The Dissemination of Fama (1970)*

A Bibliometric Analysis

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What is the life of a seminal paper? This article addresses this question by studying the dissemination of Fama (1970), which introduced the efficient market hypothesis. Using network analysis, I study the various groups of research that cite Fama (1970) and how they evolve over time. I show that the paper was not only a canonical article in economics but also a reference in other fields such as law, management, and marketing. Market efficiency was interpreted in various ways, from a testable hypothesis about the behavior of prices to a useful assumption for evaluating policies. By tracing the various pathways through which this seminal article was exported and translated, the analysis shows the rising influence of finance across the social sciences in the second half of the twentieth century. The article also contributes to the development of quantitative methods applied to the history of economics by providing an interactive, open-source platform that allows users to explore networks and clusters.

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Introduction

On October 14, 2013, Eugene Fama received the Nobel prize, together with Robert Shiller and Lars Peter Hansen. The choice by the Nobel committee of rewarding Fama was unusually commented on by the media (Allen 2013; Authers 2013; Appelbaum 2013). The world was just recovering from the great financial crisis and the prize was rewarding the scholar who developed the efficient market hypothesis, a theory criticized for having overlooked financial instability. Commentators also emphasized that the prize rewarded both Fama and Shiller who happens to be one of his main intellectual critics. Shiller built his career in showing the shortcomings of market efficiency and and by developing an alternative framework known as behavioral finance. Rewarding both scholars sent the signal that the debate was still open. Shiller himself was critical of Fama, which was uncommon for a fellow laureate. "I don't know if Fama ever states his theory really clearly", he said after the nomination, "if he did it might sound a little odd" (Allen 2013)

These reactions prompted essays from financial economists, who felt the necessity to justify the significance of Fama's contributions and to emphasize the complementarity with Shiller's (e.g. Campbell 2014). One of those accounts was given by Cochrane (2014), who argued that "the efficient-markets theory did not become famous because it is complex. The greatness of Fama's contribution lies in the fact that efficient-markets became the organizing principle for decades of empirical work in financial economics." "When you think of Fama, don't think of Einstein", he pursued "Think of Darwin, who also saw that a simple principle—evolution by natural selection—organized and gave purpose to a vast collection of facts."

The simple principle to which Cochrane is referring to was popularized by Fama in a literature review published in the *Journal of Finance* in 1970. The review was a synthesis of the already important literature on the behavior of asset prices in the 1960s. Fama offered a simple framework that gave sense to heterogeneous empirical research. These various empirical studies, Fama argued, could be understood as tests of the very same idea: in a functioning market, price should reflect all information available and relevant to market participants. If not, information could be used to make a profit, which could be observed in empirical tests. Fama divided three different ways to test this idea, the weak, semi-strong and strong tests of market efficiency depending on the type of information that should be reflected in prices: respectively past, public, and private information.

The success of this framework made Fama (1970) a canonical article in financial economics and while the review in itself became quickly outdated, it became one of the most cited papers in economics and finance. Cochrane (2014) underlines the importance of Fama's contribution to research in asset pricing but the dissemination of Fama (1970) went far beyond the field of asset pricing, and financial economics. It became an important reference about a specific view of finance, the efficient market hypothesis (EMH), that spread to other communities of research. To give an appreciation of the popularity of the article, I compute in the figure 1 the number of citations of Fama (1970) and two other important and more recent reviews by Fama on market efficiency—the sequel to the 1970 article (1991) and an essay on behavioral finance (1998). The last two articles are also reviews on the EMH but far more recent regarding advances in theoretical and empirical asset pricing. Yet the 1970 article has been consistently

cited more than the two other articles.

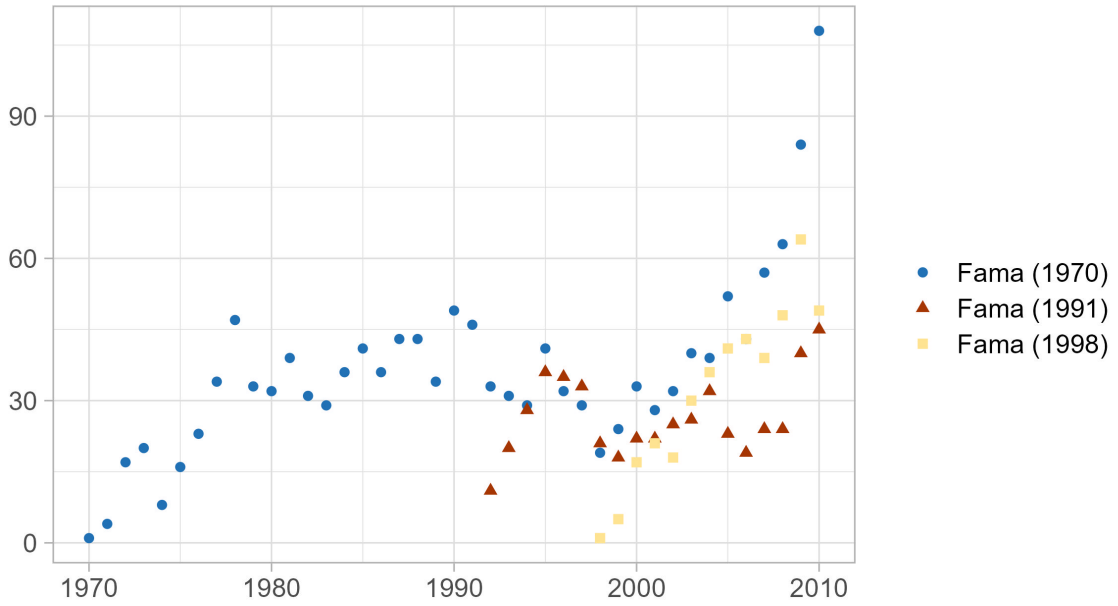

Figure 1: Number of citations by year for Fama (1970), Fama (1991), and Fama (1998). Source: Web of Science

In this article, I study the dissemination of Fama (1970) over the years using a network analysis. My goal is not to use Fama (1970) as a proxy to study the history of finance, or even the influence of Fama. It is rather the *story of a paper* and its reception. I study how a specific paper disseminates over time, across different communities of research, and through various interpretations. I show that far from being a canonical article of a single community, Fama (1970) disseminates in various fields in economics and other disciplines, such as law and management. I also show that the dissemination of market efficiency—through Fama (1970)—led to various interpretations and applications of the EMH. Understood as a testable hypothesis for some researchers, the EMH was a powerful insight into information to be developed by others fields, or even an useful assumption to use price as benchmark for evaluating policies.

To assess my argument, I use a network analysis. The paper aims at contributing to the development of quantitative methods applied to the history of economics. In particular, I developed an R interactive platform that allows users to explore networks by interacting with nodes and clusters. Such platform facilitates the interpretation of clusters for authors and the transparency of the process for reviewers and readers. The paper also contributes to the history of financial economics by analyzing the dissemination of a seminal article in the field. If the importance of Fama (1970) in the emergence of financial economics has been studied (e.g. Walter 1996; Jovanovic 2008), its dissemination in the following decades in finance and other fields remained largely unexplored. This study fills that gap, but in doing so, it speaks

to a broader set of questions about the power and influence of economic ideas. Specifically, this paper provides a bibliometric account of the rising influence of finance in social sciences (see Fourcade and Khurana 2013). I trace the bibliographical pathways through which a core financial concept was exported, translated into subfields of economics, accounting, law, management, and marketing.

The next section details the construction of networks and clusters. I then present the results of the analysis, focusing on the presentation of clusters. The final section discusses the implications of this analysis for understanding the dissemination of Fama (1970) and its impact on financial economics and beyond. The conclusion discusses the implications of this analysis for the history of economics.

Building networks

Using the Web of Science Core Collection, I build a corpus of 2419 published articles citing Fama's review from its publication in 1970 to 2010. I estimate a coupling network exploiting the data on the references of documents. In a coupling network analysis, the nodes are documents and the edges are a measure of the proximity of their bibliography. The fundamental hypothesis of coupling analysis is that documents that share the same references are likely to be similar in their research. The coupling network is then a representation of the intellectual proximity between documents of the corpus. This method has been increasingly used in the history of economics to make sense of large corpora (Claveau and Gingras 2016; Truc 2020; Goutsmedt 2021). I detail below the methodology used to build the coupling network. The full analysis is implemented in `R` and is available on the GitHub repository https://github.com/tdelcey/research.

Coupling similarity and clusters

One crucial aspect of coupling analysis is the measure used to estimate the proximity between documents. The simplest methods are measures derived from the raw count of shared references (Shen et al. 2019). However, large networks tend to have noisy edges that can make the network too dense and difficult to interpret. One way to decrease the density of the network is to remove edges that are below a certain weight threshold. While being simple, this method is also arbitrary and the level of the chosen threshold can strongly affect the network. I use instead the stochastic degree sequence model of Neal (2014) that defines *statistically significant* edges. Intuitively, the stochastic degree sequence model keeps edges that are important and that represent the core structure of the network, also called the backbone, and thereby removing noisy edges. The interpretation of the network and cluster is generally easier than with a raw network.[1]

Because the method is removing noisy edges, that is, *real observations*, it might be interesting to give a more precise definition of what is considered as noisy or not by the model. Consider

[1]The R implementation of the stochastic degree sequence model is available in the `backbone` package (Zachary P Neal 2022).

B, a bipartite network linking documents and references. B is a $d \times r$ matrix, where d is the number of documents and r is the number of references. Any element of B is defined as $B_{ik} = 1$ if document i cites reference k, otherwise $B_{ik} = 0$. The sum of a column represents the number of documents citing a reference k. The sum of a row represents the number of references in a document i. B is basically the raw data. Now consider P, the projection onto a bibliographic coupling of B. P is a $d \times d$ matrix defined as $B \times B^T$. Any element of P, P_{ij}, is defined as the number of references shared between documents i and j. P_{ij} might be viewed as the raw count of shared references between documents. The *backbone* of P is denoted as P', a similar $d \times d$ matrix where $P'_{ij} = 1$ if document i and document j are *significantly* linked, otherwise $P'_{ij} = 0$. P'_{ij} is defined by the following general rule:

$$P'_{ij} = \begin{cases} 1 & \text{if } \Pr(P^*_{ij} \geq P_{ij}) < \frac{\alpha}{2}, \\ 0 & \text{otherwise.} \end{cases}$$

Where P^*_{ij} is the number of references shared between documents i and j from a null hypothesis. Backbone models differ in the definition of the null hypothesis. The stochastic degree sequence model generates N bipartite networks $\mathcal{B}^*$ that share *on average* the degree sequence of the observed network B. It is important that P' is filtering the raw data contained in P and one could argue that it is a form of data reduction since we remove *observed* edges. However, as for any frequentist approach, the stochastic degree sequence model evaluates the probability of observing a relationship. The model is thus removing *observed* edges but whose existence is likely not meaningful to assess a coupling relationship between documents and to identify clusters.

In the context of coupling analysis, a cluster is a set of documents that share more references with each other than with the rest of the clusters. I identify clusters using the Leiden method (Traag, Waltman, and Eck 2019), an improvement of the Louvain method (Blondel et al. 2008). This class of algorithms is a cluster detection method that aims at maximizing the modularity of a network.[2] Modularity optimization algorithms have been widely used in the history of economics to identify consistent group of research in large networks (e.g., Goutsmedt 2021; Truc 2020). Clusters are often interpreted as communities of research that share a common set of ideas, methods and values and are organized around a common set of institutions such as universities or journals. However, in the context of this paper, this interpretation might be misleading as the clusters do not necessarily constitute a full community but only a subset of documents citing Fama (1970). A rising (declining) cluster in the present analysis does not necessarily reflect the emergence (disappearance) of a community of research but rather the

[2]The modularity of a network P' is defined as $Q(P') = \frac{1}{2m} \sum_{i,j} (P'_{ij} - \frac{k_i k_j}{2m}) \delta(c_i, c_j)$, where k_i is the degree of node i and m is the number of edges in the network. $\delta(c_i, c_j)$ is the Kronecker delta equal to 1 if its arguments are equal, 0 otherwise (it ensures that the modularity is only compute on nodes from the same community). The key point of the modularity is the difference between the observed edges P'_{ij} and the expected number of edges $\frac{k_i k_j}{2m}$. The more this difference is important, the more the nodes are likely to be together in a same group. The louvain-like methods are iterative algorithms that maximize this measure. It starts with each node in its own cluster. At each iteration, the algorithm merges clusters that increase the modularity of the network. The process stops when no more clusters can be merged without decreasing the modularity.

increasing (decreasing) dissemination of Fama through a set of common research. While a new dissemination of Fama (1970) is often concomitant with the emergence of a community of research, we will see that Fama (1970) stopped being cited by important communities of research. Those clusters disappear from the network but are still potentially active areas of research.

Dynamic analysis

For historians, one issue with network analysis is that it is a static representation of the corpus. It does not capture the evolution of the corpus over time and is not able to identify the emergence and disappearance of clusters. Moreover, given that the number of documents in the corpus is exponentially increasing after the 2000s, a single network representation over the entire period would likely have a bias toward the most recent documents. To overcome this issue, I complement the static analysis with a dynamic analysis developed by Goutsmedt and Truc (2022). The idea is to build a series of overlapping networks, each network representing a specific time window of length T. The first network B_t is composed of documents published between t and $t+T$, the second network B_{t+1} is composed of documents published between $t+1$ and $t+T+1$, etc. The networks are thus overlapping and clusters tend to be similar between two neighboring networks. To capture this similarity, I merge a cluster X in B_t and a cluster X' in B_{t+1} if the share of nodes in X that moved to X' is greater than 50%.[3]

While using a dynamic network is a good way to identify the evolution of clusters, it is not without drawbacks. The choice of the time window, T, is arbitrary and can affect the results. A too large time window will likely hide the evolution of the network and the short-term dynamics. On the other hand, a too small time window will likely lose an existing relationship between documents published in an interval greater than T. Even if two documents are published with an interval of 50 years, they may still share a legitimate cognitive relationship captured by the bibliographic coupling. I thus use *both* the static network of the entire period (1970-2010) and four networks from the dynamic analysis (1971-1985, 1979-1993, 1988-2002 and 1996-2010). The static network gives an overview of the communities in which Fama (1970) disseminates while the dynamic network allows to identify the evolution of these communities over time.

Visualization and interpretation

I use the force atlas layout to spatialize the networks in two dimensions. The force atlas layout aims at minimizing the distance between nodes that are connected by an edge and maximizing the distance between nodes that are not connected. Logically, the layout tends to separate the clusters. For each network, static and dynamic, I remove isolated articles and small components (connected groups of nodes representing less than 5% of network's nodes).

[3]The share is the proportion of nodes from X that moved to X', on the total number of nodes. Two approaches are possible to estimate this denominator: we can first divide by the total number of nodes in X'. But if there are many *new* nodes in X', this method may give a low proportion while most of the nodes in X are still in X'. Another approach is to divide by the number of nodes in X' *that are also in* X, i.e. the number of nodes that were already present in the previous time window. We use this method since the number of documents increased over time.

In dynamic networks, the position of the node from the last time window is used to initialize the position of the nodes in the next time window. Except for major changes in the network, this initialization allows to keep nodes and communities in the same position over time and improves the readability of the network.

This qualitative analysis of each cluster is a back and forth process between the raw data and our classification system. One issue with this procedure is that it is subjective and hardly replicable. There is no one ultimate method to find what are the commonalities between documents and thus what a cluster is about. To make sense of a cluster, a researcher has to read the documents in the cluster and to identify the commonalities between them. This is a necessary process that can be influenced by the researcher's own background and knowledge. If quantitative metrics can help—for instance the tf-idf—they also imply several subjective choices to be made. To improve this process and make it transparent to the reader, I develop an interactive application that allows the user to visualize the clusters and to interact with the data. The application is available at https://thomasdelcey.shinyapps.io/fama_1970_app/. The user can select a cluster and see the documents that are in this cluster. I also compute for each network the top words (measured by the tf-idf), the top journals (frequency and tf-idf) and the time distribution of clusters. Tables 2, 3, 4, 5 and 6 in the appendix give the summary statistics of the clusters for each network.

Results

Table 1 gives the number of documents for each cluster and the resulting number of nodes after the procedure. Because we focus on the backbone of the network, the number of nodes is lower than the number of documents. The documents that are not nodes are isolated documents with no significant relationship and are excluded from the analysis. To put it differently, the analysis focuses only on documents participating in a consistent group of research.[4]

Period	Documents	Nodes
1971-1985	587	377
1979-1993	667	424
1988-2002	545	333
1996-2010	743	398
1970-2010	1755	1215

Table 1: Number of documents and nodes in each network.

Figure 2 is the static coupling network of the corpus for the entire period. While this network erases the temporal dimension of the corpus, it already gives important insights on the dissemination of Fama's ideas over the four decades. In particular, this dissemination spread in three directions, which I gather in three groups of clusters (henceforth meta-clusters).

The first, and arguably the most expected one, gathers research in the core of financial economics. It is mainly composed of documents that focus on the development of the asset pricing

[4] I did not exclude secondary network components—cluster of nodes that are not connected to the main component of the network— but *de facto* our networks have only one component.

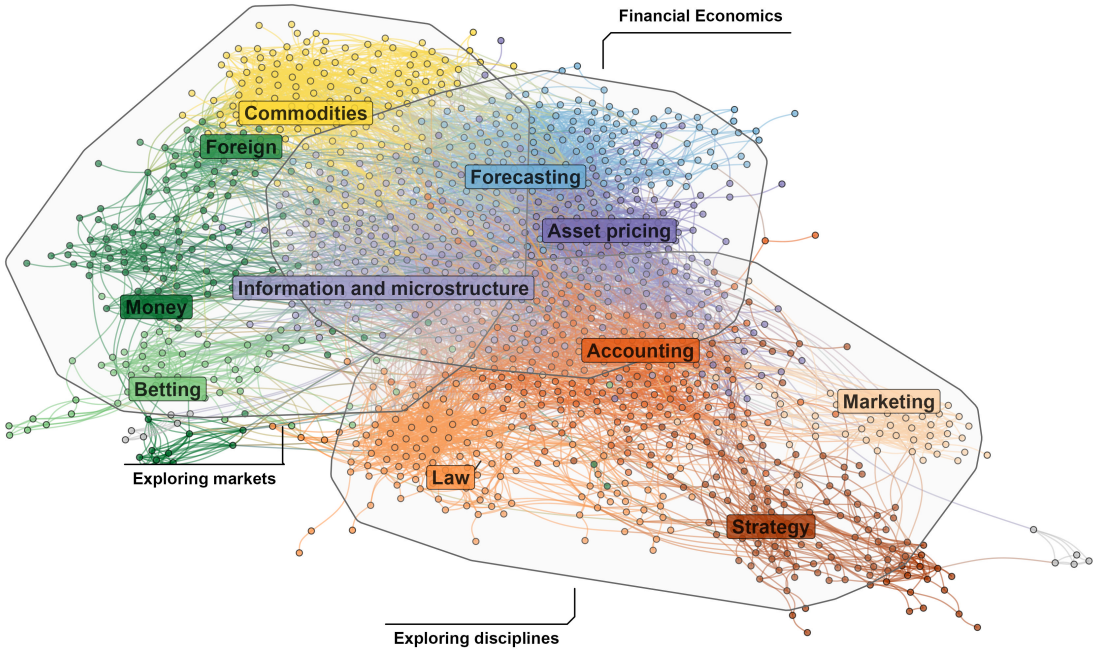

Figure 2: Static coupling network (1970-2010). This is the main component of the network with 1215 nodes and 6884 edges. Nodes are documents, edges indicate statistically significant bibliographic coupling. The color of the nodes indicates the cluster to which they belong. The spatialization is done using the force atlas layout. The circles delineate groups of clusters defined by the author.

analysis and are published either in the top journals in economics and finance—i.e., *the Journal of Finance*, *the Journal of Financial Economics*. This core group includes three clusters. The cluster 'Asset Pricing' is dedicated to the theoretical and empirical development of asset pricing models, including the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT), which are foundational to modern finance. It is also a critical examination of Fama (1970), which extensively documents empirical deviations from traditional asset pricing models and the EMH, highlighting various empirical anomalies. Completing this foundational group of financial economics is the cluster 'Information and microstructure', which delves into the theoretical underpinnings and practical mechanics of price formation, examining information asymmetry and trading processes. The cluster also includes experimental evidence that contributes to understanding the limits and actual attainment of market efficiency. Finally, the cluster 'Forecasting' directly engages with one central argument of Fama (1970), which is that stock prices are unpredictable and cannot be forecasted. This literature gains momentum in the late 1990s and early 2000s and reevaluates the challenges of forecasting stock prices, often in the context of technical analysis. While the cluster includes contributions in the core journals of finance, it also extends to specialized and applied journals, such as *The Journal of Forecasting*.

The second group, 'Exploring markets', gather communities applying the framework of the EMH to other markets. It is mainly composed of documents that sought to apply Fama's framework to other assets such as agricultural markets and published in specialized journals in finance and economics—i.e., *The American Journal of Agricultural Economics* or *the Journal of Futures Markets*. This group is exemplified by the cluster 'Commodities', which rigorously tests various forms of the EMH in commodity and futures markets for items like oil, gold, and agricultural products, often employing specialized econometric techniques. The cluster 'Foreign' specifically examines the efficiency of foreign exchange markets, testing parity conditions and the predictive power of forward rates. Furthermore, the cluster 'Money' investigates the intricate linkages between broader macroeconomic variables and monetary policy. It examines how markets process macroeconomic information and whether asset prices efficiently reflect these factors. Finally, the cluster 'Betting' extends Fama's framework to unconventional settings like wagering and prediction markets, assessing how these specialized markets aggregate information and forecast future events related to sports and even, in the recent years, politics.

The third group of clusters are research in other disciplines, in particular, in law and management. This literature uses the EMH to investigate internal issues within their disciplines. Logically, the main journals are specialized journals in management and law such as *The Journal of Law and Economics* or *The Journal of Accounting*. The 'Accounting' cluster is at the intersection of finance and accounting—we will see that it is mostly exportation of methods from financial economics to the accounting literature. The cluster 'Law' gathers legal scholars scrutinizing securities regulation and corporate governance through the prism of market efficiency. The cluster 'Strategy' involves management and strategy researchers utilizing market reactions to evaluate the impact of corporate strategies, social responsibility initiatives, and governance. Lastly, the cluster 'Marketing' applies market-based valuation to assess the financial returns of marketing policies such as marketing campaigns, brand building, and customer satisfaction efforts.

The main contribution of the static network is to show that the dissemination of Fama's ideas is not limited to financial economics but also extends to other fields of economics and disciplines, such as law, accounting, management and marketing. These results are robust to the dynamic analysis. The dynamic networks reveal the same core-peripheral structure, with a central meta-cluster in financial economics and 2 peripheral meta-clusters, either applying market efficiency to other markets or other disciplines (figure 3, 4, 5, 6). In dynamic networks, I attribute an acronym (e.g., FE for Financial Economics) to each cluster to indicate the meta-cluster they belong to. For clarity, I attribute the same set of colors to clusters that are similar between the static and dynamic networks (for instance, clusters in financial economics are variations of blue and purple). Because the dynamic networks are shorter in time, the clusters are more precise in their definition and the labels are more specific. For instance, the 'asset pricing' cluster from the static network is split into several clusters in dynamic networks. In the 1971-1985 network, we find the cluster 'Early asset pricing' that regroups foundational work on asset pricing, including the CAPM and the APT. In the following 1979-1993 and 1988-2002 networks, the cluster 'Predictability & volatility' indicates the emergence of a new community in asset pricing that is more critical of market efficiency and reflects the well-known controversy on market efficiency.

Discussion: the various disseminations of Fama (1970)

The summary of the network analysis in the preceding section reveals a broad and multi-faceted dissemination of Fama's (1970) efficient market hypothesis, organized in a distinct core-peripheral structure. A central aspect of this story is that the epistemological status of the EMH varies over time and, perhaps most importantly, between communities. At the intellectual core, primarily within financial economics, the EMH was treated as a concept to be refined, debated, and tested. From this core, the EMH was exported to a diverse periphery. In one periphery, it became an empirical tool for exploring other markets within economics. In the other periphery, it was adopted as a powerful working assumption to evaluate policies and actions in entirely different disciplines such as law and management. To illustrate these different intellectual stances, the following sections will delve into the specific research communities that constitute the dynamic networks.

A testable hypothesis

The most obvious and central explanation for Fama's success is that the EMH quickly became a central theory in financial economics. In the 1970s, the EMH was closely related to the development of other asset pricing model, as shown in the core clusters 'Early asset pricing' and 'Option' in the 1971-1985 network (figure 3). While asset pricing models sought to explain the relationship between risk and return, the EMH gives a general explanation of how prices were rationally formed in a functioning market. One crucial document in the cluster 'Early asset pricing' was Fama and MacBeth (1973), who introduced a benchmark methodology for testing the validity of the Capital Asset Pricing Model (CAPM) and offered evidence that markets did seem to rationally price risk. In the early 1970s, the EMH and theoretical models

was thus viewed as two side of the same coin. An asset pricing model was necessary to test the EMH—the famous idea of the joint hypothesis introduced by Fama (1970)—and the EMH was also used to justify model assumptions (such as the independance of returns). More broadly, the EMH was in the mind of many modelers in the early 1970s and Fama (1970) was reference point to be cited for many of them (e.g. Merton 1973).

The 'Early asset pricing' cluster also includes the first empirical studies refuting the EMH. One of the first and famous example was the "January effect" identified by Rozeff and Kinney (1976). They showed that average return of the New York Stock Exchange was significantly higher in January than in other months, implying a predictable pattern in contradiction with the EMH. In the 1970s, this kind of departures from the prediction of the EMH was not viewed as serious refutations of the theory but rather minor issues. Rozeff and Kinney (1976, 396) concluded that "it is unlikely that seasonality in stock returns will raise any serious problem for the efficient market model."[5]

The criticisms intensified in the 1980s within the core of financial economics as shown by the cluster 'Volatility & predictability' in the 1979-1993 and 1988-2002 networks (figure 4; figure 5). The debate moved beyond contained, seasonal patterns like the "January effect" to more fundamental and powerful challenges to the rationality of the market itself. Empirical attacks on the EMH went on two fronts, the first one was the excess volatility of asset prices, which was famously initiated by Shiller (1981). This literature questioned the rationality of the market by showing that observed asset prices seemed too volatile to be explained by fundamentals. The second front was the development of new econometrics tests, which was initiated by Lo and MacKinlay (1988) and Poterba and Summers (1988), which showed the predictability of returns and the existence of long-term patterns in asset prices. It was complemented by studies identifying short-term predictability, such as the evidence for one-week return reversals in Jegadeesh (1990) and Lehmann (1990).

In the following decades, this dialogue would lead to the development of behavioral finance that challenged the rational price formation implied by the EMH. However, Fama (1970) did not disseminate in this literature, as reflected by the small size of the community 'Behavioral' in the 1996-2010 network (figure 6). The review became a canonical reference but only occasionally cited for historical purposes, as the framework of EMH became outdated with the developments in financial econometrics. The transformation of Fama (1970) as a canonical reference is also reflected in the cluster "critical / perspective", which gathers retrospective and critical essays on finance, in which Fama (1970) appears as one of the central reference for the emergence of modern finance. We find in this community retrospective and methodological essays from prominent scholars such as Joseph Stiglitz (2000) but also research in other disciplines with an interest in the history of finance (MacKenzie 2003; Jovanovic 2008).

After 2000, Fama (1970) remains a well cited reference in a literature testing the EMH centered on technical analysis (figure 5, figure 6). Less identified in the core of financial economics, this cluster gathers heterogeneous research interested in finding trading rules using

[5]The climax of this view was the introduction of a special issue gathering refutations of the EMH by Michael C. Jensen (1978). Jensen qualified those departures as "anomalies" and famously argued that "there is no other proposition in economics which has more solid empirical evidence supporting it than the Efficient Market Hypothesis." (95).

sophisticated statistical methods—what Fama (1970) called the weak form of the EMH. Some research remained published in the top journals in finance but also in specialized journals such as *Journal of Economic Dynamics & Control*, *Expert Systems with Applications*, and *Journal of Forecasting*. As statistical methods became more sophisticated, the cluster evolved to include a wide range of empirical methods, from traditional econometric tests to machine learning and artificial intelligence. But maybe the most important change is that the community shifted from a normative stance (is technical analysis a profitable trading strategy?) to a descriptive one (why is technical analysis used ?). This shift is exemplified by the work of Lukas Menkhoff (Menkhoff and Taylor 2007; Menkhoff 2010), which investigates the behavior of fund managers and professionals, treating technical analysis as a sociological and psychological phenomenon to be explained and to be included in asset pricing models.

While behavioral finance challenged the rational price formation, the cluster 'Technical analysis' shows that the EMH remained an important empirical hypothesis regarding the predictability of returns. In 2007, Park and Irwin (2007, 787) argued that "academics tends to be skeptical about technical analysis", a skepticism that was explained by the still important "acceptance of the efficient market hypothesis (Fama, 1970), which implies that it is futile to attempt to make profits by exploiting currently available information such as past price trends.''

A theory to be developed

Fama (1970)'s influence did not limit itself to empirical asset pricing but also reaches important theoretical research in the intellectual core of the corpus: the development of a deeper theory of information and price formation. This is captured in the network analysis in the community 'Theory on efficiency', which exists over the entire period. In his early years, the cluster gathers documents that sought to understand how the dissemination of information and its aggregation into prices was actually taking place in markets (figure 3; figure 4). The cluster is composed of theoretical contributions that sought to question and elaborate the fundamental premise of the EMH, namely the idea that prices are entities reflecting information. What does it mean that prices reflect information in case of information asymmetry ? And how does the market aggregate these dispersed sets of information ?

One of the earliest contributions on this topic was from Fama and Laffer (1971), who emphasized that the EMH was silent on how exactly the information was generated and aggregated into prices. "There has been much work documenting the speed of adjustment of security prices to new information", they argued, "[s]o far, however, this 'efficient' markets literature has had little to say about the process of information generation itself" (Fama and Laffer 1971: 289).

This question became prominent in the 1980s with the rise of rational expectations models that could answer such questions. Grossman and Stiglitz (1980)'s famous paradox was famously critical of the EMH by showing a *contradicto in terminis* of Fama (1970) theory but many other contributions took Fama's definition as a fundamental idea that needed to be developed (Hellwig 1980; Diamond and Verrecchia 1981; Holden and Subrahmanyam 1992). For those contributions, market efficiency was the starting point of their research program that

aimed at describing how the market aggregated the dispersed information of individuals into a price system. The cluster 'Theory on efficiency' remained an important cluster in the later networks, underlining that Fama (1970) continued to play a role in the theoretical discussions on market efficiency. However, from figure 3 to figure 6, the position of the cluster in the networks shows how these discussions move away from economics and get closer to research in accounting, as discussed below.

Another important cluster was one in which research aimed to develop Fama's insights (1970). But rather than focusing on the information aggregation process, those contributions focused on the impact of what is known today as the market structure. They questioned how trading and the matching of supply and demand actually took place. In one of the most famous contributions" of this cluster, Lawrence R. Glosten and Paul Milgrom argued that matching supply and demand was not a given but required institutional arrangements that were specific to each exchange:[6]

> The usual economic view of markets is as a place where buyers and sellers come together and trade at a common price, the price at which supply equals demand. Securities exchanges are often singled out as excellent examples of markets that operate this way. In fact, however, trading on exchanges takes place over time, and some institutional arrangements are necessary to help match buyers and sellers whose orders arrive at different times. On exchanges like the New York Stock Exchange, the economic function of the specialists and the floor traders is that of middlemen: they hold the inventories that facilitate trade when trading occurs over time (Glosten and Milgrom 1985: 71)

The motivation of this literature on market structure was theoretical and normative; the goal was to determine the optimal trading system. It was also descriptive and empirical as friction in trading systems could explain puzzles in the behavior of asset prices. In a review on this issue, Cohen et al. (1980, 250) argued that various empirical phenomena could be explained by "friction in the trading process causing a bid-ask spread [the difference between the higher buying order and the lowest selling order] and price-adjustment delays that differ systematically across securities."

In the 1990s, this set of research progressively stopped referring to Fama (1970) and the clusters disappears from the networks. One reminiscence, however, of this research was the cluster 'Experimental' in the 1988-2002 network (figure 5). The cluster gathered research that used the newly developed experimental methods to simulate trading systems in laboratories. The research was empirical and includes famous experimental evidence that contributes to understanding the limits and actual attainment of market efficiency (Smith, Suchanek, and Williams 1988). But beyond the validation of the EMH, this experimental literature shared the same interest in the trading system and the aggregation of information as previous research. The laboratory allowed researchers to control the information set possessed by subjects and to test the impact of different trading systems on the behavior of asset prices.

[6] See MacKenzie (2021) for a socio-history of floor traders and market making.

The clusters on information and microstructure disappear in the 2000s showing that Fama (1970) was no longer a central reference in the 2000s (figure 6). But we saw that the development of those fields was influenced by Fama's insights on information. One common element in those various research programs was a critical stance toward the EMH and the motivation to develop the too simplistic idea that prices reflect information. The statistical behavior of asset prices—on which Fama's focused—was the final outcome of a still poorly understood process that had to be unraveled. Retrospectively, Milgrom (2021, 1384–85) acknowledges the role of the EMH and its limits on the development of the market design literature:

> Much of the early auction research focused on questions related to the information content and the level of prices. How much of the bidders' information comes to be reflected in the prices that are paid? If a lot of information is reflected in prices, how does that affect the ability of bidders to profit? Do some auction rules lead to systematically higher expected prices than others? The information problem took on a special urgency following the publication of an influential paper by Grossman and Stiglitz (1980). […] For auction theorists, this paradoxical finding just reinforced our belief that general equilibrium theory was the wrong platform to use for studying market clearing among investors with private information.

The dissemination of Fama (1970) ideas in the 1970s and 1980s was thus not only through a classical scientific discussion in which theory is set up and then tested and challenged by empirical evidence. While the EMH was a hypothesis to be tested, for those economists, it was rather a premise—prices are entities reflecting information—that needed to be developed. In a way, they were critical of the EMH but they also adopted the same worldview as Fama's (1970) ; a worldview in which market participants compete for acquiring information that would be aggregated into prices.

An empirical tool

Beyond the intellectual core of financial economics, the network analysis shows how Fama's framework was quickly exported to a wide periphery of other markets and sub-disciplines. In these communities, which form a first periphery within the broader field of economics, the EMH was often not debated as a fundamental theory but adopted as a powerful empirical tool. This is exemplified by the meta-cluster 'Exploring market' (figure 2).

One natural application of the EMH was the commodities market and this happened as early as the early 1970s (figure 3). Research in commodities referring to Fama (1970) remained important over the entire period with a peak in the 1980s.[7] The quick adoption of the EMH in agricultural economics was explained by the intellectual proximity between both fields. Futures agricultural markets had been studied by American and British economists since the 1920s. A central issue was the role of expectations in the relationship between the spot and the future price. One of the most prominent figure among American agricultural economists, Holbrook Working, had formulated hypotheses consistent with Fama's theory, by suggesting

[7] In the 1990s, it was also extended to other products, especially metal and energy (figure 5; figure 6).

that future prices were an unbiased estimation of expected spot prices (Delcey 2025). Working's idea was well-known in agricultural economics and the proximity of his ideas with those of Fama was obvious for specialized scholars (Leuthold and Hartmann 1979: 483). Moreover, agricultural economists were applied researchers who conducted empirical analysis and shared with financial economists a common interest in the econometrics of price series. The quality of the data was particularly good in agricultural economics since the 1930s, when the United States Department of Agriculture started to collect data on agricultural prices (Delcey and Noblet 2024). Hence, agricultural markets have been a natural object of study for early financial economists (e.g. Cootner 1961). From the 1970s, the weak-form and semi-strong forms developed by Fama were applied to commodity data and have structured research on this issue for the next decades (Carter 1999: 231-233). From the mid-1970s to the 1990s, standard questions were the profitability of trading strategies in the commodities market, the relationship between spot and future prices, and the impact of public information on prices.

Another early connection between financial economics and other economic fields was macroeconomics. The network analysis shows how Fama (1970) disseminated in the 1970s and 1980s in the field of macroeconomics, especially in the context of monetary economics and the study of foreign markets (figure 3). Like with agricultural economists, the intellectual proximity between the fields of finance and macroeconomics facilitated the rapid dissemination of Fama's framework. The similarity between the rational expectation hypothesis and the EMH was well-known (Delcey and Sergi 2023). For instance, Thomas Sargent, in the cluster *Money* of figure 3, saw in the large empirical support for market efficiency a justification for using the rational expectations hypothesis (e.g. Sargent, Fand, and Goldfeld 1973: 539). Financial economists were also interested in investigating issues traditionally studied by macroeconomics. In the 1970s, the central issue was the relationship between asset returns and inflation that was prompted by the oil shocks (Fama 1975; Nelson 1976; Lintner 1975). One canonical study from this cluster on inflation was from Fama (1975) himself. This paper exemplified how the EMH changed the traditional way of thought in macroeconomics (Campbell 2014). In the early 1970s, a standard macroeconomic question was to explain the level of interest rates. Many ideas were proposed to explain the level of interest rates, such as the Fisher effect, the liquidity preference theory, or the expectations hypothesis. For macroeconomists, it was natural to use the interest rate as the dependent variable. Fama (1975) did the opposite and suggested using the interest rate as the explanatory variable. Within the EMH's framework, it was natural to think that the interest rate was a price containing any information about factors that could affect its future level. Fama tested this idea by trying to predict the future inflation rate by using the current interest rate.[8]

The popularity of research in the metacluster exploring market peaked in the 1980s (figure 4). But this vector of dissemination of Fama (1970) remains important over the entire period, even after the 2000s (figure 6). The cluster *Betting* is perhaps the most blatant illustration of this ability of the EMH to be applied to new markets. From the 1980s, Betting markets were

[8]The EMH predicted that the regression coefficient of the interest rates should be 1 since any information about the expected inflation was integrated into current prices. Any other past variables used as explanatory variables such as past inflation should have a coefficient close to 0.

perceived as an interesting acase study to analyze behaviors under uncertainty as in financial markets but with a simple institutional arrangement than that of more complex financial markets. Despite being already disputed in finance, the EMH was viewed as a powerful tool to analyze those markets In his review of the topic, Raymond D. Sauer (1998) praised the framework of Fama as a "flexible empirical tool" and added that "[t]he optimality of learning in a stochastic environment, the nature of the error term in pricing models, and the identification of informed trading are examples where the concept of market efficiency has been creatively employed." The economics of wagering markets was of course a niche research program but became an important cluster after 2000, prompted by sports and election betting.

In these literatures, the EMH became a ready-to-use empirical tool to analyze markets subject to speculation. One central successful application of Fama's framework was the event study methodology—a methodology developed by Fama et al. (1969) to evaluate the effect of public information on stock prices. In agricultural and macroeconomics, event studies were regularly used to study the effects on prices of central bank or government reports.[9] The idea behind using event studies was originally to test the ability of the market to react to public information. But the methodology was also used in a normative way to evaluate policy by observing its effect on prices. Carter (1999, 234), for instance, argued that most event studies in agricultural economics concluded that price reacted efficiently to the publication of the department reports, but since the publication of the reports had an effect, they also concluded that "the reports might have economic value" (Carter 1999: 234). It was also the event study methodology and its normative application that facilitated the exportation of Fama's in the last meta-clusters, 'Exploring Disciplines.'

A tool to evaluate policy

The dissemination of Fama (1970) extended to an even broader periphery, reaching beyond economics into disciplines like management, accounting, and law. In the meta-cluster 'Exploring Disciplines', which forms the other periphery of the static network (figure 2), the EMH was often neither debated nor tested but adopted as a foundational working assumption to evaluate policies and corporate actions. The dissemination of Fama (1970) in accounting and law began as soon as the early 1970s (figure 3). Scholars from the University of Chicago played a central role in this story. The connection between finance on the one side and accounting and law on the other side was facilitated by the close relationship between these disciplines at Chicago. Spreading the financial ideas was notably promoted by Fama's colleagues and students at Chicago—including Jeffrey F. Jaffe, Ray Ball, Philip Brown, Ross Watts, George J. Benston, James Ellert, and William Schwert. More generally, the rise of business schools in the 1970s, with their interdisciplinary approach, facilitated the integration of finance into other disciplines of management (Fourcade and Khurana 2013).

The connection between finance and accounting was facilitated by the emergence of event studies: among the many "events" that could affect stock prices, the publication of financial reports was a central and natural one. An important paper was from two of Fama's doctoral

[9] See, for instance, Jones, Lamont, and Lumsdaine (1998); Plosser (1982); Mishkin (1982); Colling and Irwin (1990); Grunewald, McNulty, and Biere (1993) ; McNew and Espinosa (1994)

students, Ball and Watts, titled "Some Time Series Properties of Accounting Income" (1972). Ball and Watts were pioneers in the econometric analysis of accounting data and its relation to financial data. The first study on this question was published in 1968, before the publication of Fama's review, but Fama's theoretical framework and the event study methodology were already being discussed at Chicago. Ball, along with Philip Brown (1968), another Chicago student, conducted a study using corporate accounting data to test financial market efficiency. The article argued that firms' earnings announcements were anticipated by the markets and correctly discounted in their stock prices. This article is now considered one of the canonical papers in modern accounting research (Ball and Brown 2014).

These works extended Fama's research program not for their results but for their methods. The early 1970s marked a foundational period where a flurry of studies began using financial economics tools to test the information content of accounting data. While some of these studies showed that markets did not fully incorporate accounting data, constituting a refutation of strong-form market efficiency (e.g., Ball 1972), their main contribution was methodological. By adopting the event study methodology, these studies cemented the method of Fama (1970) as a standard tool in accounting research. Accounting researchers described this shift as a form of scientization, moving away from a normative approach—which sought to define good accounting practices—towards a positive and quantitative approach—which aimed to define the consequences of accounting practices. In 1972, Ball and Watts (1972, 4) argued that "[m]ost of the available empirical research on changes in accounting techniques attempts to establish reasons for, rather than consequences of, accounting changes."[10] This new program was so successful that it not only spurred the creation of pioneering journals like the *Journal of Accounting Research*,[11] but also dominated the leading journals in finance, such as the *Journal of Finance*, the *Journal of Financial Economics*, and the *Journal of Business*.

In strategy, this approach was adopted later and in a more fragmented way. Starting in the late 1970s and throughout the 1980s, strategy researchers began to adopt the event study methodology to assess the impact of strategic decisions on shareholder value. The topics were varied, ranging from the impact of corporate social responsibility (Alexander and Buchholz 1978), mergers and acquisitions (Schwert 1996), or CEO succession (Reinganum 1985) on stock market performance. These works in strategy were published in a wider range of journals, including general management journals (*Academy of Management Journal*) and specialized ones (*Strategic Management Journal*).

This diffusion also occurred in marketing but later. While the first studies applying financial methods to marketing decisions appeared in the late 1970s (Reilly, McGann, and Marquardt 1977), the trend accelerated significantly in the 1990s (figure 3). Marketing researchers primarily used these methods not just to assess general corporate actions, but to quantify the financial value of their own core concepts, such as brand equity (Simon and Sullivan 1993), celebrity endorsements (Agrawal and Kamakura 1995), and later, customer satisfaction (Anderson, Fornell, and Mazvancheryl 2004). This research found a strong institutional home within the

[10] See Oler, Oler, and Skousen (2010, 641) for a retrospective

[11] As an anecdote, Ball and Brown (1968) was rejected by the dominant journal of the time, the_ Accounting Review_, and was published without referees in the Journal of Accounting Research.

discipline's own leading journals, such as the *Journal of Marketing*, *Marketing Science*, and the *Journal of Marketing Research*.[12]

The network analysis also shows that Fama's ideas disseminated into financial law, a process in which scholars from the University of Chicago played an important role. Throughout the 1970s, a wave of economic studies laid the empirical groundwork for this migration. One of the pioneering studies was Benston's critique of the SEC's disclosure requirements, in which he argued that the 1934 Act had no measurable effect because the market was already efficient (Benston 1973). Benston studied a group of companies subject to the regulation and a group not subject to the regulation and concluded that "the '34 Act had no measurable effect on the residual market prices of companies that did and did not disclose their sales." The results, he argued, were "consistent with the hypothesis that the market was efficient before the legislation was enacted" (Benston 1973: 152). This approach was reproduced and systematized by researchers such as G. William Schwert and Gregg Jarrell (Schwert 1981; Jarrell 1981). Schwert interpreted event studies as a "positive analysis of government regulation" (Schwert 1981: 121). This critique found resonance in legal circles (Kripke 1979). This line of research was so influential that in 1980, the SEC explicitly prompted a reform of its disclosure system—that would simplify and reduce the number of reports—on the basis of the EMH:

> To the extent that the market acts efficiently and this information is adequately reflected in the price of a registrant's outstanding securities, the SEC concludes there seems little need to reiterate this information in a prospectus in the context of a distribution ("Proposed Rules" 1980: 63694).

A second, and equally profound, area of influence was the redefinition of financial fraud through the "fraud-on-the-market" theory. Historically, a plaintiff had to prove they had personally relied on a specific fraudulent statement to invest. The EMH offered a new alternative (Jovanovic, Andreadakis, and Schinckus 2016). The core logic, advanced by legal scholars like Daniel Fischel, was that in an efficient market, a security's price already incorporates all public information. Therefore, a misstatement that distorts this price constitutes a fraud "on the market" itself, and any investor who trades at that manipulated price is implicitly harmed, obviating the need to prove individual reliance (Macey et al. 1991; Cornell and Morgan 1989). Daniel Fischel, a leading figure of this approach, illustrates the integration of economic reasoning into legal discourse. In an influential paper, he argued that if "the market"—acting as the "reasonable man"—has not been misled, then no compensable injury has occurred (Fischel 1982: 15). This theory relied entirely on the assumption of efficiency: according to Fischel, if any inefficiencies existed, they would create "potential for entrepreneurial gain," and this arbitrage process would swiftly eliminate any price divergences, ensuring the market's return to an equilibrium where price accurately reflects available information (Fischel 1982: 14).

[12]This approach was not as successful as it has been in accounting. The financial approach to the brand equity was rivaled by the more popular "customer" approach, which used surveys to determine the value of a brand on the basis of consumers' knowledge and their attitudes toward it (see Rojas-Lamorena, Del Barrio-García, and Alcántara-Pilar 2022). Still, this integration fostered the development of a recent subfield in marketing known as the "marketing-finance interface" (Edeling, Srinivasan, and Hanssens 2021).

The EMH thus became a landmark, not merely as a theory to be debated within finance, but as a powerful, practical toolkit for evaluation in law. In 1984, lawyers Ronald Gilson and Reinier Kraakman declared that market efficiency "is now the context in which serious discussion of the regulation of financial markets takes place" (Gilson and Kraakman 1984: 549). Few contrarian voices remained but they also acknowledged the shift in the legal discourse and the primacy gained by the concept of market efficiency in financial regulation (Stout 1988; Langevoort 1992). "Whatever their opinion of the merits of a particular law or rule", Stout (1988, 638) wrote, "judges, scholars, and SEC policymakers alike seem to assume that informationally efficient markets must be nurtured and promoted."

Conclusion

In figure 1, the enduring citation popularity of Fama (1970) at first presented a historiographical puzzle. Why did this "quickly outdated" review remain a central reference point for decades, even as its author published more technically advanced sequels? Fama (1970) was more than a historical landmark. This bibliometric analysis has shown the paper's ability to export outside the core of asset pricing. Maybe the most significant impact of the EMH was not as a testable theory about the way asset prices behave, but as a practical assumption that enabled a new form of evaluation in other fields. By positing that stock prices efficiently reflect all available information, the EMH provided a powerful yardstick: the impact of any corporate decision, new regulation, or strategic action could now be quantitatively measured by its effect on shareholder value. This transformed the EMH from a scientific claim to be verified into a practical assumption to be wielded. It became, in effect, a tool for seeing and evaluating the world in financial terms.

This analysis also provides insights into the history of recent economics by showing how our principal materials—articles—live across different groups of researchers. The ideas conveyed by a document cannot be appreciated in isolation but only in the context of the community of research in which it is discussed and used. Because groups of research did not have the same motivations, they also give a contribution different interpretations and meanings. An idea emerged thanks to the insight of its author(s) but it is transformed and kept alive through the various and polysemic interpretations of his readers. The popularity of Fama's framework was not only due to its initial empirical grounding or his conceptual rigor—it was not—but to its unexpected plasticity, allowing it to be molded into a testable hypothesis, a theoretical premise, and a practical tool for evaluation.

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Appendix

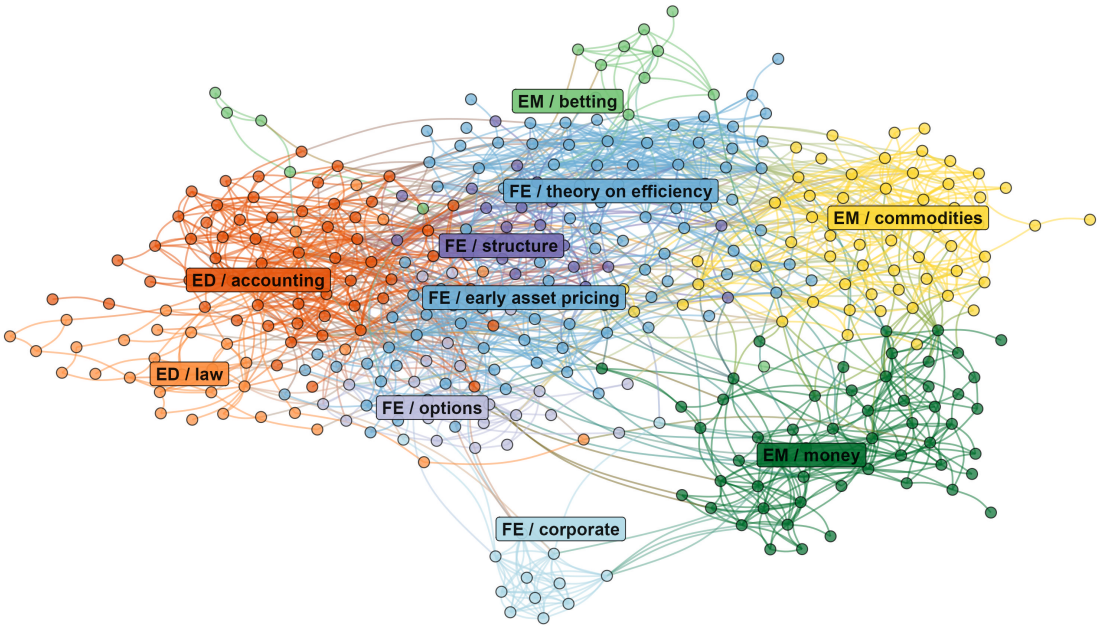

Figure 3: Dynamic coupling network (1971-1985). This is the main component of the network with 377 nodes and 1687 edges. Nodes are documents, edges indicate statistically significant bibliographic coupling. The color of the nodes indicates the cluster to which they belong. The spatialization is done using the force atlas layout.

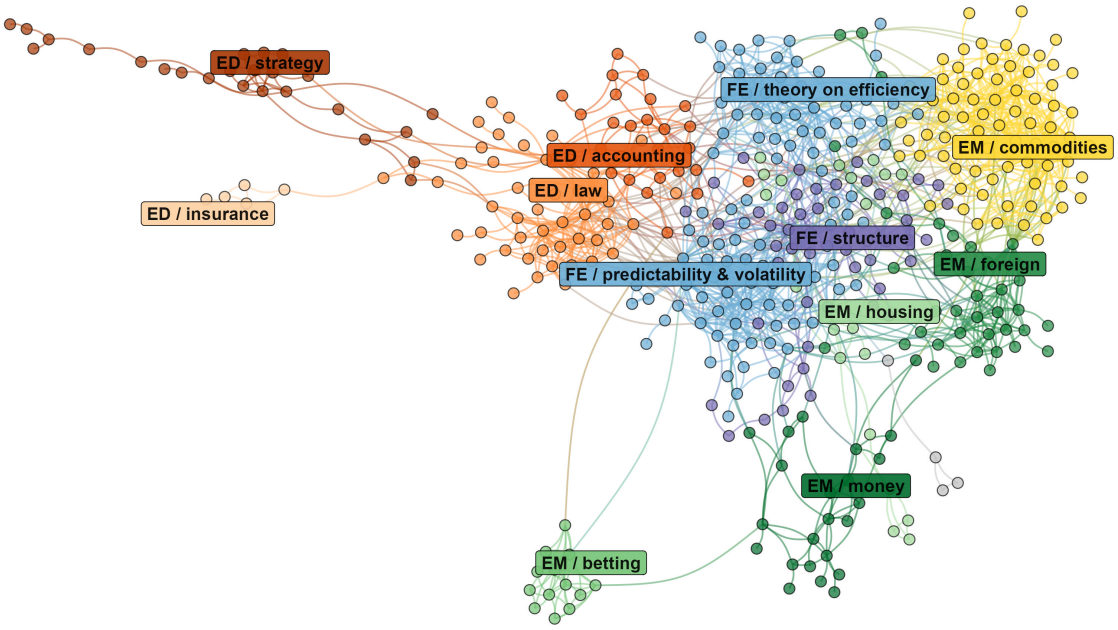

Figure 4: Dynamic coupling network (1979-1993). This is the main component of the network with 424 nodes and 1519 edges. Nodes are documents, edges indicate statistically significant bibliographic coupling. The color of the nodes indicates the cluster to which they belong. The spatialization is done using the force atlas layout.

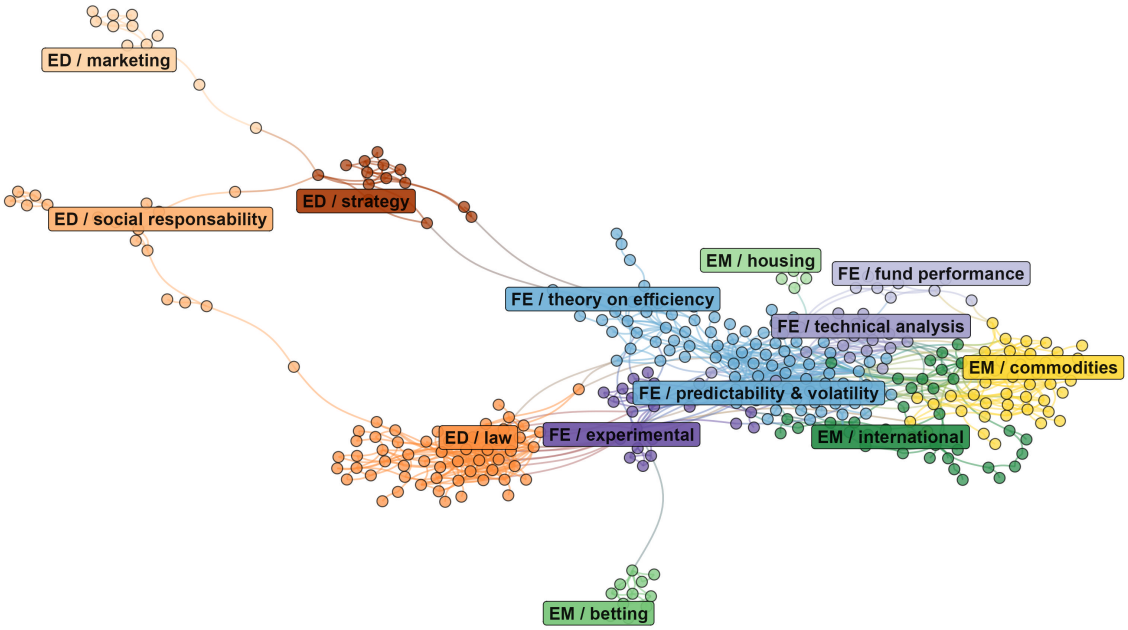

Figure 5: Dynamic coupling network (1988-2002). This is the main component of the network with 333 nodes and 964 edges. Nodes are documents, edges indicate statistically significant bibliographic coupling. The color of the nodes indicates the cluster to which they belong. The spatialization is done using the force atlas layout.

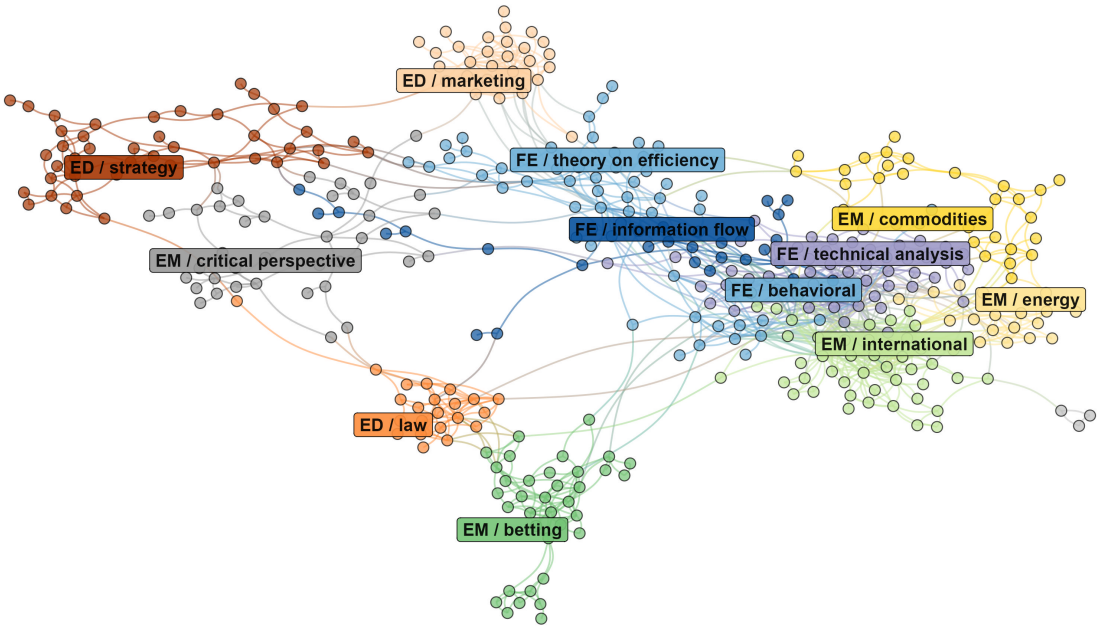

Figure 6: Dynamic coupling network (1996-2010). This is the main component of the network with 398 nodes and 1074 edges. Nodes are documents, edges indicate statistically significant bibliographic coupling. The color of the nodes indicates the cluster to which they belong. The spatialization is done using the force atlas layout.

Cluster	Meta-cluster	Nodes	Top words	Top journals	Period
Asset pricing	Financial Economics	177	timing, mutual, anomalies, stock, returns	journal of finance, journal of financial economics, review of financial studies, journal of business finance & accounting, journal of portfolio management	1972-2010
Forecasting	Financial Economics	155	technical, stock, housing, market, estate	journal of economic dynamics & control, applied economics letters, economic modelling, romanian journal of economic forecasting, studies in nonlinear dynamics and econometrics	1977-2010
Accounting	Exploring disciplines	150	accounting, earnings, insider, option, quarterly	accounting review, journal of accounting research, journal of finance, journal of accounting & economics, journal of financial economics	1971-2010
Commodities	Exploring markets	128	futures, cattle, commodity, agricultural, gold	journal of futures markets, energy economics, american journal of agricultural economics, applied economics, journal of agricultural and resource economics	1972-2010
Information and microstructure	Financial Economics	126	experimental, market, noisy, equilibrium, stock	journal of finance, journal of economic dynamics & control, econometrica, quantitative finance, journal of financial economics	1971-2010
Law	Exploring disciplines	122	fraud, 10, rule, 5, law	virginia law review, george washington law review, northwestern university law review, cornell law review, vanderbilt law review	1971-2010
Strategy	Exploring disciplines	118	acquisitions, ceo, resource, corporate, social	strategic management journal, academy of management journal, journal of management, organization science, strategic organization	1972-2010
Money	Exploring markets	91	money, monetary, supply, surprises, inflation	journal of money credit and banking, journal of finance, economic record, financial management, journal of monetary economics	1972-2010
Betting	Exploring markets	58	betting, horse, politics, racetrack, track	american journal of political science, management science, journal of product innovation management, acta politica, american journal of psychology	1971-2010
Marketing	Exploring disciplines	53	advertising, brand, customer, satisfaction, firm	journal of marketing, journal of the academy of marketing science, marketing science, journal of marketing research, journal of economic psychology	1977-2010
Foreign	Exploring markets	26	forward, spot, rate, parity, premium	journal of international money and finance, economic and social review, journal of macroeconomics, oxford economic papers-new series, canadian journal of economics-revue canadienne d economique	1979-2008

Table 2: Summary statistics of clusters in the static network (1970-2010). Top words are the tf-idf of documents' titles. Top journals are the 5 highest frequencies. The period is the minimum and maximum year of publication found in the cluster.

Cluster	Nodes	Top words	Top journals	Period
EM / commodities	59	forward, futures, foreign, gold, london	journal of futures markets, applied economics, australian journal of agricultural economics, journal of international money and finance, australian economic papers	1972-1985
ED / accounting	58	accounting, dividend, earnings, announcements, quarterly	journal of accounting research, accounting review, carnegie-rochester conference series on public policy, journal of accounting and public policy, journal of business research	1972-1985
EM / money	55	money, inflation, monetary, supply, term	journal of money credit and banking, journal of monetary economics, brookings papers on economic activity, economic record, canadian journal of economics-revue canadienne d economique	1972-1985
FE / early asset pricing	52	seasonality, timing, performance, inefficiency, mutual	applied economics, bell journal of economics and management science, journal of financial and quantitative analysis, journal of financial economics, developing economies	1972-1985
FE / theory on efficiency	47	economy, experimental, expectations, models, speculation	american journal of agricultural economics, journal of economic theory, american economic review, econometrica, american bar foundation research journal	1971-1985
ED / law	33	effects, stockholder, mergers, pollution, takeovers	journal of law & economics, academy of management journal, harvard business review, review of economics and statistics, quarterly journal of economics	1971-1985
FE / options	23	option, options, pricing, closed, convertible	journal of financial economics, journal of financial and quantitative analysis, journal of futures markets, bell journal of economics, journal of finance	1973-1983
FE / structure	20	bid, generation, limit, specialist, transaction	journal of financial and quantitative analysis, journal of financial economics, journal of finance, review of business and economic research, review of economics and statistics	1972-1985
EM / betting	16	betting, horse, maturity, racetrack, racing	management science, american journal of psychology, economica, review of business and economic research, australian economic papers	1971-1985
FE / corporate	14	disclosing, issue, norgaard, earnings, share	financial management, journal of banking & finance, journal of finance	1972-1983

Table 3: Summary statistics of clusters in the dynamic network (1970-1979)

Cluster	Nodes	Top words	Top journals	Period
EM / commodities	74	futures, commodity, cattle, live, gold	journal of futures markets, applied economics, american journal of agricultural economics, energy economics, journal of agricultural economics	1979-1993
FE / predictability & volatility	55	predictable, stumpage, asset, random, buy	jahrbucher fur nationalokonomie und statistik, american journal of agricultural economics, journal of political economy, review of economic studies, review of financial studies	1979-1993
FE / structure	48	inventory, seasonality, volatility, rights, autocorrelation	journal of financial economics, journal of financial and quantitative analysis, journal of futures markets, journal of finance, explorations in economic history	1979-1993
ED / law	46	securities, fraud, corporate, regulation, 5	virginia law review, journal of law & economics, journal of legal studies, marketing science, northwestern university law review	1979-1993
FE / theory on efficiency	46	experimental, timing, mutual, information, acquisition	journal of economic theory, econometrica, journal of financial economics, american journal of agricultural economics, journal of political economy	1979-1993
EM / foreign	37	rate, exchange, foreign, forward, spot	journal of international money and finance, economic journal, economic and social review, canadian journal of economics-revue canadienne d economique, journal of business & economic statistics	1979-1993
ED / accounting	26	earnings, accounting, analyst, judgment, price	accounting review, journal of accounting research, accounting organizations and society, organizational behavior and human decision processes, decision sciences	1979-1993
ED / strategy	25	strategic, wealth, firm, strategy, corporate	strategic management journal, academy of management journal, journal of management, academy of management review, administrative science quarterly	1979-1993
EM / money	23	surprises, rates, monetary, rationality, term	journal of monetary economics, journal of money credit and banking, journal of financial research, oxford bulletin of economics and statistics, journal of finance	1979-1991
EM / housing	22	estate, real, housing, hong, kong	areuea journal-journal of the american real estate & urban economics association, applied economics, developing economies, housing finance review, journal of real estate finance and economics	1979-1993
EM / betting	13	betting, racetrack, track, horse, races	management science, european journal of operational research, interfaces, australian economic papers, applied economics	1980-1993
ED / insurance	5	industry, losses, air, aircraft, airline	journal of risk and insurance, journal of transport economics and policy, economic inquiry	1983-1988

Table 4: Summary statistics of clusters in the dynamic network (1979-1993)

Cluster	Nodes	Top words	Top journals	Period
FE / predictability & volatility	60	stock, temporary, prices, components, permanent	review of financial studies, applied economics letters, journal of banking & finance, journal of housing economics, world bank economic review	1988-2002
ED / law	55	fraud, securities, damages, rule, 10	george washington law review, business lawyer, northwestern university law review, virginia law review, michigan law review	1988-2002
EM / commodities	45	futures, cointegration, commodity, cattle, live	journal of futures markets, american journal of agricultural economics, economic and social review, journal of agricultural and resource economics, journal of agricultural economics	1988-2002
EM / international	35	chaos, gold, exchange, volatility, futures	journal of futures markets, journal of international money and finance, journal of economic history, journal of international economics, journal of the japanese and international economies	1988-2001
FE / theory on efficiency	29	earnings, behavioral, judgment, economics, price	journal of accounting & economics, organizational behavior and human decision processes, journal of financial economics, journal of economic behavior & organization, american economic review	1988-2002
FE / technical analysis	22	technical, rules, trading, average, buy	journal of forecasting, jahrbucher fur nationalokonomie und statistik, journal of institutional and theoretical economics-zeitschrift fur die gesamte staatswissenschaft, journal of money credit and banking, studies in nonlinear dynamics and econometrics	1988-2002
FE / experimental	21	experimental, stumpage, bubbles, laboratory, informational	american journal of agricultural economics, annales-histoire sciences sociales, auditing-a journal of practice & theory, journal of economic psychology, journal of finance	1988-2002
ED / social responsability	17	responsibility, ethics, social, driven, environmental	journal of business ethics, academy of management journal, journal of business research, columbia law review, human resource management	1988-2001
ED / strategy	14	control, mergers, strategic, acquisitions, firms	strategic management journal, journal of management, journal of business venturing, journal of economic perspectives, organization science	1988-2001
EM / betting	11	betting, cross, basketball, british, equation	european journal of operational research, applied economics, economic inquiry, journal of economic literature, journal of monetary economics	1988-2000
ED / marketing	11	brand, advertising, event, study, attitude	journal of marketing, information systems research, journal of advertising, journal of the academy of marketing science, marketing science	1989-2002
FE / fund performance	9	funds, mutual, fund, managed, conditional	journal of finance, south african journal of economics, quarterly journal of economics, journal of futures markets, journal of political economy	1989-2002
EM / housing	4	property, 90, controls, development, land	urban studies, journal of real estate finance and economics, journal of the american real estate and urban economics association	1992-1999

Table 5: Summary statistics of clusters in the dynamic network (1988-2002)

Cluster	Nodes	Top words	Top journals	Period
FE / technical analysis	51	technical, rules, average, heterogeneous, moving	journal of economic dynamics & control, journal of forecasting, expert systems with applications, international journal of forecasting, journal of financial economics	1996-2010
EM / international	45	walk, weak, form, central, note	applied economics letters, journal of portfolio management, politicka ekonomie, journal of banking & finance, journal of economic surveys	1996-2010
FE / theory on efficiency	43	accounting, aggregate, book, mergers, risk	journal of accounting & economics, journal of finance, journal of financial economics, journal of accounting research, journal of risk and insurance	1996-2010
ED / strategy	43	environmental, social, corporate, firm, ceo	strategic organization, academy of management journal, strategic management journal, journal of business ethics, ecological economics	1996-2010
EM / critical perspective	38	analysts, charting, format, geography, perception	journal of post keynesian economics, accounting and finance, academy of management journal, american journal of economics and sociology, annals of the association of american geographers	1996-2010
EM / betting	36	betting, political, politics, virtual, markets	american journal of political science, applied economics, journal of product innovation management, management science, acta politica	1997-2010
ED / marketing	29	customer, firm, advertising, satisfaction, marketing	journal of marketing, journal of marketing research, journal of the academy of marketing science, marketing science, journal of business research	1998-2010
EM / commodities	28	commodity, agricultural, futures, evaluation, mutual	american journal of agricultural economics, journal of agricultural and resource economics, journal of finance, journal of business finance & accounting, annual review of financial economics, vol 2	1996-2010
FE / information flow	26	insider, announcement, convergence, damages, drift	journal of banking & finance, accounting review, european journal of communication, federal reserve bank of st louis review, german economic review	1996-2010
ED / law	22	prudent, puffery, reform, regulating, securities	virginia law review, cornell law review, duke law journal, southern california law review, vanderbilt law review	1996-2010
EM / energy	19	oil, crude, futures, dependence, petroleum	energy economics, energy policy, journal of futures markets, agricultural economics, american journal of agricultural economics	1997-2010
FE / behavioral	15	fluctuations, implications, activity, austrian, borse	quantitative finance, journal of economic perspectives, journal of business economics and management, journal of monetary economics, oxford review of economic policy	1996-2010

Table 6: Summary statistics of clusters in the dynamic network (1996-2010)