Science is an all-pervasive influence on our lives and ideas and has long been a source of inspiration for artists. Many papers have been published on the epistemic link between science and art. Two categories of references can be found in the literature: the first involves the impacts of science on art [1,2], and the second is focused on the influences of art on science [3,4].

This article deals with the former category of references and provides a small discussion on the influence of scientific knowledge on the artistic process. When science is used as inspiration for art, artists often refer to the pictorial dimensions of scientific models. Because science gives us the opportunity to see reality through new perspectives, scientific results (i.e. the visual impact of these results) are often used as inspiration by artists [5]. Sometimes this dimension is mentioned explicitly, as when artists such as Eric Heller transform the visual images produced by a scientific discovery (made using microscopic photography or spectroscopy).

In this paper, I contend that artwork can also be produced to illustrate scientific knowledge that does not necessarily have a pictorial dimension. In the following section, I provide epistemological reasons why scientific knowledge need not have a pictorial dimension to inspire an artistic approach. As an economist and philosopher, I focus my attention on knowledge developed in the social sciences and more specifically in financial economics. Using this perspective, I present two of my own collages to illustrate how a non-pictorial scientific (economic) theory can engender an artistic illustration.

The Interpretive Dimension of Science
Science is a part of culture. Several philosophers, such as Rorty [6], Lyotard [7] and Baudrillard [8], argue that science is a human practice whose main objective is to develop certain beliefs about the world. Some of these beliefs progressively crystallize and become recognized scientific knowledge. From this perspective, all scientific theories are considered to be stabilized conventions [9]. Science is a “way of saying something” about reality but it is not the only way. Van Fraassen explains that “science does not simply represent the phenomena but it interprets them [and] that interpretation is incomplete in various ways” [10]. Heelan and van Fraassen provide an analogy between science and literature by comparing the first to an “open text” [11] in which the “inadequacy” [12] of interpretation necessitates a creative process in order for us to be able to think about reality in the terms proposed by the theory. This ability is based on the necessary coherence principle of a scientific model, which is supposed to be based on a specific logic.

In this article, I focus on the possibility of developing an “art of science” in the literal sense of the words, that is, an art illustrating scientific theories (and not their results or the reality they involve). Scientific knowledge is then used for itself, independent of the reality it is supposed to represent (even if this knowledge does not directly involve a pictorial dimension). Since all scientific theories are idealized and incomplete representations of reality, there are several “imperceptible gaps” that exist between reality and scientific knowledge. These gaps occur due to the fact that all theories necessarily “miss something” about the reality that they are supposed to describe. Because it explains this reality through a specific dimension, scientific knowledge does not capture the entire meaning of studied phenomena (in economics, for example, reasoning is often based on the ceteris paribus assumption [i.e. that all other conditions remain the same]). As van Fraassen empha-
sized, these gaps transform science into an interpretive activity. Indeed, scientists must circumvent the inadequacies of their theories by providing specific interpretations of reality in order to develop their scientific statements (this interpretive dimension of science has especially been emphasized since the emergence of quantum physics [13]). Whatever the discipline, all scientific knowledge is based on a pre-interpreted world embedded in a linguistic scheme [14]. Eger emphasized the “double hermeneutics” observed in science: first, the rewording of common language in order to use (or to avoid) it in scientific activity and, second, the interpretation of scientific theories (as well as the interpretation of the gaps discussed above) [15].

In this essay, I argue that all the inadequacies of scientific theories are meaningful and can therefore be used in an artistic approach. The fact that science is a mode of representation (and not a perfect mirror of reality) implies that we can develop an artistic interpretation of science, that is, an art of science.

**WHAT KIND OF ART?**

**Financial Economics as a Non-Representational Art**

All scientific knowledge involves a kind of paradox: All descriptions or explanations of a phenomenon reduce it to a specific framework, making it impossible to capture all the dimensions of that phenomenon. In this section, I will illustrate how I use these “gaps” between scientific knowledge and reality as inspiration. As mentioned above, science has always been a rich source of visual ideas. Marx Ernst, for example, created collages of pictures from articles on the use of photography in a scientific manner (i.e., articles on the scientific use of photography). “Ernst found in scientific images a fresh way of seeing, and he used them to help make visualizations of the invisible within himself” [16]. Ernst mainly used the visual results of scientific theories to provide a new image of reality. This is not my objective. I provide here two examples from my own experience: two collages inspired by a specific theory developed in economics. My collages are not inspired by the pictorial dimension of a scientific theory. I simply tried to create a possible visual illustration of the theory; my research on visual combinations was directly influenced by my knowledge (I probably would not have provided the same kind of picture if I were not an economist). These collages have no aesthetic objective but rather provide a visual perspective on the theoretical categories usually used in financial economics, such as “information,”“random” or “replication.” My artistic approach here involves a kind of rationality, since all elements refer to the theoretical theme in a work that appears to be simultaneously a real, subjective exercise of rationality and a rational exercise of subjectivity.

The two collages I present are illustrations of what we call the efficient market hypothesis (EMH) of financial economics. Although we use the word hypothesis, this framework is more of a theory [17] because it is founded on theoretical ingredients that are conceptually very simple but difficult to observe in reality: a perfect integration of information in prices and a random walk.

The first element consists of the claim that the prices of assets traded on stock exchanges reflect all known information. A consequence of this informational efficiency is that people cannot outperform the market by using known information. Professional asset managers are not consistently able to earn high returns by analyzing market information, because this information is directly reflected in the prices of securities so that they cannot provide a reliable payoff for investors. In any given period, investors will realize excess returns simply by chance. The best investing strategy, then, is to “replicate” the market in order to “match” its trend (to replicate the market means to construct a portfolio that, proportionally, is a perfect mirror of the whole market). This framework is often presented as the financial translation of the idealized (and ideological) model of “perfect competition” [18,19]. Despite its apparent simplicity, this theory has many eco-

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Fig. 2. The Benchmark, collage, dry pastels, 45 × 35 in, 2003. (© Christophe Schinckus)
nomic implications and generates many debates.

The second constituent of EMH involves a random walk: The evolution of returns, it holds, can be described by a statistical framework. According to Fama [20], the fact that prices evolve randomly shows the coherence of the EMH. If prices were predictable, investors would become very rich simply by applying financial theory. From this perspective, the random walk (i.e., here the random evolution of prices) is a logical consequence of informational efficiency.

Financial economics is a logical discipline based on concepts from statistics and economics. It is not commonplace to associate economics with art, and very few papers attempt to emphasize the dimensions shared by these two disciplines. While Le Gall [21] shows that Gournot used the concept of beauty to evaluate economic laws, Havelmo writes that the construction of a model can be seen as a “creative process, an art” [22].

One could also mention Leonard’s work [23] connecting the pictorial language (statistics) used by Otto Neurath to German art. This paper is directly in line with these precursory articles about economics and art.

In this paper, I argue that the EMH paradigm is a non-representational work of art. Representational art [24] has an affinity with reality: It uses form to denote ready-made content, whereas non-representational art does not refer to anything outside of itself [25]. The EMH framework is directly in line with this non-representative way of thinking about financial reality.

As mentioned above, the EMH is based on the perfect competition paradigm and describes an idealized vision of society in which auto-regulated financial markets let the fundamental value (price) of assets emerge. The description of financial reality in these terms is very similar to an artistic process, because we have to project onto reality theoretical principles resulting from a pure conceptual framework (inspired by the rules developed in the perfect competition paradigm).

However, not all these rules are observed in financial reality— I adopt here Quine’s inscrutability thesis [26]—and people have to believe or pretend to believe that financial markets can be thought of in terms of perfect competition. The EMH is therefore a creative abstraction based on an unrealistic representation of financial reality. To be accepted in financial theory, this abstraction must be sustained by a “story,” such as proposed by Fama [27].

Articulating the EMH, Fama recognizes that the EMH is “of course, not descriptive of markets met in practice” [28]. However, despite admitting the unrealistic dimension of his story, Fama proposes a structuring narration founded on three forms of efficiency and a specific statistical framework (a random walk). As an artist would do, Fama implicitly asks people to follow him in his created and perfect (economic) world. This is an artistic approach to financial reality. Projecting stylistic principles onto reality and persuading people to believe in these unrealistic rules is a feature of all artistic processes [29,30].

Collages Illustrating Financial Economics

Now that I have presented financial economics as an art and the EMH paradigm as a non-representative story, I will practice the first by providing two collages describing the second. The EMH theory has no specific pictorial representation in financial economics; therefore, I use my knowledge of this theory as inspiration.

The creation of my collage can be broken down into two steps: First, I identified some common elements for my collages. These are key themes from the EMH that I used in both collages: information, the idea of replication and initials. Second, I chose certain particular elements (related to EMH) that individualize each collage: random for the s and curves, often observed in portfolio management (based on EMH), in the second work.

In the first collage (Fig. 1), we find the key themes mentioned above: The two similar lines on the far right and far left of the work symbolize the idea of replication of the market (the main left dark line). The vertical dark line on the right refers to the same idea but emphasizes the fact that this replication can be different in practice [31]. Pieces of newspaper represent the key theme of information, and the letters H and I are for “hypothesis” and “information.” The arrangement of this collage could be considered random. This is the individualizing element of this work. Moreover, neither this nor the other collage I discuss is geometrically perfect, because, in keeping with the represented theory, the supposed or projected perfection must be in the sum of the elements (i.e., the market) and not perceived in any single one element.

I used the same approach in the second collage (Fig. 2), where the two orange lines on the left are a replication of the main vertical line in the middle of the work. Pieces of newspaper again represent the key role played by information in this theory, and the letters C, A and R refer to the key themes (capital, assets, returns) used in this framework. The points above and below the central horizontal line illustrate the statistically random implications of this theory. The geometric form used as the base of the vertical symbolizes the fact that this theory is the core of modern financial theory [32]. Finally, the individualizing component is seen in the curved elements scattered around the arrangement, which are directly inspired by the curves we often observe in portfolio management.

Conclusion

In this essay, I have argued that the hermeneutic dimension of science can be used in an artistic approach in which a work of art emerges from rational categories. In this process, subjectivity meets rationality. I have demonstrated my claim with my own collages illustrating a very famous theory in financial economics: the efficient market hypothesis, whose main theoretical themes inspired my research into pictorial combinations. More precisely, my knowledge of this theoretical framework led to certain particular visual associations that I would never have made if I did not know this theory. Because science is a kind of creation of reality, it can be directly used as inspiration for art.

The art of science, as proposed in this paper, provides a broadened perspective on an existing scientific theory by providing an illustration of the dimensions that are not directly captured in the theory. In economics, for example, theories are often presented as causal (implying a specific mechanism) and temporal (time dependent). In this paper, the visual contribution of the collage offers a non-causal and timeless representation of this theory. By considering a visual illustration of theoretical categories used in financial economics, we can broaden our way of thinking about the conventionalized concepts used in economics.

References and Notes

Unedited references as provided by the author.


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9. B. Latour and S. Woolgar, Laboratory Life: The Social Construction of Scientific Facts (Sage, Los Angeles, USA, 1979). According to these authors, all scientific discoveries presuppose scientific community based on conventional norms that determine what can be considered a scientific discovery.
18. Gillet [17].
24. R. Collingwood, The Principles of Art, Oxford, Oxford University Press (1958). Non-representative art appears to be the main paradigm of contemporary art; as Collingwood explained, "The doctrine that all art is representative is a doctrine commonly attributed to Plato and Aristotle and something like it was actually held by theorists of Renaissance and the seventeenth century. Later, it was generally maintained that some kinds of arts were representative and others not. Today, the only tolerable view is that no art is representative."
26. W. V. Quine, Word and Object (Cambridge, MA: MIT Press, 1960). Quine’s inscrutability thesis refers to the fact that we have no direct access to reality; we need a linguistic framework, a make-believe, to describe this reality.
29. Le Gall [27].
32. Gillet [17].

Christophe Schinckus has a Ph.D. in economics and an M.A. in philosophy of science. On one hand, his research focuses on the emergence of econophysics (statistical physics applied to economics); on the other hand, he tries to show that knowledge in economics and finance can be considered as an artistic process. He has also published several Lettrist poems and theoretical papers on Lettrism.
Leonardo Special Section

The Future of Art History in the Context of New Discoveries of Psychology and the Cognitive Sciences

A Call for New Discussion

Guest Editor: David Carrier

In March 2009, an important conference, “E. H. Gombrich auf dem Weg zu einer Bildwissenschaft des 21. Jahrhunderts” was held in Greifswald, Germany, on the centenary of Gombrich’s birth. The work of this seminal 20th century art historian and art critic relied upon the psychology of his day—many of his references to the scientific literature dated to the 1950s. However by the 1980s, many younger art historians were no longer engaged by his ways of thinking. Feminists, modernists, multi-cultural thinkers, queer studies scholars—all had their issues with Gombrich.

Gombrich, like all of us, was a person of his own time. But one result of the late-20th-century shift in how art historical research was conducted was that most scholars resisted any attempt to ground analysis in the study of psychology.

This, then, is a call for submissions exploring the theme “The Future of Art History in the Context of New Discoveries of Psychology and the Cognitive Sciences.” We are interested not in purely historical perspectives, but in research looking to the future: What are the most promising new approaches? How can they aid our understanding of visual art? We are interested both in general programmatic statements and in innovative accounts of individual works of art.

Knowing the importance of this topic, and the fact that all interesting claims are sure to be highly controversial, we welcome friendly, engaged debate.

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