothesis and the rational anticipation hypothesis. While the two concepts developed autonomously in the 1960s, they gradually became associated in the 1970s around the work of Thomas Sargent, Franco Modigliani, and Robert Shiller on the determination of the yield curve. The chapter showed how new definitions based on rational expectations were used in the early 1980s to criticize the validity of the hypothesis. By focusing on this association, the aim of this chapter has been to analyze the meeting between financial economists

and macroeconomists on the analysis of financial markets. As a result, the efficient market research program has underwent a profound transformation. Economists, mostly outsiders of the field, criticized it for the lack of rigor of its methodology, for the weakness of certain empirical tests, and for ignoring theoretical questions regarded as fundamental.

Chapter 4 was an epistemological analysis of the efficient market hypothesis. After presenting Hayek and market efficiency theoretical frameworks, the chapter proposed to compare them by distinguishing epistemological and methodological choices. Epistemology is the fundamental hypothesis of scholars, while methodology is their operationalization. This comparison showed that, despite significant methodological differences, these two theoretical frameworks shared the same epistemology. Both Hayek's theory and the hypothesis of market efficiency are based on a conception of prices that reflect market aggregated information. This chapter thus highlighted the diversity of functions related to the concept of market efficiency. Often considered as a testable hypothesis, the notion of market efficiency also provides *ex ante* interpretation of asset prices and financial markets.

Future research directions

Far from ending the discussion, the results of this thesis raised many questions that call for prospective research. Each of these chapters focused on distinct periods and issues for which it will be possible to extend the analysis. For example, regarding the "prehistory" of financial economics, a more comprehensive appraisal of Working's contribution to financial economics is a logical extension of the thesis. Beyond his work on the notion of information, future research may investigate more comprehensively the trajectory of this author, from the importance of U.S. institutionalism in his education

to his leadership at Stanford University. Moreover, future work may also focus on important issues that this thesis has neglected. For instance, while Chapter 1 emphasized the importance of data construction in the research of agricultural economists, the analysis of more recent periods has overlooked this important aspect of economists' research. A figure like Shiller, beyond his theoretical stands on irrational exuberance, is also known for having renewed the empirical research in financial economics and bringing new kinds of data, indicators, and econometric tests (Campbell 2014).

Among the possible developments, I would like to discuss here two issues that arise directly from the thesis: the use of quantitative methods for analyzing the recent economic thought and the political expertise of financial economics.

For a quantitative history of contemporary developments

Another natural development of this thesis is exploring the most recent research on the efficient market in the 1980s and beyond. Chapter 3 analyzed some important works that appeared in the early 1980s, but this thesis only briefly sketched the transformations in the field that took place over the next two decades. One of the main challenges for analyzing this period is to identify the evolution of the *status* of market efficiency during this period. Indeed, from the 1980s onwards, the notion seems to have become less and less a fairly well-defined research program, but rather a sort of allusive benchmark in several areas of financial economics, such as behavioral finance (Thaler 1999), both empirical and theoretical asset pricing (Campbell 2000), or market micro-structure (O'Hara 1997).

The significance of market efficiency in such research deserves further investigation. Given the growing importance of publications and fields of

research related to the concept of market efficiency, it seems increasingly difficult to analyze these changes without quantitative tools. Quantitative tools have been at the heart of recent discussions in the history of economic thought (*e.g.* Edwards, Giraud, and Schinckus 2018). These methods are increasingly viewed as very useful to complement qualitative analysis. In particular, they are well fitted to manage the huge rise of publications *and* the rise of references within one publication in the second half of the century (Claveau and Gingras 2016).

Such tools are particularly fitted to investigate the network of economists, and their evolution, by analyzing communities, their features, and their interrelations. For instance, Truc (2020), using co-citations analysis and network visualization, maps behavioral economics literature from the last forty years and found that behavioral finance emerged independently from others behaviorists and kept relatively closed boundaries. Efficient market hypothesis' theorists, like Fama (1970), remain well-cited in behavioral finance. It suggests that the debates did not end and that market efficiency remained an essential landmark in the field.

Following the stance of this thesis, bibliometrics is useful for investigating intradisciplinary interactions. For instance, these tools could be applied to develop the analysis of chapter 3 on the relationship between communities of macroeconomists and financial economists. Since the 1980s, various discussions have emerged between these two fields on banking and monetary theory, the determination of interest and exchange rates, or modeling price bubbles. All these issues are "boundary-objects" between finance and economics, which brings together a very wide community of economists. In addition to in-depth qualitative analysis, quantitative analysis can serve the historian as a tool to explore, delineate these large corpuses.

The political expertise of financial economists

The historical perspective provided by this thesis has emphasized the evolution of ideas, theories, and tools used by economists to analyze financial markets. It has also shed light on the changing *audience* to which economists are speaking. In the context of agricultural economics studied in Chapter 1, economists viewed themselves as experts in the service of the public sphere. In the context of the 1960s, the very same idea was developed to address the practical knowledge needed by business schools. Working and Fama raised a similar issue: can an individual possess better information than that contained in the price? Yet, the finality of the approaches outlined by the two authors is radically different. Working was interested in refuting the political position of GFA's economists. The latter considered price volatility to be unjustified. To make such claim, GFA's economists implicitly assumed that they had better information on economic fundamentals than that reflected in prices. In the 1960s, Fama criticized the practice of investors who made the same hypothesis to construct their investment strategy.

Since Working and GFA debates, the dialogues between economists and the public sphere have become more complex. Historically, the main audience of modern financial economists was the world of practice. The sociologists of science have shown the influence of ideas and tools from financial economics on the transformation of investors' practice (MacKenzie 2008). However, financial ideas are obviously not confined to the private sphere. For example, it has been documented how the efficient market hypothesis has been used to redefine U.S. legislation on fraud (*e.g.* Jovanovic 2018) and international accounting standards (*e.g.* Walter 2010).

It is clear that the global financial crisis has led financial economists to take an increasing interest in issues relating to the regulation of financial

markets, including macroprudential policies (see, Thiemann, Melches, and Ibrocevic 2020). However, we still know little about the influence of financial economics, from its emergence to the present day, on actors in the public sphere such as regulators or central bankers. The main difficulty is that financial economists very seldom explicitly intervene in public debates. It is much more difficult to understand how their ideas are disseminated and potentially amended within the public sphere. The example of Fama gives a clear illustration. Although he defended a pro-market view in his interviews, Fama also rejected the implication of his research in the process of de-regulating financial markets (see Klein 2018). On the other hand, regulators such as Adair Turner, director of the UK financial markets regulation agency between 2008 and 2012, has acknowledged the influence of this hypothesis in the regulation of financial markets in recent decades:

It is therefore likely that one of the root causes of the crisis was that the aggregate maturity transformation performed by the financial system grew significantly in the pre-crisis years but that, fatally, we failed to spot this [...] because we were over influenced by an efficient market theory which suggested that we could rely on the free market naturally to gravitate to a socially optimal balance. (Turner 2011, p. 17)

Beyond their explicit discourse and their institutional positions, economists may be indirectly influential by the dissemination of their tools and style of reasoning to the public sphere (Maas, Medema, and Guidi 2019). It is thus necessary to study these more implicit and indirect ways through which financial economists diffused their ideas. In this thesis, I analyzed the way financial economists *thought*, and sometimes *made recommendations*, about financial markets. A natural extension of such work would be to analyze the

way these economists have *trained* and *advised* actors in the public sphere. Such research would not focus on the history of academic work, but rather on the role of economic thought within governmental institutions, such as national regulatory agencies, central banks, and the bank for international settlements. It would shed light on why and how the efficient market hypothesis still remained an essential concept in the public debate to discuss financial markets and their regulation.

Bibliography

- Acosta, J. and G. Rubin (2019). "Bank Behavior in Large-Scale Macroeconomic Models of the 1960s". In: *History of Political Economy* 51.3, pp. 471–491.
- Alonzo, A. (2017). *100 Years of USDA Market News: The Trusted Source - Then, Now and Always*.
- Archives, N. (1995). "Web version based on Guide to Federal Records in the National Archives of the United States". In: *Records of the Bureau of Agricultural Economics*. Robert B. Matchette et al. Washington, DC: National Archives and Records Administration, p. 2428.
- Arena, R. (1999). "Hayek et l'équilibre économique: une autre interprétation/Hayek and Equilibrium: an Alternative Interpretation". In: *Revue d'économie politique* 109.6, pp. 847–858.
- Audier, S. (2013). "Les paradigmes du "Néolibéralisme"". In: *Cahiers philosophiques* 133.2, pp. 21–40.
- Bachelier, L. (1900). "Théorie de la spéculation". PhD thesis. Sorbonne de Paris.
- Backhouse, R. E. (June 2001). "How and Why should We Write the History of Twentieth-Century Economics?" In: *Journal of the History of Economic Thought* 23.2, pp. 243–251.
- BAE (1923). *Report of the Chief of the Bureau of Agricultural Economics*. Washington, D.C.: Office of Government Printing.

- BAE (1924). *Report of the Chief of the Bureau of Agricultural Economics*. Washington, D.C.: Office of Government Printing.
- (1925). *Report of the Chief of the Bureau of Agricultural Economics*. Washington, D.C.: Office of Government Printing.
- (1926). *Report of the Chief of the Bureau of Agricultural Economics*. Washington, D.C.: Office of Government Printing.
- (1928). *Report of the Chief of the Bureau of Agricultural Economics*. Washington, D.C.: Office of Government Printing.
- (1931). *Report of the Chief of the Bureau of Agricultural Economics*. Washington, D.C.: Office of Government Printing.
- (1933). *Report of the Chief of the Bureau of Agricultural Economics*. Washington, D.C.: Office of Government Printing.
- (1934). *Report of the Chief of the Bureau of Agricultural Economics*. Washington, D.C.: Office of Government Printing.
- Barber, W. J. (1989). *From New Era to New Deal: Herbert Hoover, the Economists, and American Economic Policy, 1921-1933*. Reprint edition. Cambridge: Cambridge University Press.
- Barber, W. J. (2001). "Economists and Professional Organisations in Pre-World War I America". In: *The Spread of Political Economy and the Professionalisation of Economists: Economic Societies in Europe, America and Japan in the Nineteenth Century* 50, p. 216.
- Berdell, J. and J. W. Choi (Dec. 2018). "Clashing Analyses of Speculation and the Early Regulation of US Futures Markets". In: *Journal of the History of Economic Thought* 40.4, pp. 539–560.
- Bernstein, P. L. (1993). *Capital ideas: the improbable origins of modern Wall Street*. New York: Simon and Schuster.

- Berthonnet, I. (2014). "De l'efficacité à la concurrence: Histoire d'une thèse entre économie néoclassique et néolibéralisme". PhD thesis. Lille 1.
- Biddle, J. (1999). "Statistical Economics, 1900-1950". In: *History of Political Economy* 31.4, pp. 607–651.
- (June 2017). "2016 HES Presidential Address: Statistical Inference in Economics, 1920-1965: Changes in Meaning and Practice". In: *Journal of the History of Economic Thought* 39.2, pp. 149–173.
- Birner, J. (2006). "La place de Sensory Order dans l'oeuvre de F.A. Hayek". In: *Cahiers d'économie politique/Papers in Political Economy* 51.2, pp. 109–138.
- Black, F. (1986). "Noise". In: *The Journal of Finance* 41.3, pp. 529–543.
- Black, F. and M. Scholes (1973). "The Pricing of Options and Corporate Liabilities". In: *Journal of political economy* 81.3, pp. 637–654.
- Blanchard, O. (Jan. 1979). "Speculative Bubbles, Crashes and Rational Expectations". In: *Economics Letters* 3.4, pp. 387–389.
- (2016). *Macroeconomics*. 7th Global edition. London: Pearson.
- Blanchard, O. and M. W. Watson (July 1982). *Bubbles, Rational Expectations and Financial Markets*. Working Paper 945. National Bureau of Economic Research.
- Blaug, M. (1992). *The methodology of economics: Or, how economists explain*. Cambridge, UK: Cambridge University Press.
- Boas, T. C. and J. Gans-Morse (2009). "Neoliberalism: From New Liberal Philosophy to Anti-liberal Slogan". In: *Studies in comparative international development* 44.2, pp. 137–161.
- Boettke, P. J. (2018). *FA Hayek: Economics, Political Economy and Social Philosophy*. London: Palgrave Macmillan.

- Boettke, P. J. and K. W. O'Donnell (2013). "The Failed Appropriation of FA Hayek by Formalist Economics". In: *Critical Review* 25.3-4, pp. 305–341.
- Bogle, J. C. (Sept. 2011). "How the Index Fund Was Born". In: *Wall Street Journal*.
- Boianovsky, M. (May 2020). "Paul Samuelson's Ways to Macroeconomic Dynamics". In: *The European Journal of the History of Economic Thought* 27.4, pp. 1–29.
- Bourdeau, M. (Oct. 2014). "L'idée d'ordre spontané ou le monde selon Hayek". In: *Archives de Philosophie* Tome 77.4, pp. 663–687.
- Bourdieu, P. (1976). "Le champ scientifique". In: *Actes de la Recherche en Sciences Sociales* 2.2, pp. 88–104.
- Brian, E. and C. Walter (2007). *Critique de la valeur fondamentale*. Paris: Springer.
- Brisset, N. (2018). "Models as Speech Acts: The Telling Case of Financial Models". In: *Journal of Economic Methodology* 25.2018, pp. 21–41.
- Brown, S. J., W. N. Goetzmann, and A. Kumar (1998). "The Dow Theory: William Peter Hamilton's Track Record Reconsidered". In: *The Journal of Finance* 53.4, pp. 1311–1333.
- Buchanan, J. M. and V. J. Vanberg (Oct. 1991). "The Market as a Creative Process". In: *Economics & Philosophy* 7.2, pp. 167–186.
- Burda, M. and C. Wyplosz (2013). *Macroeconomics: a European text*. Oxford: Oxford university press.
- Burgin, A. (Oct. 2012). *The great persuasion: reinventing free markets since the depression*. Cambridge, Massachusetts: Harvard University Press.
- Burton, M., R. F. Nesiba, and B. Brown (2010). *An introduction to financial markets and institutions*. 3rd. London: Routledge.
- Butos, W. N. (1985). "Hayek and general equilibrium analysis". In: *Southern Economic Journal* 52.2, pp. 332–343.

- (1997). “Hayek and Rational Expectations”. In: *Austrian economics in debate*. Ed. by W. Keizer, B. Tieben, and V. Z. Zijp. Routledge. London: Psychology press, pp. 220–242.
- Cahill, D. and M. Konings (Sept. 2017). *Neoliberalism*. Cambridge, UK: Polity Press.
- Caldwell, B. (1984). *Disentangling Hayek, Hutchison and Popper on the methodology of economics*. Manuscript. Greensboro: University of North Carolina.
- (1988). “Hayek’s Transformation”. In: *History of Political Economy* 20.4, pp. 513–541.
- (2011). “The Chicago School, Hayek, and Neoliberalism”. In: *Building Chicago Economics: New Perspectives on the History of Americas Most Powerful Economics Program*. Ed. by P. Mirowski, T. Stapleford, and R. Van Horn. New York: Cambridge University Press, pp. 301–34.
- Call, L. E., R. M. Green, and C. O. Swanson (1925). *How To Grow and Market High-Protein Wheat*. Tech. rep. Agricultural Experiment Station, Kansas State Agricultural College, Departments of Agronomy, Agricultural Economics and Milling Industry.
- Campbell, J. Y. (2000). “Asset Pricing at the Millennium”. In: *The Journal of Finance* 55.4, pp. 1515–1567.
- Campbell, J. Y. (2014). “Empirical asset pricing: Eugene fama, lars Peter hansen, and Robert Shiller”. In: *The Scandinavian Journal of Economics* 116.3, pp. 593–634.
- Campbell, J. Y., A. Lo, and A. MacKinlay (1997). *The econometrics of financial markets*. Princeton, NJ: Princeton University Press.
- Caré, S. (2016). “La dérive des continents néolibéraux: essai de typologie dynamique”. In: *Revue de philosophie économique* 17.1, pp. 21–55.
- Cargill, T. F. (1975). “The Term Structure of Interest Rates: a Test of the Expectations Hypothesis”. In: *The Journal of Finance* 30.3, pp. 761–771.

- Challe, d. (2008). "Valeur fondamentale et efficacité informationnelle". In: *Critique de la valeur fondamentale*. Ed. by C. Walter and E. Brian. Christian Walter et Éric Brian. Paris: Springer, pp. 25–54.
- Chancellier, E. (2014). "Les Débuts du Bureau of Agricultural Economics - La modélisation des récoltes (1922-1930)". In: *Histoires & Sociétés Rurales* 42.2, pp. 113–147.
- Charron, J.-O. (2017). "Inefficient Debate. The EMH, the Remarkable Error and a Question of Point of View". In: *Accounting, Economics, and Law: A Convivium* 7.3.
- Cherrier, B. (2017). "Classifying Economics: A History of the JEL Codes". In: *Journal of Economic Literature* 55.2, pp. 545–579.
- Chiapello, E. and C. Walter (2016). "The Three Ages of Financial Quantification: A Conventionalist Approach to the Financiers' Metrology". In: *Historical Social Research / Historische Sozialforschung* 41.2 (156), pp. 155–177.
- Claveau, F. and Y. Gingras (2016). "Macrodynamics of economics: A Bibliometric History". In: *History of Political Economy* 48.4, pp. 551–592.
- Cochrane, J. H. (2005). *Asset Pricing*. Princeton, N.J: Princeton University Press.
- (2011). "Presidential Address: Discount Rates". In: *The Journal of Finance* 66.4, pp. 1047–1108.
- (May 2017). "Macro-Finance". In: *Review of Finance* 21.3, pp. 945–985.
- Colin-Jaeger, N. and T. Delcey (2020). "When efficient market hypothesis meets Hayek on information: beyond a methodological reading". In: *Journal of Economic Methodology* 27.2, pp. 97–116.
- Conant, C. A. (1904). *Wall Street and the country : a study of recent financial tendencies*. New York ; London : G. P. Putnam's sons.

- Cooper, T. (1929). “[Encouraging the Farmer to Take Agricultural Outlook Material and Use It]: Discussion”. In: *Journal of Farm Economics* 11.1, pp. 125–127.
- Cootner, P., ed. (1964). *The random character of stock market prices*. MIT Press. Cambridge, Massachusetts.
- Cootner, P. H. (1962). “Stock Prices: Random vs Systematic Changes”. In: *Industrial Management Review* 3.2, pp. 24–45.
- Cot, A.-L. and J. Lallement (2006). “1859-1959: de Walras à Debreu, un siècle d’équilibre général”. In: *Revue économique* 57.3, pp. 377–388.
- Cowles, A. (1933). “Can Stock Market Forecasters Forecasts”. In: *Econometrica* 1.3, pp. 309–324.
- (1938). *Common-stock Indexes, 1871-1937*. Principia Press. Bloomington.
- (1944). “Stock Market Forecasting”. In: *Econometrica* 12.3/4, pp. 206–214.
- Cowles, A. and H. Jones (1937). “Some a Posteriori Probabilities in Stock Market Action”. In: *Econometrica* 5.3, pp. 289–294.
- Craig, S. (Nov. 2001). ““The Farmer’s Friend”: Radio Comes to Rural America, 1920-1927”. In: *Journal of Radio Studies* 8.2, pp. 330–346.
- Da Silva, D. F. R. (2017). “Lucas’s Research in the Late 1960s and the Natural Rate of Unemployment”. In: *History of Political Economy* 49.1, pp. 137–159.
- Dardot, P. and C. Laval (Feb. 2020). *La nouvelle raison du monde: Essai sur la société néolibérale*. La Découverte.
- Darity, W., R. Leeson, and W. Young (Apr. 2004). *Economics, Economists and Expectations: From Microfoundations to Macroapplications*. London ; New York: Routledge.
- De Bondt, W. F. M. and R. H. Thaler (1985). “Does the Stock Market Overreact?” In: *The Journal of Finance* 40.3, pp. 793–805.
- De Long, J. B. et al. (1990). “Noise trader risk in financial markets”. In: *Journal of political Economy* 98.4, pp. 703–738.

- De Vroey, M. (2016). *A history of macroeconomics from Keynes to Lucas and beyond*. Cambridge University Press.
- Delcey, T. (Mar. 2019). "Samuelson vs Fama on the Efficient Market Hypothesis: The Point of View of Expertise". In: *Oeconomia. History, Methodology, Philosophy* 9-1, pp. 37–58.
- Delcey, T. and F. Sergi (July 2019). *The Efficient Market Hypothesis and Rational Expectations. How Did They Meet and Live (Happily?) Ever After*.
- Didier, E. (2009). *En quoi consiste l'Amérique ? Les statistiques, le New Deal et la démocratie*. Anthropologie des sciences et des techniques. Paris: La Découverte.
- Dimand, R. (June 2007). "Irving Fisher and Financial Economics: The Equity Premium Puzzle, the Predictability of Stock Prices, and Intertemporal Allocation Under Risk". In: *Journal of the History of Economic Thought* 29.2, pp. 153–166.
- (Sept. 2009). "The Cowles Commission and Foundation on the Functioning of Financial Markets from Irving Fisher and Alfred Cowles to Harry Markowitz and James Tobin". In: *Revue d'Histoire des Sciences Humaines* 20, pp. 79–100.
- Dimand, R. and W. Veloce (2010). "Alfred Cowles and Robert Rhea on the Predictability of Stock Prices". In: *The Journal of Business Inquiry* 9.1, pp. 56–64.
- Dornbusch, R. (1976). "Expectations and Exchange Rate Dynamics". In: *Journal of political Economy* 84.6, pp. 1161–1176.
- Dostaler, G. (2001). *Le libéralisme de Hayek*. Paris: La Découverte.
- Duarte, P. G. and G. T. Lima (2012). *Microfoundations reconsidered: The relationship of micro and macroeconomics in historical perspective*. London: Edward Elgar Publishing.

- Duvel, J. W. T. and G. W. Hoffman (1928). *Major Transactions in the 1926 December Wheat Future*. Technical Bulletin 79. Washington, D.C.: United States Department of Agriculture.
- Edlinger, C. and A. Parent (Mar. 2014). "The Beginnings of a 'Common-sense' Approach to Portfolio Theory by Nineteenth-Century French Financial Analysts Paul Leroy-Beaulieu and Alfred Neymarck". In: *Journal of the History of Economic Thought* 36.1, pp. 23–44.
- Edmans, A., I. Goldstein, and W. Jiang (2012). "The Real Effects of Financial Markets: The Impact of Prices on Takeovers". In: *The Journal of Finance* 67.3, pp. 933–971.
- Edwards, J., Y. Giraud, and C. Schinckus (Oct. 2018). "A quantitative Turn in the Historiography of Economics?" In: *Journal of Economic Methodology* 25.4, pp. 283–290.
- Elliott, F. (1929). "Experimental Method in Economic Research". In: *Journal of Farm Economics* 11.4, pp. 594–596.
- Estabrook, L. M. (1923). "The Use of Crop Reports by Farmers". In: *Journal of Farm Economics* 5.1, pp. 28–35.
- Ezekiel, M. (Feb. 1938). "The Cobweb Theorem". In: *The Quarterly Journal of Economics* 52.2, pp. 255–280.
- Fama, E. F. (Oct. 1965a). "Random Walks in Stock Market Prices". In: *Financial analysts journal* 51.1, pp. 75–80.
- (Jan. 1965b). "The Behavior of Stock-Market Prices". In: *The Journal of Business* 38.1, pp. 34–105.
- (May 1970). "Efficient Capital Markets: A Review of Theory and Empirical Work". In: *The Journal of Finance* 25.2, pp. 383–417.
- (1972a). "Components of Investment Performance*". In: *The Journal of Finance* 27.3, pp. 551–567.

- Fama, E. F. (1972b). "Perfect Competition and Optimal Production Decisions Under Uncertainty". In: *The Bell Journal of Economics and Management Science* 3.2, pp. 509–530.
- (1975). "Short-term Interest Rates as Predictors of Inflation". In: *The American Economic Review* 65.3, pp. 269–282.
- (Mar. 1976a). "Efficient Capital Markets: Reply". In: *The Journal of Finance* 31.1, p. 143.
- (Oct. 1976b). "Forward Rates as Predictors of Future Spot Rates". In: *Journal of Financial Economics* 3.4, pp. 361–377.
- (1976c). *Foundations of finance: portfolio decisions and securities prices*. New York: Basic Books.
- (Jan. 1980). "Banking in the theory of finance". In: *Journal of Monetary Economics* 6.1, pp. 39–57.
- (Nov. 1984). "Forward and Spot Exchange Rates". In: *Journal of Monetary Economics* 14.3, pp. 319–338.
- (1991). "Efficient Capital Markets: II". In: *The Journal of Finance* 46.5, pp. 1575–1617.
- (Sept. 1998). "Market Efficiency, Long-term Returns, and Behavioral Finance". In: *Journal of Financial Economics* 49.3, pp. 283–306.
- Fama, E. F. and K. R. French (Oct. 1988). "Dividend Yields and Expected Stock Returns". In: *Journal of Financial Economics* 22.1, pp. 3–25.
- Fama, E. F. and R. H. Thaler (June 2016). "Are Markets Efficient?" In: *Chicago Booth Review*.
- Fama, E. F. et al. (1969). "The Adjustment of Stock Prices to New Information". In: *International Economic Review* 10.1, pp. 1–21.
- Feller, W. (1957). *An Introduction to Probability Theory and its Applications*. John Wiley & Sons. New York.

- Fischer, S. (1996). "Robert Lucas's Nobel memorial prize". In: *The Scandinavian Journal of Economics* 98.1, pp. 11–31.
- (2008). "New Classical Macroeconomics". In: *The New Palgrave Dictionary of Economics*. Ed. by S. Durlauf and L. E. Blume. Palgrave Macmillan. Basingstoke: Palgrave Macmillan.
- Fisher, I. (1896). "Appreciation and Interest". In: *Economic Journal* 11.4, pp. 567–570.
- (1930). *The Theory of Interest*. Macmillan. New York.
- Fisher, L. and J. H. Lorie (1964). "Rates of return on investments in common stocks". In: *The Journal of Business* 37.1, pp. 1–21.
- Fisher, R. A. (1925). *Statistical Methods for Research Workers*. Edinburgh: Oliver and Boyd.
- Fite, G. C. (1971). "The Reluctant Farmer: The Rise of Agricultural Extension to 1914. By Roy V. Scott. Urbana, III., University of Illinois Press, 1970. pp 362." In: *Business History Review* 45.4, pp. 530–531.
- Forder, J. (2014). *Macroeconomics and the Phillips curve myth*. First edition. Oxford studies in the history of economics. Oxford: Oxford University Press.
- Fourcade, M. and R. Khurana (Mar. 2013). "From Social Control to Financial Economics: the Linked Ecologies of Economics and Business in Twentieth Century America". In: *Theory and Society* 42.2, pp. 121–159.
- (June 2017). "The Social Trajectory of a Finance Professor and the Common Sense of Capital". In: *History of Political Economy* 49.2, pp. 347–381.
- Fourcade Gourinchas, M. and S. Babb (2002). "The Rebirth of the Liberal Creed: Paths to Neoliberalism in Four Countries". In: *American Journal of Sociology* 108.3, pp. 533–579.

- Fox, J. (Feb. 2011). *The Myth of the Rational Market: A History of Risk, Reward, and Delusion on Wall Street*. Reprint edition. New York, NY: HarperBusiness.
- Fox, K. A. (1986). "Agricultural Economists as World Leaders in Applied Econometrics, 1917-33". In: *American Journal of Agricultural Economics* 68.2, pp. 381–386.
- Friedman, M. (Feb. 2009). *Capitalism and Freedom: Fortieth Anniversary Edition*. Chicago: University of Chicago Press.
- Garber, P. M. (1990). "Famous First Bubbles". In: *Journal of Economic perspectives* 4.2, pp. 35–54.
- (2001). *Famous first bubbles: The fundamentals of early manias*. Cambridge, Massachusetts: MIT Press.
- GFA (1924). *Report of the Chief of the Grain Futures Administration 1923*. Washington, D.C.: Office of Government Printing.
- Gindis, D. (Oct. 2020). "On the origins, meaning and influence of Jensen and Mecklings definition of the firm". In: *Oxford Economic Papers* 72.4, pp. 966–984.
- Goetzmann, W. N. (2016). *Money Changes Everything How Finance Made Civilization Possible*. Princeton: Princeton University Press.
- Gordon, M. J. and E. Shapiro (1956). "Capital Equipment Analysis: The Required Rate of Profit". In: *Management Science* 3.1, pp. 102–110.
- Goutsmedt, A. (Dec. 2017). "Les macroéconomistes et la stagflation : essais sur les transformations de la macroéconomie dans les années 1970". Ph.D. Dissertation. Paris 1.
- Grimes, W. E. (1929). "Experimental Method in Economic Research". In: *Journal of Farm Economics* 11.4, pp. 584–586.
- Grossman, S. J. and R. Shiller (1980). "The Determinants of the variability of Stock Market Prices". In: *American Economic Review* 71.2, pp. 222–227.

- Grossman, S. J. and J. E. Stiglitz (1976). "Information and Competitive Price Systems". In: *The American Economic Review* 66.2, pp. 246–253.
- (1980). "On the Impossibility of Informationally Efficient Markets". In: *The American Economic Review* 70.3, pp. 393–408.
- Guerrien, B. and O. Gun (2011). "Efficient Market Hypothesis: What Are We Talking About?" In: *Real-world economics review* 56.11, pp. 19–30.
- Guth, R. A. (Nov. 2008). "Chicago Business School Gets Huge Gift". In: *Wall Street Journal*.
- Hacking, I. (Oct. 1983). *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Cambridge: Cambridge University Press.
- Hall, R. E. (1996). "Robert Lucas, Recipient of the 1995 Nobel Memorial Prize in Economics". In: *The Scandinavian Journal of Economics* 98.1, pp. 33–48.
- Hamburger, M. J. and C. M. Latta (1969). "The Term Structure of Interest Rates: Some Additional Evidence". In: *Journal of Money, Credit and Banking* 1.1, pp. 71–83.
- Hamburger, M. J. and E. N. Platt (1975). "The Expectations Hypothesis and the Efficiency of the Treasury Bill Market". In: *The Review of Economics and Statistics* 57.2, pp. 190–199.
- Harding, T. S. (1947). *Two Blades of Grass. A History of Scientific Development in the U.S. Department of Agriculture*. Norman: University of Oklahoma Press.
- Harrison, J. M. and D. M. Kreps (June 1979). "Martingales and Arbitrage in Multiperiod Securities Markets". In: *Journal of Economic Theory* 20.3, pp. 381–408.
- Harrison, J. M. and S. R. Pliska (1981). "Martingales and stochastic integrals in the theory of continuous trading". In: *Stochastic processes and their applications* 11.3, pp. 215–260.

- Hart, V. (1929). "Encouraging the Farmer to Take Agricultural Outlook Material and Use It". In: *Journal of Farm Economics* 11.1, pp. 108–125.
- Hayek, F. A. (1937). "Economics and Knowledge". In: *Economica* 4.13, pp. 33–54.
- (1945). "The Use of Knowledge in Society". In: *The American Economic Review* 35.4, pp. 519–530.
- (1948a). "Free Enterprise and Competitive Order". In: *Individualism and economic order*. University of Chicago Press. Chicago, pp. 107–18.
- (1948b). *Individualism and Economic Order*. University of Chicago Press.
- (1952). *The Sensory Order*. University of Chicago Press. Chicago.
- (1953). *The counter-revolution of science*. Liberty Fund Inc.
- (1976). *Law, Legislation and Liberty, Volume 2: The Mirage of Social Justice*. Chicago: University of Chicago Press.
- (1979). *Law, Legislation and Liberty, Volume 3: The Political Order of a Free People*. Chicago: University of Chicago Press.
- Hicks, J. (1939). *Value and Capital: An Inquiry into some Fundamental Principles of Economic Theory*. Oxford: Clarendon Press.
- Hirschman, D. and E. P. Berman (Oct. 2014). "Do Economists Make Policies? On the Political Effects of Economics". In: *Socio-Economic Review* 12.4, pp. 779–811.
- Hirshleifer, J. (1973). "Where Are We in the Theory of Information?" In: *American Economic Review* 63.2, pp. 31–39.
- Hoffman, G. W. (1937). "Past and Present Theory Regarding Futures Trading". In: *Journal of Farm Economics* 19.1, pp. 300–309.
- Hoffman, G. W. and J. W. T. Duvel (1941). *Grain Prices and the Futures Market: A 15-year Survey, 1923-1938*. Technical Bulletin. United States Department of Agriculture.

- Holt, C. C. et al. (1960). *Planning Production, Inventories, and Work Force*. Prentice-Hall. Englewood Cliffs, N.J.
- Hoover, K. (1992). *The new classical macroeconomics*. The International Library of Critical Writings in Economics series. London ; New York: Edward Elgar Publishing.
- Hoover, K. D. (1988). *The New Classical Macroeconomics: A Sceptical Inquiry*. Oxford: Basil Blackwell.
- Hoover, K. D. and W. Young (2013). "Rational Expectations: Retrospect and Prospect: A Panel Discussion with Michael Lovell, Robert Lucas, Dale Mortensen, Robert Shiller, and Neil Wallace". In: *Macroeconomic Dynamics* 17.5, pp. 1169–1192.
- Horn, R. V., P. Mirowski, and T. A. Stapleford (Oct. 2011). *Building Chicago Economics: New Perspectives on the History of America's Most Powerful Economics Program*. Cambridge: New York: Cambridge University Press.
- Howells, P. G. and K. Bain (2010). *The Economics of Money, Banking and Finance: a European Text*. 6th. Englewood Cliffs, N.J.: Prentice Hall.
- Hutchison, T. W. (1981). *The politics and philosophy of economics: Marxians, Keynesians and Austrians*. Oxford: Blackwell Oxford.
- Jensen, M. C. (1968). "The Performance of Mutual Funds in the Period 1945-1964". In: *The Journal of Finance* 23.2, pp. 389–416.
- (1978). "Some Anomalous Evidence Regarding Market Efficiency". In: *Journal of Financial Economics* 6.2-3, pp. 95–101.
- Jensen, M. C. and W. H. Meckling (Oct. 1976). "Theory of the Firm: Managerial Behavior, agency Costs and Ownership Structure". In: *Journal of Financial Economics* 3.4, pp. 305–360.

- Jovanovic, F. (2000). "L'origine de la théorie financière: une réévaluation de l'apport de Louis Bachelier / The origin of financial theory: A reevaluation of the contribution of Louis Bachelier". In: *Revue d'économie politique* 110.3, pp. 395–418.
- (Jan. 2008). "The Construction of the Canonical History of Financial Economics". In: *History of Political Economy* 40.2, pp. 213–242.
- (2009a). "Le modèle de marche aléatoire dans l'économie financière de 1863 à 1976". In: *Revue d'Histoire des Sciences Humaines* 20.1, p. 51.
- (2009b). "L'institutionnalisation de l'économie financière : perspectives historiques". In: *Revue d'Histoire des Sciences Humaines* 20.1, p. 3.
- (June 2012). "Bachelier: Not the Forgotten Forerunner He Has Been Depicted as. An Analysis of the Dissemination of Louis Bachelier's Work in Economics". In: *The European Journal of the History of Economic Thought* 19.3, pp. 431–451.
- (2018). "Beyond Performativity, How and Why American Courts Should Not Have Used Efficient Market Hypothesis". In: *The Making of Finance. Perspectives from the Social Sciences*. Ed. by I. Chambost, M. Lenglet, and Y. Tadjeddine. Toronto, Canada: Routledge.
- Jovanovic, F., S. Andreadakis, and C. Schinckus (Sept. 2016). "Efficient market hypothesis and fraud on the market theory a new perspective for class actions". In: *Research in International Business and Finance* 38, pp. 177–190.
- Jovanovic, F. and C. Schinckus (Jan. 2017). *Econophysics and Financial Economics: An Emerging Dialogue*. Oxford, New York: Oxford University Press.
- Jovanovic, F. and G. Numa (2020). "The Re-introduction of Financial Economics Ideas in France Between the mid-1970 and the mid-1980". In: *History of Political Economy* Forthcoming.

- Jullien, D. (Sept. 2018). "Practices of Using Interviews in History of Contemporary Economics A Brief Survey". In: *History of Political Economy* 50.3, pp. 563–570.
- Jung, J. and R. Shiller (Apr. 2005). "Samuelson's Dictum and the Stock Market". In: *Economic Inquiry* 43.2, pp. 221–228.
- Kane, E. J. and B. G. Malkiel (1967). "The Term Structure of Interest Rates: An Analysis of a Survey of Interest-rate Expectations". In: *The Review of Economics and Statistics* 49.3, pp. 343–355.
- Kantor, B. (1979). "Rational Expectations and Economic Thought". In: *Journal of Economic Literature* 17.4, pp. 1422–1441.
- Kendall, M. (1953). "The analysis of Economic Time-Series-Part I: Prices". In: *Journal of the Statistical Royal Society. Serie A (General)* 116.1, pp. 11–34.
- Keuzenkamp, H. A. (1991). "A Precursor to Muth: Tinbergen's 1932 Model of Rational Expectations". In: *The Economic Journal* 101.408, pp. 1245–1253.
- Khalil, E. L. (2002). "Information, Knowledge and the Close of Friedrich Hayek's System". In: *Eastern Economic Journal* 28.3, pp. 319–341.
- Khurana, R. (2007). *From Higher Aims to Hired Hands - The Social Transformation of American Business Schools and the Unfulfilled Promise of Management as a Profess.* Princeton, N.J.: Princeton University Press.
- King, W. I. (1930). *Index numbers elucidated.* Longmans economic series. New York, London etc.: Longmans, Green and co.
- Kirkendall, R. S. (1966). *Social Scientists and Farm Politics in the Age of Roosevelt.* Columbia: University of Missouri Press.
- Kirzner, I. M. (1988). "The Economic Calculation Debate: Lessons for Austrians". In: *The review of Austrian economics* 2.1, pp. 1–18.
- Klein, D. B. (2018). "Eugene F. Fama." In: *Econ Journal Watch* 15.3, pp. 365–375.

- Konings, M. (2018). *Capital and time: For a new critique of neoliberal reason*. Stanford: Stanford University Press.
- Krippner, G. R. (May 2005). "The Financialization of the American Economy". In: *Socio-Economic Review* 3.2, pp. 173–208.
- Krugman, P. (Sept. 2009). "How Did Economists Get It So Wrong?" In: *The New York Times*.
- Kydland, F. E. and E. C. Prescott (1982). "Time to Build and Aggregate Fluctuations". In: *Econometrica* 50.6, pp. 1345–1370.
- Laffer, A. B. and R. Zecher (1975). "Some Evidence on the Formation, Efficiency and Accuracy of Anticipations of Nominal Yields". In: *Journal of Monetary Economics* 1.3, pp. 327–342.
- Laidler, D. E. W. (1982). *Monetarist Perspectives*. Harvard University Press.
- Lakatos, I. (1976). "Falsification and the Methodology of Scientific Research Programmes". In: *Can Theories be Refuted?* Ed. by S. Harding. Vol. Synthese Library (Monographs on Epistemology, Logic, Methodology, Philosophy of Science, Sociology of Science and of Knowledge, and on the Mathematical Methods of Social and Behavioral Sciences). Dordrecht: Springer, pp. 205–259.
- Lakatos, I. and A. Musgrave (1970). *Criticism and the growth of knowledge*. Vol. Proceedings of the International Colloquium in the Philosophy of Science. 4. Cambridge: Cambridge University Press.
- Lenfant, J.-S. (2017). "Early Debates on Quality, Market Coordination and Welfare in the U.S. in the 1930s". HAL Working paper.
- LeRoy, S. F. (1973). "Risk Aversion and the Martingale Property of Stock Prices". In: *International Economic Review* 14.2, pp. 436–446.
- (Mar. 1976). "Efficient Capital Markets: Comment". In: *The Journal of Finance* 31.1, pp. 139–141.

- (1989). “Efficient Capital Markets and Martingales”. In: *Journal of Economic Literature* 27.4, pp. 1583–1621.
- Lininger, F. F. (1929). “Market Information and the Farmer’s Problems”. In: *The Annals of the American Academy of Political and Social Science* 142, pp. 341–351.
- Lo, A. (2008). “Efficient Market Hypothesis”. In: *The New Palgrave Dictionary of Economics*. Ed. by S. Durlauf and L. E. Blume. Steven N. Durlauf, and Lawrence E. Blume. Basingstoke: Palgrave Macmillan.
- Long, J. B. and C. I. Plosser (1983). “Real Business Cycles”. In: *Journal of political Economy* 91.1, pp. 39–69.
- Louçã, F. (2004). “Swinging all the Way: the Education of Doctor Lucas and Foes”. In: *History of political economy* 36.4, pp. 689–735.
- Lucas, R. E. (1972). “Expectations and the Neutrality of Money”. In: *Journal of economic theory* 4.2, pp. 103–124.
- (1978). “Asset Prices in an Exchange Economy”. In: *Econometrica* 46.6, pp. 1429–45.
- (1996). “Robert E. Lucas Jr. Biographical.” In: *The Nobel Prizes*. Stockholm: Nobel Foundation. Stockholm.
- Lucas, R. E. (Sept. 2009). “In defence of the dismal science”. In: *The Economist*.
- Lutz, F. A. (Nov. 1940). “The Structure of Interest Rates”. In: *The Quarterly Journal of Economics* 55.1, pp. 36–63.
- Lévy, D. and G. Duménil (2014). *La grande bifurcation*. Paris: La Découverte.
- Maas, H., S. G. Medema, and M. Guidi (June 2019). “Introduction to Economics as a Public Science”. In: *Oeconomia. History, Methodology, Philosophy* 9-2, pp. 201–207.
- MacCauley, F. R. (1925). “Forecasting security prices”. In: *Journal of the American Statistical Association* 20.150, pp. 244–249.

- MacKenzie, D. (2008). *An engine, not a camera: how financial models shape markets*. Inside technology. Cambridge, Mass.: MIT.
- Malkiel, B. G. (1989). "Efficient Market Hypothesis". In: *Finance*. Ed. by J. Eatwell, M. Milgate, and P. Newman. The New Palgrave. London: Palgrave Macmillan UK, pp. 127–134.
- (Mar. 2003). "The Efficient Market Hypothesis and Its Critics". In: *Journal of Economic Perspectives* 17.1, pp. 59–82.
- Mandelbrot, B. (1963). "The Variation of Certain Speculative Prices". In: *The Journal of Business* 36.4, pp. 394–394.
- (1966). "Forecasts of future prices, unbiased markets, and" martingale" models". In: *The Journal of Business* 39.1, pp. 242–255.
- McCloskey, D. N. (May 1998). *The Rhetoric of Economics*. University of Wisconsin Press.
- McCloskey, D. N. (1983). "The Rhetoric of Economics". In: *Journal of Economic Literature* 21.2, pp. 481–517.
- McDean, H. C. (1984). "Professionalism, Policy, and Farm Economists in the Early Bureau of Agricultural Economics". In: *Agricultural History* 58.3, pp. 373–392.
- Mehl, P. (1934). "Trading in Futures and Price Fluctuations". In: *Journal of Farm Economics* 16.3, pp. 481–495.
- (1940). "Trading in Wheat and Corn Futures in Relation to Price Movements". In: *Journal of Farm Economics* 22.3, pp. 601–612.
- Mehrling, P. (1997). *The money interest and the public interest: American monetary thought, 1920-1970*. Cambridge, Mass: Harvard University Press.
- (2005). *Fischer Black and the revolutionary idea of finance*. New York: Wiley.
- (2016). "Financial Economics". In: *Handbook on the History of Economic Analysis*. Ed. by G. Faccarello and H. Kurz. Gilbert Faccarello & Heinz

- Kurz. Vol. *Developments in Major Fields of Economics*. Edward Elgar Publishing, pp. 198–207.
- Meiselman, D. (1962). *The term structure of interest rates*. Englewood Cliffs, N.J.: Prentice-Hall.
- Merton, R. C. (1985). “On the current state of the stock market rationality hypothesis”. Working paper. Sloan School of Management, MIT.
- Merton, R. C. (2006). “Paul Samuelson and Financial Economics”. In: *The American Economist* 50.2, pp. 9–31.
- Mignon, V. (Mar. 2008). “Les ambiguïtés de la théorie de l’efficience informationnelle des marchés financiers”. In: *Regards croisés sur l’économie* 1.3, pp. 104–117.
- Mirowski, P. (Dec. 2007). “Naturalizing the market on the road to revisionism: Bruce Caldwell’s Hayek’s challenge and the challenge of Hayek interpretation”. In: *Journal of Institutional Economics* 3.3, pp. 351–372.
- (2009). “Why There is (as yet) no Such Thing as an Economics of Knowledge”. In: *The Oxford handbook of philosophy of economics*. Ed. by D. Ross and H. Kincaid. Oxford Handbooks. Oxford.
- Mirowski, P. and E. Nik-Khah (Aug. 2017). *The knowledge we have lost in information: the history of information in modern economics*. Oxford, New York: Oxford University Press.
- Mirowski, P. and D. Plehwe, eds. (2009). *The road from Mont Pèlerin: the making of the neoliberal thought collective*. Cambridge, Mass: Harvard University Press.
- Mishkin, F. S. (1978). “Efficient-Markets Theory: Implications For Monetary Policy”. In: *Brookings Papers on Economic Activity* 1978.3, pp. 707–752.
- (1983). *A rational expectations approach to macroeconometrics: Testing policy ineffectiveness and efficient-markets models*. Chicago: University of Chicago Press.

- Mishkin, F. S. (Jan. 1990). "What Does the Term Structure Tell Us About Future Inflation?" In: *Journal of Monetary Economics* 25.1, pp. 77–95.
- Mishkin, F. S. (2016). *The economics of money, banking, and financial markets*. Harlow: Pearson.: Eleventh Edition.
- Mäki, U. (Oct. 2016). "Philosophy of interdisciplinarity. What? Why? How?" In: *European Journal for Philosophy of Science* 6.3, pp. 327–342.
- Mäki, U., A. Walsh, and M. F. Pinto (2017). *Scientific imperialism: Exploring the boundaries of interdisciplinarity*. London: Routledge.
- Modigliani, F. and R. A. Cohn (Mar. 1979). "Inflation, Rational Valuation and the Market". In: *Financial Analysts Journal* 35.2, pp. 24–44.
- Modigliani, F. and M. H. Miller (1958). "The Cost of Capital, Corporation Finance and the Theory of Investment". In: *The American Economic Review* 48.3, pp. 261–297.
- Modigliani, F. and R. Shiller (1973). "Inflation, Rational Expectations and the Term Structure of Interest Rates". In: *Economica* 40.157, pp. 12–43.
- Modigliani, F. and R. Sutch (1966). "Innovations in Interest Rate Policy". In: *The American Economic Review* 56.1/2, pp. 178–197.
- (1967). "Debt management and the term structure of interest rates: an empirical analysis of recent experience". In: *Journal of Political Economy* 75.4, Part 2, pp. 569–589.
- (1969). "The Term Structure of Interest Rates: A Reexamination of the Evidence: Reply". In: *Journal of Money, Credit and Banking* 1.1, pp. 112–120.
- Morgan, M. S. (Nov. 1991). *The History of Econometric Ideas*. Cambridge: Cambridge University Press.
- Morgan, M. S. and M. Rutherford (1998). *From Interwar Pluralism to Postwar Neoclassicism*. Durham: Duke University Press.

- Mougeot, C. (2009). "Théorie autrichienne du cycle et théorie des cycles d'équilibre". In: *Revue française d'économie* 24.4, pp. 67–92.
- Muth, J. F. (1961). "Rational Expectations and the Theory of Price Movements". In: *Econometrica: Journal of the Econometric Society* 29.3, pp. 315–335.
- Niehans, J. (1975). "Some Doubts About the Efficacy of Monetary Policy Under Flexible Exchange Rates". In: *Journal of International Economics* 5.3, pp. 275–281.
- Nik-Khah, E. (2011). "Chicago neoliberalism and the genesis of the Milton Friedman Institute (20062009)". In: *Building Chicago Economics*. Ed. by P. Mirowski, T. Stapleford, and R. Van Horn, pp. 368–388.
- O'Hara, M. (1997). *Market microstructure theory*. N.J.: Wiley.
- Ouz, F. (June 2010). "Hayek on Tacit Knowledge". In: *Journal of Institutional Economics* 6.2, pp. 145–165.
- Porter, T. M. (1981). "A Statistical Survey of Gases: Maxwell's Social Physics". In: *Historical Studies in the Physical Sciences* 12.1, pp. 77–116.
- Posner, R. A. (Aug. 2009). "Economists on the Defensive—Robert Lucas". In: *The Atlantic*.
- Poterba, J. M. and L. H. Summers (1988). "Mean reversion in stock prices: Evidence and implications". In: *Journal of financial economics* 22.1, pp. 27–59.
- Preda, A. (2000). "Financial Knowledge and the Science of the Market in England and France in the 19th Century". In: *Facts and figures: Economic representations and practices*. Ed. by H. Kalthoff, R. Rottenburg, and H.-J. Wagener. Metropolis Verlag. Marburg, pp. 205–228.
- (2001). "The Rise of Popular Investor: Financial Knowledge and Investing in England and France, 1840-1880". In: *The Sociological Quarterly* 42.2, pp. 205–232.

- Preda, A. (June 2004). "Informative Prices, Rational Investors: The Emergence of the Random Walk Hypothesis and the Nineteenth-Century "Science of Financial Investments"". In: *History of Political Economy* 36.2, pp. 351–386.
- (Oct. 2006). "Socio-Technical Agency in Financial Markets: The Case of the Stock Ticker". In: *Social Studies of Science* 36.5, pp. 753–782.
- Quine, W. V. (1951). "Main Trends in Recent Philosophy: Two Dogmas of Empiricism". In: *The Philosophical Review* 60.1, pp. 20–43.
- Regnault, J. (1863). *Calcul des chances et philosophie de la bourse*.
- Roberts, H. V. (1959). "Stock-Market Patterns and Financial Analysis: Methodological Suggestions". In: *The Journal of Finance* 14.1, pp. 1–10.
- (1967). "Statistical versus clinical prediction of the stock market". In: *Unpublished manuscript*.
- Roll, R. (1968). "The Efficient Market Model Applied to US Treasury Bill Rates". Ph. D. diss. Graduate School of Business, University of Chicago.
- Rosenberg, A. (1992). *Economics-Mathematical politics or science of finimishing returns?* Chicago: University of Chicago Press.
- Ross, S. A. (Dec. 1976). "The Arbitrage Theory of Capital Asset Pricing". In: *Journal of Economic Theory* 13.3, pp. 341–360.
- Ross, S. A. (1978). "A Simple Approach to the Valuation of Risky Streams". In: *The Journal of Business* 51.3, pp. 453–475.
- Ross, S. A. (1987). "The Interrelations of Finance and Economics: Theoretical Perspectives". In: *The American Economic Review* 77.2, pp. 29–34.
- (2008). "Finance". In: *The New Palgrave Dictionary of Economics*. Manchester: Palgrave Macmillan.
- Rubinstein, M. (2001). "Rational Markets: Yes or No? The Affirmative Case". In: *Financial Analysts Journal* 57.3, pp. 15–29.

- Rutherford, M. (2001). "Institutional Economics: Then and Now". In: *The Journal of Economic Perspectives* 15.3, pp. 173–194.
- (2011a). *The institutionalist movement in American economics, 1918-1947: science and social control*. Cambridge; New York: Cambridge University Press.
- (2011b). "The USDA Graduate School: Government training in statistics and economics, 1921-1945". In: *Journal of the History of Economic Thought* 33.4, pp. 419–447.
- Rutterford, J. and D. P. Sotiropoulos (Nov. 2016). "Financial Diversification before Modern Portfolio Theory: UK financial Advice Documents in the Late Nineteenth and the Beginning of the Twentieth Century". In: *The European Journal of the History of Economic Thought* 23.6, pp. 919–945.
- Saleuddin, R. (2018). *The Government of Markets: How Interwar Collaborations between the CBOT and the State Created Modern Futures Trading*. Palgrave Studies in the History of Finance. London: Palgrave Macmillan.
- Samuelson, P. (1953). *Houthakker to Samuelson, February 12th 1953*. Correspondence series 1933 - 2010. Paul A. Samuelson Papers, 1933-2010 and Undated at David M. Rubenstein Rare Book Manuscript Library, Duke University, United States.
- (1957). "Intertemporal Price Equilibrium: A Prologue to the Theory of Speculation". In: *Weltwirtschaftliches Archiv* 79, pp. 181–221.
- (1961a). *Samuelson to Working, May 9, 1961*. Correspondence series 1933 - 2010. Paul A. Samuelson Papers, 1933-2010 and Undated at David M. Rubenstein Rare Book Manuscript Library, Duke University, United States.
- (1961b). *Working to Samuelson, May 2nd 1961*. Correspondence series 1933 - 2010. Paul A. Samuelson Papers, 1933-2010 and Undated at David

- M. Rubenstein Rare Book Manuscript Library, Duke University, United States.
- Samuelson, P. (1961c). *Working to Samuelson, May 31st 1961*. Correspondence series 1933 - 2010. Paul A. Samuelson Papers, 1933-2010 and Undated at David M. Rubenstein Rare Book Manuscript Library, Duke University, United States.
- (1965a). “Proof that Properly Anticipated Prices Fluctuate Randomly”. In: *Industrial Management Review* 6.2, pp. 41–49.
- (1965b). “Rational Theory of Warrant Pricing”. In: *Industrial Management Review* 6.2, pp. 13–39.
- (1973a). “Mathematics of Speculative Price”. In: *Society for INdustrial and Applied Mathematics* 15.1, pp. 1–42.
- (1973b). “Proof That Properly Discounted Present Values of Assets Vibrate Randomly”. In: *Bell Journal of Economics* 4.2, pp. 369–374.
- (Jan. 1974). “Challenge to Judgment”. In: *The Journal of Portfolio Management* 1.1, pp. 17–19.
- (Jan. 1989). “The Judgment of Economic Science on Rational Portfolio Management: Indexing, Timing, and Long-horizon Effects”. In: *The Journal of Portfolio Management* 16.1, pp. 4–12.
- (1994). “The Long-term Case for Equities”. In: *The Journal of Portfolio Management* 21.1, pp. 15–24.
- (2004). “The Backward Art of Investing Money”. In: *Journal of Portfolio Management* 30.5, pp. 30–33.
- Samuelson, P. A. and J. E. Stiglitz (1991). *The collected scientific papers of Paul A. Samuelson. Vol. 2: [...] 7. printing*. Cambridge, Mass.: MIT Press.
- Santos, J. (2008). “A History of Futures Trading in the United States”. In: *EH. Net Encyclopedia, www.eh.net*.

- Sargent, T. J. (1969). "Commodity Price Expectations and the Interest Rate". In: *The Quarterly Journal of Economics*, pp. 127–140.
- (1972a). "Anticipated Inflation and the Nominal rate of Interest". In: *The Quarterly Journal of Economics* 86.2, pp. 212–225.
- (1972b). "Rational expectations and the term structure of interest rates". In: *Journal of Money, Credit and Banking* 4.1, pp. 74–97.
- (1973). "Interest rates and prices in the long run: a study of the Gibson paradox". In: *Journal of Money, Credit and Banking* 5.1, pp. 385–449.
- (1996). "Expectations and the Nonneutrality of Lucas". In: *Journal of Monetary Economics* 37.3, pp. 535–548.
- (2008). "Rational Expectations". In: *The New Palgrave Dictionary of Economics*. Steven N. Durlauf, and Lawrence E. Blume. Basingstoke: Palgrave Macmillan.
- Schinckus, C. (Sept. 2009). "La finance comportementale ou le développement d'un nouveau paradigme". In: *Revue d'Histoire des Sciences Humaines* 20.1, pp. 101–127.
- (2011). "Archeology of Behavioral Finance". In: *IUP Journal of Behavioral Finance* 8.2, p. 7.
- Scott, R. V. (1971). *The Reluctant Farmer: The Rise of Agricultural Extension to 1914*. Urbana: University of Illinois Press.
- Sent, E.-M. (1998a). "Sargent and the Unbearable Lightness of Symmetry". In: *Journal of Economic Methodology* 5.1, pp. 93–114.
- (1998b). *The Evolving Rationality of Rational Expectations: An Assessment of Thomas Sargent's Achievements*. Cambridge: Cambridge University Press.
- (2002). "How (Not) to Influence People: the Contrary Tale of John F. Muth". In: *History of Political Economy* 34.2, pp. 291–319.

- Sergi, F. (Mar. 2017). "De la révolution lucasienne aux modèles DSGE : réflexions sur les développements récents de la modélisation macroéconomique". Ph.D. Dissertation. Paris 1.
- Sergi, F. (2020). "The Standard Narrative about DSGE Models in Central Banks Technical Reports". In: *The European Journal of the History of Economic Thought* 27.2, pp. 163–193.
- Sharpe, W. F. (1966). "Mutual Fund Performance". In: *The Journal of Business* 39.1, pp. 119–138.
- Sheffrin, S. M. (1983). *Rational expectations*. Cambridge University Press.
- Shiller, R. (1972). "Rational Expectations and the Structure of Interest Rates." PhD thesis. Cambridge: MIT.
- (1973a). "A Distributed Lag Estimator Derived From Smoothness Priors". In: *Econometrica* 41.4, pp. 775–788.
- (1973b). "Rational Expectations and the Term Structure of Interest Rates: Comment". In: *Journal of Money, Credit and Banking* 5.3, pp. 856–860.
- (1979). "The volatility of Long-term Interest Rates and expectations Models of the Term Structure". In: *Journal of political Economy* 87.6, pp. 1190–1219.
- (1981). "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?" In: *American Economic Review* 71.3, pp. 421–36.
- (1984). "Stock Prices and Social Dynamics". In: *Brookings Papers on economic activity* 2, pp. 457–498.
- (2003). "From Efficient Markets Theory to Behavioral Finance". In: *The Journal of Economic Perspectives* 17.1, pp. 83–104.
- Siegel, J. J. (Oct. 2009). "Efficient Market Theory and the Crisis". In: *Wall Street Journal*.
- Sims, C. A. (June 1980). *Martingale-Like Behavior of Prices*. Working Paper 489. National Bureau of Economic Research.

- Smith, V. L., G. L. Suchanek, and A. W. Williams (1988). "Bubbles, Crashes, and Endogenous Expectations in Experimental Spot Asset Markets". In: *Econometrica* 56.5, pp. 1119–1151.
- Stapleford, T. A. (June 2017). "Business and the Making of American Economics, 1910-1940". In: *History of Political Economy* 49.2, pp. 233–265.
- Star, S. L. and J. R. Griesemer (Aug. 1989). "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39". In: *Social Studies of Science* 19.3, pp. 387–420.
- Stigler, G. J. (1961). "The Economics of Information". In: *The journal of political economy* 69.3, pp. 213–225.
- Summers, L. H. (1985). "On Economics and Finance". In: *The Journal of Finance* 40.3, pp. 633–635.
- (July 1986). "Does the Stock Market Rationally Reflect Fundamental Values?" In: *The Journal of Finance* 41.3, pp. 591–601.
- Taqqu, M. S. (Jan. 2001). "Bachelier and His Times: A Conversation With Bernard Bru". In: *Finance and Stochastics* 5.1, pp. 3–32.
- Taylor, H. C. (1940). "Early History of Agricultural Economics". In: *Journal of Farm Economics* 22.1, pp. 84–97.
- Thaler, R. H. (1999). "The End of Behavioral Finance". In: *Financial Analysts Journal* 55.6, pp. 12–17.
- Thiemann, M., C. R. Melches, and E. Ibrocevic (June 2020). "Measuring and Mitigating Systemic Risks: How the Forging of New Alliances Between Central Bank and Academic Economists Legitimize the Transnational Macroprudential Agenda". In: *Review of International Political Economy* Forthcoming.
- Thompson, E. A. (2007). "The Tulipmania: Fact or Artifact?" In: *Public Choice* 130.1-2, pp. 99–114.

- Tinbergen, J. (1933). "The notions of Horizon and Expectancy in Dynamic Economics". In: *Econometrica* 1.3, pp. 247–264.
- Tirole, J. (1982). "On the Possibility of Speculation under Rational Expectations". In: *Econometrica* 50.5, pp. 1163–1181.
- (1985). "Asset Bubbles and Overlapping Generations". In: *Econometrica* 53.6, pp. 1499–1528.
- Treynor, J. L. (1965). "How to Rate Management of Investment Funds?" In: *Harvard Business Review* 43.1, pp. 63–75.
- Truc, A. (2020). *Forty Years of Behavioral Economics*. Working Paper. Centre interuniversitaire de recherche sur la science et la technologie, Université du Québec à Montréal.
- Turner, A. (2011). *Leverage, maturity transformation and financial stability: challenges beyond Basel III*. Speech. Cass Business School.
- United States (2017). *U.S CODE, Title 7, Chapter 13 Agricultural and Mechanical Colleges, Subchapter IV Agricultural Work Appropriation*.
- USDA (1907). *Yearbook of Agriculture 1906*. Washington, D.C.: Office of Government Printing.
- (1914). *Yearbook of Agriculture 1913*. Washington, D.C.: Office of Government Printing.
- (1915). *Yearbook of Agriculture 1914*. Washington, D.C.: Office of Government Printing.
- (1919). *Yearbook of Agriculture 1918*. Washington, D.C.: Office of Government Printing.
- USDA (1923). *Report of Chief of Bureau of Agricultural Economics*. Washington, D.C.: Government Printing Office.
- USDA (1926). *Yearbook of Agriculture 1925*. Washington, D.C.: Office of Government Printing.

-
- (1927). *Yearbook of agriculture 1926*. Washington, D.C.: Office of Government Printing.
- (1930). "Classified List of Projets of the Agricultural Experiment Stations - Compiled in the Office of Experiment Stations". In: ed. by United States Department of Agriculture.
- Vestuti, G. (2004). "Caldwell B.(2004)," Hayek's Challenge. An Intellectual Biography of FA Hayek"". In: *Economia politica* 21.3, pp. 511–513.
- Vines, D. and S. Wills (2018). "The Rebuilding Macroeconomic Theory Project: an Analytical Assessment". In: *Oxford Review of Economic Policy* 34.1-2, pp. 1–42.
- Vives, X. (2008). *Information and Learning in Markets*. Princeton: Princeton University Press.
- (Oct. 2014). "On the Possibility of Informationally Efficient Markets". In: *Journal of the European Economic Association* 12.5, pp. 1200–1239.
- Vuilleme, G. (2013). "Sur le statut épistémologique de l'hypothèse d'efficience des marchés". In: *Revue de philosophie économique* 14.2, pp. 93–118.
- (Apr. 2014). "Epistemological Foundations for the Assessment of Risks in Banking and Finance". In: *Journal of Economic Methodology* 21.2, pp. 125–138.
- Walter, C. (1996). "Une histoire du concept d'efficience sur les marchés financiers". In: *Annales. Histoire, Sciences Sociales* 51.4, pp. 873–905.
- (1999). "Aux origines de la mesure de performance des fonds d'investissement: les travaux d'Alfred Cowles". In: *Histoire & Mesure* 14.1, pp. 163–197.
- (2005a). "La gestion indicielle et la théorie des moyennes". In: *Revue d'économie financière* 79.2, pp. 113–136.
- (2005b). "Les quatre causes de l'efficacité informationnelle des marchés". In: *Finance Bien Commun* 23.3, pp. 107–115.

- (2006). “Les martingales sur les marchés financiers, une convention stochastique ?” In: *Revue de synthèse* 127.2, p. 379.
- Walter, C. (2010). “IAS 39 et la martingalisation des marchés financiers”. In: *Nouvelles normes financières*. Ed. by C. Walter and H. Rodarie. Paris: Springer, pp. 97–123.
- (2013). *Le modèle de marché au hasard en finance*. Paris: Économica.
- (2015). “La seconde quantification de la finance”. In: *Cités* 4, pp. 53–64.
- Wang, Y. (2008). “Finance (New Developments)”. In: *The New Palgrave Dictionary of Economics*. Basingstoke: Palgrave Macmillan.
- Warren, G. F. (Jan. 1932). “The Origin and Development of Farm Economics in the United States”. In: *Journal of Farm Economics* 14.1, p. 2.
- Weintraub, E. R. (Dec. 1999). “How Should We Write the History of Twentieth-century Economics?” In: *Oxford Review of Economic Policy* 15.4, pp. 139–152.
- Weintraub, E. R. (1993). *General Equilibrium Analysis: Studies in Appraisal*. University of Michigan Press.
- (May 2002). *How Economics Became a Mathematical Science*. Durham ; London: Duke University Press Books.
- ed. (2014). *MIT and the transformation of American economics*. History of political economy 46, Annual suppl. Durham, NC: Duke Univ. Press.
- Wheeler, W. A. (1923). “Down on the Farm in 1923”. In: *Radio Broadcast*, pp. 212–214.
- Wik, R. M. (1988). “The USDA and the Development of Radio in Rural America”. In: *Agricultural History* 62.2, pp. 177–188.
- Williams, C. (1929). “Continuous Economic Information Readily Available to Farmers”. In: *Journal of Farm Economics* 11.1, pp. 79–94.
- Williams, J. B. (1938). *The Theory of Investment Value*.

- Wilson, J. and C. Jones (2002). "An Analysis of the S&P 500 Index and Cowless Extensions: Price Indexes and Stock Returns, 1870-1999". In: *The Journal of Business* 75.3, pp. 505–533.
- Wilson, M. L. (1929). "Experimental Method in Economic Research". In: *Journal of Farm Economics* 11.4, pp. 578–583.
- Winthrop, S. H. (Sept. 2014). *Catching lightning in a bottle: how merrill lynch revolutionized the financial world*. Hoboken, NY: Wiley.
- Wood, J. H. (1964). "The Expectations Hypothesis, the Yield Curve, and Monetary Policy". In: *The Quarterly Journal of Economics* 78.3, pp. 457–470.
- Working, H. (1922). *Factors Determining the Price of Potatoes in St. Paul and Minneapolis*. Vol. 10. University Farm. University of Minnesota, Agricultural Experiment Station.
- (1934). "A Random-Difference Series for Use in the Analysis of Time Series". In: *Journal of the American Statistical Association* 29.185, pp. 11–24.
- (1935). "Differential Price Behavior as a Subject for Commodity Price Analysis". In: *Econometrica* 3.4, pp. 416–427.
- (1937). "Futures Trading and Regulations: Discussion by Holbrook Working". In: *American Journal of Agricultural Economics* 19.1, pp. 309–312.
- (1949a). "The Investigation of Economic Expectations". In: *The American Economic Review* 39.3, pp. 150–166.
- (1949b). "The Theory of Price of Storage". In: *The American Economic Review* 39.6, pp. 1254–1262.
- (1953). "Futures Trading and Hedging". In: *The American Economic Review* 43.3, pp. 314–343.
- (1958). "A Theory of Anticipatory Prices". In: *The American Economic Review* 48.2, pp. 188–199.

-
- (1962). “New Concepts Concerning Futures Markets and Prices”. In: *The American Economic Review* 52.3, pp. 431–459.
- (1963). “Futures Markets Under Renewed Attack”. In: *Food Research Institute Studies* 4.1, pp. 1–12.
- Young, W. (2014). *Real business cycle models in economics*. Routledge.
- Young, W. and W. Darity (2001). “The Early History of Rational and Implicit Expectations”. In: *History of political economy* 33.4, pp. 773–813.
- Zijp, R. v. (1990). *Why Lucas Is Not a Hayekian*. Tech. rep. Series 33, Tinbergen Institute. Rotterdam.

Remerciements

J'aimerais tout d'abord remercier les membres du jury. Au-delà d'offrir leur expertise pour évaluer ce travail, leurs écrits ont constitué parmi les principales influences de ma recherche. Je suis extrêmement reconnaissant aux rapporteurs, Valérie Mignon et Perry Mehrling, qui ont accepté d'examiner cette thèse. Je voudrais tout particulièrement exprimer toute ma gratitude à Annie L. Cot qui m'a dirigé durant ces cinq années de thèse. Il serait difficile de décrire en quelques mots la qualité de sa direction et ma reconnaissance qui en découle. Au-delà d'une thèse, sa direction fut plus globalement l'apprentissage progressif du métier de chercheur. Pour cela, pour sa rigueur, sa disponibilité et son soutien sans faille, je la remercie vivement.

Bien qu'il soit nécessaire d'apposer mon seul nom sur cette thèse, cela cache la dimension profondément collective d'un tel travail. En premier lieu, j'ai pu profiter durant ces cinq années de conditions de travail exceptionnel au sein de l'axe Économie Politique du Centre d'Économie de la Sorbonne, et je remercie chaleureusement les équipes du deuxième étage qui ont été mes voisins de bureaux pendant toutes ces années. En plus de ce confort matériel, j'ai également pu, grâce au soutien de l'axe, présenter mes travaux dans de nombreuses conférences durant ces 5 années. J'aimerais en particulier remercier Olivier Allain, Martine Bernadeau, Francesca Di Legge et Jérôme Gautié qui ont toujours su répondre à mes nombreuses sollicitations. Je suis extrêmement reconnaissant du soutien apporté par l'école doctorale, merci à Mouez Foudha, Nathalie Louni, Loïc Sorel, Jean-Christophe Fouillé, Christelle Gauvrit, et Jean-Philippe Carrié. Merci également aux membres du *History of Political Center* à Duke University, et en particulier Bruce Cadwell et Angela Zemonek pour m'avoir accueilli chaleureusement pendant

les trois mois passés là-bas.

Trois chapitres de cette thèse furent l'objet de collaborations avec d'autres chercheurs, Nathanaël Colin-Jaeger, Guillaume Noblet et Francesco Sergi. Avant tout des amis, ils sont aussi devenus des coauteurs. En plus de leurs collaborations à cette thèse, ils ont constitué parmi les lecteurs et commentateurs les plus assidues de mes recherches. Je les remercie pour leurs contributions inestimables à cette thèse et surtout pour leurs amitiés.

J'aimerais exprimer ma profonde gratitude envers le groupe de recherche qui m'a accueilli lorsque j'ai débuté cette thèse (REhPERE). J'ai profité des innombrables relectures, commentaires, discussions formelles et informelles avec ces chercheurs. Pour beaucoup, ils sont évidemment bien plus que des collègues. Dans un ordre qui suit une marche aléatoire, merci en particulier à Aurélien Goutsmedt, Nicolas Camilotto, Elizaveta Burina, Erich Pinzon-Fuchs, Quentin Couix, Niels Boissonnet, Matthieu Renault, Cléo Chassonery-Zaïgouche, Cristian Frasser, Judith Favereau, François Allison, Kevin Leportier, Jérôme Lallement, Justine Loulergue, Dorian Jullien, Maxime Desmarais-Tremblay, Julien Gradoz, Thibaud Choppin de Janvry, Pierrick Dechaux, Nicolas Brisset, Jean-Sébastien Lenfant, Clara Leonard.

Ces années ont été avant tout un travail quotidien à la maison des sciences économique. Je n'aurais jamais espéré pouvoir trouver un environnement de travail aussi chaleureux et stimulant. Un dernier mais un vraiment grand merci à tous ceux qui ont, de près ou de loin, contribué (et souvent bien plus que moi) à cette vie collective: merci au 2^{ème} à Matthieu, Pouick, Robin, Niels, Malo, Poppy, Quitterie, Quentin, Guillaume, Dorian, Marion, Thibaud, Florent, Medhi, Céline ; au 3^{ème} à Hélène, Sofia, Léon, Yara, Adriana ; et bien sur au 4^{ème} à Justine, Rémi, Antoine, au deuxième Matthieu, et au deux autres Quentins !