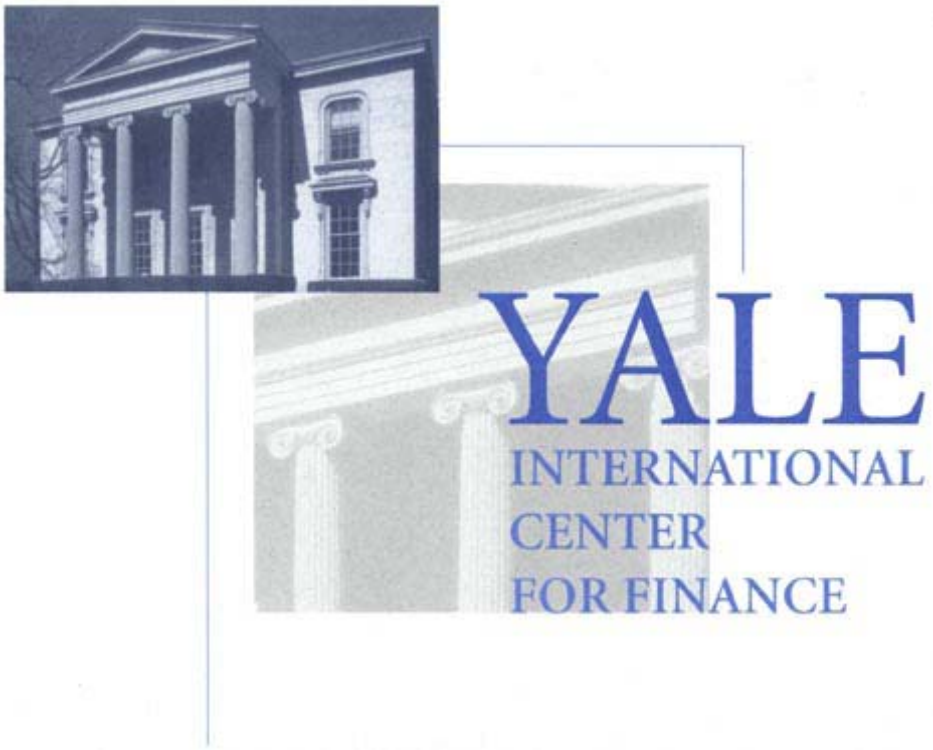

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Abstract

There are many conflicting interpretations of security prices and price determination in financial markets. They range from academic theories based on efficient markets and rational expectations hypotheses, to more traditional methods of fundamental analysis, to theories of "value" and "growth" investing, to chart-reading and technical analysis, to notions such as "reflexivity.". These interpretations are logically inconsistent with each other, but they seem to co-exist, sometimes even on the same trading desk. In this paper, we seek to formulate an explanation for this strange coexistence, using some tools from critical theory to understand how financial markets operate. Structuralism is used to analyze various kinds of narratives appearing in the financial literature, which are intended to have explanatory force, and appearance of sometimes contradictory elements in such narratives; post-structuralism is used to explain the way in which contradictory interpretations co-exist. We discuss some practical implications for security valuation, option valuation, trading strategies, market risk management, and volatility estimation.

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1. Introduction

As an academic activity, the study of financial markets seems to draw from many disciplines – from mathematics to psychology, economics to sociology – and draws on them in ways which are frequently, in fact typically, inconsistent with each other. In the markets themselves, one observes an even more bewildering variety of interpretations, almost as many interpretations as there are traders in the market. Everyone is at the mercy of capricious fluctuations in prices, and the response is an obsessive generation of explanations and conceptual frameworks, from the most narrow and rigorously quantitative theories to constructions which are fantastically complex and eclectic to the point of incoherence. And somehow everything and nothing seems to work: more precisely, everything works for someone, and nothing works for everyone.

What does all this mean? Where do theories of markets come from, and how do they function in the lives of traders and the day-to-day activities of markets themselves? Is there a metatheory (i.e., a method of evaluating theories) of markets that could explain this proliferation of theories, their interrelationships, and their conflicts? In what way could such a metatheory possibly be firmly grounded? And could it possibly have any practical implications? There are tools, drawn from the literature of structuralism and post-structuralism, which may help us grasp the structure and dynamics of this web of interpretations.

This paper takes some first steps along this path. For the benefit of readers whose background is purely financial economic theory, a great deal of introductory material has been included – an introduction to some aspects of structuralism and post-structuralism, and also an overview of various kinds of explanations in circulation in financial markets.

The paper is organized as follows. Section 2 introduces by way of examples the main themes of this paper. A rapid survey of various conflicting theories of security prices, accepted by different groups within the (overlapping) academic and financial markets communities is presented in Section 3. Some examples are developed in more detail in order to convey some of the flavor and subtleties of these different interpretive frameworks. In Section 4 we provide an overview on structuralism, outlining the basic framework of structuralism using examples from linguistics and Lévi-Strauss' work on structural anthropology. We then sketch some developments from post-structuralism, focusing on the critique by Derrida (1966) of the human sciences and of the project of structuralism. In Section 5 we suggest some ways in which critical theory may be applied

to understand how financial markets operate. Structuralism is used to analyze various kinds of narratives appearing in the financial literature which are intended to have explanatory force and appearance of sometimes contradictory elements in such narratives; post-structuralism is used to explain the way in which contradictory interpretations co-exist. Lastly, we discuss some practical implications in financial economics and market risk management. In section 6, we revisit the thesis advanced in the previous sections from the point of view of modern physical sciences and the consequences for measuring market volatility.

2. Financial Discourse

The emphasis of the exposition in this section will be on theories as forms of discourse, or as contributing elements to discourse, rather than theories as truth-generating logical machines. In fact, the term "interpretive framework" might be more appropriate than "theory." The analysis we proffer is not so much about theories in competition with each other, as it is about interpretive frameworks interacting with each other; it is not so much interested in making judgments about the correctness of specific theories, as in understanding what market participants are doing in the continual process of generating and deploying interpretations.

Perhaps the distinction between theories and interpretive framework needs to be explained. In modern science, a theory is a set of rules or mathematical models that allow one to make predictions. A theory does not need to have an interpretation. The notion of "positive economics" is an example. The interpretation of a theory is its object, the reality the theory is supposed to represent. It is important to distinguish between the interpretation of a theory and its meaning. We can make meaningful assertions that do not refer to any existing object. Often a theory as a model can have different meanings and different interpretations. Consider a regime-shifting model in econometrics. We can look at it as a computational device to make prediction, or we can try to find interpretations based on the meaning we assign to regimes. Regimes can be abstract hidden factors ─for example, economic expansion/recession─or can be attached to concrete quantities that we can observe.

Discourse on markets is carried on at various levels: at the level of price information alone; of information on economic facts external to the market; of information on the psychological state of market participants; and at a reflexive level,

about the nature of discourse itself. So various theories may therefore address all these levels, and indeed switch back and forth between these levels.

2.1 What is a Theory of Financial Markets or Security Prices?

Before diving in, though, a precautionary observation is called for. What is a theory of financial markets or of security prices? What does such a theory attempt to explain or to achieve? It is important to realize, from the outset, that there is not even consensus at this level. For example, here are just four possible answers to this question:

- Most crudely, a theory might attempt to *predict* the future course of security prices.
- A theory might attempt to trace the lines of *causation* between changes in security prices and other phenomena in the world, such as economic, political, and social events.
- There are theories which rigorously define the notion of *risk* inherent in different kinds of securities, how this risk is transformed as securities are combined in portfolios or in dynamic trading strategies, and how this risk is related to return in a probabilistic sense; this is a dominant focus of mathematical finance.
- There are theories which attempt to ascribe an underlying *value* to a security, and which may or many not attempt to relate this "true value" to the price of a security at any particular time.

Within each category there are innumerable competing theories, and a single theory may have something to say about all four questions. And it is also important to realize that these questions usually overlap in practice. For example, theories of causation, or theories of risk, may have predictive implications, while "fair value" is often asserted to be a function of risk. But the main point is that when people theorize about markets, they do not even necessarily agree on what the nature or purpose of a theory is; and so a metatheoretical analysis, if it is to be meaningful, should avoid making any presuppositions on this point.

2.2. Oppositions

Here are some examples, randomly selected and crudely sketched, of different theories, or interpretive frameworks. These often seem to fall rather naturally into pairs of

opposing points of view. It has to be emphasized that, in each example, there is no universal consensus about which view is correct, and there are both consistently successful and consistently unsuccessful traders who hold either view – although it is true that in academic finance, certain views have become dominant.

- The fundamental determinants of economy-wide equity valuations in emerging markets are regarded by some to be the "economic fundamentals" of the country (see Niemira and Zukowski, 1998); and by others to be political and social factors.[1]
- There is a distinction between range traders, who regard security prices as fluctuating about an equilibrium value, and thus view a deviation from that equilibrium as likely to be reversed, and momentum traders or trend-followers, who believe that, in appropriate circumstances, security prices tend to continue moving in the same direction for sustained periods (see Lefèvre, 1923).
- Two opposing philosophies of equity selection are value investing and growth investing (see Coggin and Fabozzi, 2003). Applied crudely, a value-oriented analysis might suggest that a stock with a high price/earnings ratio is overvalued, and is likely to suffer a drop in price; in contrast, a growth-oriented analysis might conclude that a rising price/earnings ratio may reflect increasing optimism about *future* growth in earnings, and that the stock price may therefore continue to rise.
- Some analysts believe that there is a notion of the "fair value" of a company, which is independent of its market valuation, and which may be determined by a sufficiently thorough analysis of its activities, accounts, and prospects; while many academics believe that the market clearing price of a company's stock, as it reflects the analysis carried out by the whole range of investors, and hence their collective informed judgment, is therefore is the best indication of its true value. (For an early discussion, see Graham and Dodd, 1934.)
- Mainstream finance academics tend to believe, along the above lines, that all relevant information about a security has been factored into its current price, so that its price on any earlier date yields no additional information (and, by implication, that the price follows a random walk in a certain technical sense); on

[1] This is reminiscent of the Marxian distinction between base versus superstructure.

the other hand, many investors believe that the historical path of a security's price (the "charts") helps predict its future direction. (See Malkiel, 1992 versus O'Neil, 1995, and Section 5.)

- Some traders, particularly professional investors, focus on economic factors external to financial markets, such as expected inflation, expected growth or corporate earnings; others, in contrast, particularly professional market makers taking short-term positions, focus on the behavior and attitudes of other market participants. (See Niederhoffer, 1997.)
- The future course of an economy is partly determined by expectations: for example, workers' expectations determine their wage demands and hence inflation, while capitalists' expectations determine the future level of investment. One may assume that expectations are "rational," in the technical sense that they are self-consistent with macroeconomic models of the dynamic path of the economy incorporating expectations (see below); or, alternatively, that they are "Keynesian," that is, determined by convention and/or recent past experience. These alternative assumptions lead to totally different approaches to economic modeling. (Contrast Sheffrin, 1996, with Keynes, 1936.)
- When an emerging market experiences a currency crisis and capital flight, it is unclear, from a theoretical point of view, whether the local monetary authority should lower interest rates to stimulate domestic investment, or raise interest rates to promote "confidence" and hopefully reverse capital outflows (Ssee Krugman, 1999).
- On a more technical level, analyses of productive capacity and potential growth may assume constant returns to scale, implying that exogenous factors are the main determinants of future growth; or they may assume increasing returns to scale, implying that growth is self-sustaining, since a decision to expand production itself increases productivity (see Solow, 1998).

In each of these examples, the two points of view are logically incompatible. But it is very important to note that in the minute-by-minute activity on a proprietary trading desk, the thought processes and decision rules of individual traders may quite rapidly switch between these inconsistent points of view. Traders often describe what they do as being akin to poetry – one interpretation is that the activity of trading exhibits similar

alternations and oppositions to a poem, and requires a like sensitivity to tension and contradiction as that required of a poet.

It might be argued that the coexistence of different and mutually contradicting theories simply reflects the fact that economics as a scientific theory is in an early stage of development. One might think that the accumulation of empirical facts and the refinement of theoretical thinking will progressively eliminate weak theories and will let strong theories emerge.

Though it is true that economics is a young science and that many economic theories will be forgotten in due time, however, the coexistence of competing theoretical explanations and of different interpretative frameworks seems to be a fundamental feature of human knowledge that we find also in the physical sciences. Despite the never ending quest for a "theory of everything" science is still divided and layered both practically and conceptually.

We will come back to these questions in a later section. Let's now describe in more details the type of "oppositions" that we find in current economic thinking and explanations. In a later section we will attempt to understand how these different discourses operate by making use of some of the tools employed in structuralist analysis and post-structuralist discourse.

3. Markets

In this section we discuss interpretations of financial markets, presenting a few illustrations of different interpretive frameworks in practice, mostly oversimplified for brevity. It will be seen that within each individual framework, ignoring their possible interactions, the texture of discourse is already quite rich and subtle, even in the oversimplified way in which it is presented here. Note that although all of these frameworks are commonly applied with seeming success, in this paper we make no assertions about the underlying validity of any of them. To repeat, the goal is not to determine which explanations are "correct", but to understand the activity of producing explanations.

3.1 "Technical" Narratives

In trading terminology, "technical factors" refer to the influence of psychological and/or supply/demand conditions on price behavior, and the presumed significance of key price levels or price patterns. For instance, a specific price level above the current price of a security might be regarded as a "resistance level" – the price "resists" rising toward that

level, but once it does, it is liable to overshoot it dramatically. One rationale for such predicted behavior may be that a major market participant holds a very large short position in the security and has placed a stop loss order to cover the position at that price level: that participant will attempt to use its market power to ensure that the price does not rise, but if it does cross the stop loss level a large purchase will be triggered, further driving the price up. Other rationales are also possible. A concrete example of this kind of thinking is as follows:

> …I had watched [wheat] a long time. For months it sold between $1.10 and $1.20… one day it closed at above $1.19. I got ready for it. Sure enough the next day it opened at $1.205, and I bought. It went to $1.21, to $1.22, to $1.23, to $1.25, and I went with it. Now I couldn't have told you at the time just what was going on. I didn't get any explanations about its behavior during the course of the limited fluctuations. I couldn't tell whether the breaking through the limit would be up through $1.20 or down through $1.10… As a matter of fact, it seems Europe had been buying quietly and a lot of traders had gone short of it at around $1.19. Owing to the European purchases and other causes, a lot of wheat had been taken out of the market, so that finally the big movement got started. (Lefèvre, 1923.)

A critical aspect of this kind of approach is that one does not need to know *why* prices are exhibiting a certain pattern; in deciding how to act, one simply observes the patterns themselves. This leads directly to the common practice of "chart reading" or "technical analysis," which attempts to identify repetitive patterns on which predictions can be based. For example, an "upside breakout from the 10-week moving average" or a "cup and saucer formation" might signal the beginning of an upward trend in prices, while a "head and shoulders" pattern might signal the end of such a rally. It is often, but not always, argued that this kind of approach is valid because such patterns are evidence of the existence of certain psychological or supply/demand conditions which affect likely future price behavior.

Chart reading has grown into a vast and disreputable field, with thousands of competing systems, most of byzantine complexity. It must be noted that chart reading in any form is inconsistent with the assumptions underlying almost all academic work on finance. But although the published literature is dominated by charlatans, it is also undoubtedly true that technical factors are of critical importance in short-term trading, and arguable that many successful traders seem somehow to derive useful information

from inspecting price charts, even if they could not be described as purely "technical analysts".

3.2 Traditional "Macro" Narratives

Many bond investors and hedge funds make long-term investment decisions based on "macro" analysis, which attempts to identify, on an economy-wide scale, the economic, social, and political factors that influence interest rates and the causal links between them. For example, if unemployment rises, wage demands will fall, inflation will remain lower. and the Fed will permit interest rates to remain low. (For many other examples of this kind of reasoning, see Niemira and Zukowski, 1998.) Note that this kind of analysis is probably broader in scope, and definitely much less rigorous, than the academic discipline of macroeconomics.

An extended example of a "macro" narrative, setting out a presumed chain of causation, would be: (1) President Reagan greatly boosted defense spending in the early 1980s; (2) the Soviet Union responded by increasing its own spending on defense; (3) this created economic problems in the USSR; (4) these problems led to political weakness, and also prompted Gorbachev to introduce the policy of *glasnost*; (5) as a direct result, the Berlin Wall fell; (6) East and West Germany were reunified; (7) to ease the transition for East Germans, there were massive fiscal transfers from West to East; (8) the resulting explosion in Government spending introduced the risk of inflation; (9) to counter this, the Bundesbank maintained a tight monetary policy, keeping real interest rates extremely high; (10) other European central banks were obliged to follow suit in order to avoid derailing the project of monetary union; (11) high real interest rates depressed investment throughout Europe; (12) as a consequence, unemployment ballooned; (13) the Left thus gained political ascendancy; and so on.

Some comments are called for. First, it is clear that this kind of narrative need not be finite and linear, can be extended indefinitely in either direction and can also exhibit branching in either direction, as two chains of events converge to produce a result or as an event has a range of different consequences. Second, that the reasoning is economic in nature – unlike, for example, chart reading – but does not confine itself to looking at purely economic factors; politics, mass psychology, and institutional and social conventions play an equally important role in the story. Third, this kind of reasoning strongly resists mathematical formalization (though interesting attempts have been made

to formalize it). Fourth, the narrative exhibits a constant interplay between the dynamics of the market and the dynamics of the economic, social, and political "real world".

Finally, no explanation is final; any narrative can be refined, and always in many different ways. For instance, a common building block of such a causal analysis is the observation/assumption that when the central bank tightens monetary policy (reduces the money supply), production tends to fall; but Appendix A to this paper sets out various lower level explanations of why this occurs, as presented by Frederic Mishkin, former director of research at the Federal Reserve Bank of New York. Each of these theories could in turn be refined in a number of different ways, and the refinements in turn refined… a search for basic, irreducible economic facts on which to build a causal theory is fruitless, as they are endlessly deferred.

3.3 A Rational Expectations Narrative

Because academic theories of rational expectations have assumed such an extraordinary ascendancy, yet seem so unintuitive to a lay audience, it may be useful to give a concrete example of a "rational expectations" theory of price formation – indeed, an example which helped motivate the theory. This is the so-called "cobweb" model of farm production.

Farmers tend to plant more than usual when they expect prices to be higher; but the actual price for the crop depends, in part, on the amount that was planted – the more that was planted, the larger the harvest and the lower the price. So the relationship between crop prices from year to year and farmers' expectations about prices is extremely complex, and the dynamic behavior of prices will depend on how these expectations are formed. One way of approaching this problem is to observe how farmers make price predictions, for example, by asking them.

By contrast, a rational expectations approach to modeling crop prices does not begin with empirical observation, and might proceed as follows. Step 1: Farmers should base their planting decisions on the best possible predictions about the future crop price (i.e. the one that is likeliest to be correct). Step 2: Assuming for the moment that all farmers make the same prediction, for each possible predicted price one can estimate the amount that will be planted and thus the actual price that will result when the crop is harvested; that is, we have a function *f* that relates the actual price to the predicted price:

$$p_{\text{actual}} = f\left(p_{\text{predicted}}\right).$$

Step 3: The *best* prediction is the one that will turn out to be correct, *provided all farmers base their planting decisions on it*; that is, it is the price $p_{\text{bestprediction}}$ which satisfies:

$$p_{\text{bestprediction}} = f\left(p_{\text{bestprediction}}\right).$$

This description of steps (2) and (3) ignore uncertainty about the weather, and future demand, which both affect the future price; *f* should really be regarded as computing the *likeliest* price that will result from acting on a prediction based on various additional assumptions about the weather and demand. Also note that the temporary assumption in step (2), that all farmers make the same prediction, is justified in step (3): the theory concludes that all farmers, being intelligent profit maximizers, will all apply the same (correct) theory itself to make their predictions, and will therefore, in fact, all make the same prediction, namely the best prediction. This central tenet of rational expectations theory was stated more generally in the seminal work by Muth (1961):

> I should like to suggest that expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory.

The implications of this fascinating axiom will be discussed further below. It is simply noted here that, while theories based on rational expectations do not seem to describe the real world very accurately, they are arguably the only known mathematical theories of price formation which are, in a narrow sense, logically consistent throughout.

3.4 Reflexive Narratives

Our final example of a form of reasoning commonly applied to understanding markets and making predictions of the renowned hedge fund manager George Soros' notion of "reflexivity":

> [Market participants] cannot obtain perfect knowledge of the market because their thinking is always affecting the market and the market is affecting their thinking… participants cannot confine their thinking to facts. They must take into account the thinking of all participants including themselves. (Soros, 1995.)

In other words, phenomena such as speculative bubbles do not occur for purely psychological and irrational reasons, but because decisions taken by investors *en masse* in response to price changes affect underlying economic variables themselves, causing a further movement in prices. Thus, "a boom/bust process occurs only when market prices find a way to influence the so-called fundamentals that are supposed to be reflected in market prices." For example, when a company's shares become overvalued, it can

efficiently acquire other companies using its own overvalued equity as currency. Thus, it can engineer a rise in earnings per share (as in the conglomerate boom of the 1960s) or increase its market power (as in the Internet boom of the 1990s). In both cases, the outcome is apparently rosier prospects for the company, justifying a further rise in the stock price.

Crises in emerging markets form another important class of examples:

> [When countries depend on external investment] a loss of confidence in a country can produce an economic crisis that justifies that loss of confidence… [O]nce you take the possibility of self-fulfilling crises seriously, *market psychology* becomes crucial – so crucial that within limits the expectations, even the prejudices of investors become economic fundamentals – because believing makes it so. (Krugman, 1999; emphasis added.)

Incidentally, the phrase "market psychology" has been highlighted here because there appear to be no general rules that determine whether a country's actions will inspire "confidence." For example, when countries permit a currency devaluation, the reaction has typically been violently negative, yet the opposite was the case when Brazil experienced its crisis in January 1999.

Mortgage trading is another example of reflexivity in markets, more technical in its details but of considerable interest because of the size of the mortgage market in the United States, approximately $1 trillion, constituting nearly 40% of the domestic fixed income market. In this case, the narrative might go as follows: First, mortgage lenders raise money to lend to borrowers by selling the mortgages to investors. The price that investors are willing to pay depends on the timing of the cash flows they expect to receive; this, in turn, depends on how many borrowers are likely to refinance their mortgages; and this, in turn, depends on the future level of mortgage rates, which determines any potential interest saving from refinancing; and mortgage rates are in turn linked to market interest rates in general, such as yields on Treasury bonds. When purchasing and trading mortgages, therefore, investors employ elaborate prepayment models which attempt to predict how refinancings will change in response to changes in Treasury yields.

Second, because these models are attempting to predict human behavior, they are never completely reliable. Investors will tend to lower the price they are willing to pay

for their mortgages if they become less certain about the reliability of their models. They also attempt to determine what price other investors will pay; that is, in setting their own price. investorsincorporate not just the results of their own models and their assessments of their own models' reliability, but their perception of the models that other investors are using and the confidence that other investors place in their models.

But finally, this means that when investors lose faith in their models, this affects mortgage prices, hence mortgage rates, hence borrowers' behavior, hence the reliability of the models. This is precisely what occurred in October 1998: prepayment fears and uncertainty about the reliability of prepayment models contributed to a dramatic fall in the price at which mortgages could be sold, and thus a sudden rise in mortgage rates that had to be charged to borrowers, inconsistent with the relationships between mortgage rates and Treasury yields assumed by the models – leading to further market disruption.

4. Structuralism

4.1 Hystorical Notes

In this section, we will discuss a number of conceptual tools that have been introduced by a vast cultural movement called *structuralism* and by its evolution into *post-structuralism* and *post modernism*. Let's first place structuralism into its historical context. Structuralism developed over a period of time that occupies almost all of the 20th century. In the last three decades of the 20th century a new movement called post-structuralism or post-modernism developed as an evolution and often in opposition to structuralism.

To understand the birth of structuralism, consider that at the end of the 19th century the faith in the physical sciences was at its peak. The Universal Expositions held in Paris and London were the tangible signs of this faith. The Eiffel Tower built for the 1889 Paris Universal exposition was a monument to science and technology. As we will discuss in a later section, the 18th and 19th centuries witnessed a widening gap between the physical sciences on one side and visual arts, literature, social sciences, and philosophy on the other side. At the end of the 19th century, however, many people working in these "soft sciences" wanted to adopt some of the methods that were so successful in the physical sciences.

However, the physical sciences were based on the paradigm of differential equations typical of mechanics. This paradigm critically depends on processes of accurate measurement and it is unwieldy in domains such as the social sciences. Thus the search

for new ways of thinking that could retain at least some of the rigor of the physical sciences. Structuralism is an attempt to introduce the formal rigor of mathematical and logical reasoning in areas not suitable for measurements. The idea of structuralism is to describe structures and their dynamics as opposed to the time dynamics of quantitative variables.

4.2 "Structure": Saussure and Lévi-Strauss

The most rapid way to introduce the principle of "structure" is by a series of examples. The descriptions of the examples may be clearer if the reader bears in mind the following broad principles, which are stated here merely as rough guidelines – not axioms:

1. A structuralist analysis looks for patterns or structure, in other words for repeated elements.
2. Structure is identified by an analysis which is *synchronic* rather than *diachronic*: That is, an analysis which looks at (e.g., a set of myths existing simultaneously at a given time as part of a system), rather than an analysis which traces how individual myths developed over time.
3. The elements of a structure have no intrinsic or independent significance, but only acquire significance when viewed as part of the structure as a whole.
4. The "function" of structure turns out to be expressive rather than instrumental.

4.2.1 An example from structural linguistics

While structuralism's influence is most notorious in anthropology and literary and cultural criticism, it originally emerged in the field of linguistics, notably in the work of Saussure (1915). Two of the key insights of structuralism are first expressed there: the requirement that structural analysis adopt a synchronic point of view; and the fact that signification is determined, not by the intrinsic properties of individual signifiers, but by the differences between them. On the latter point:

> Values always involve: (a) something *dissimilar* which can be exchanged for the item whose value is under consideration, and (b) *similar* things which can be *compared* with the item whose value is under consideration. In the language itself, there are only differences… and no positive terms… the essential function of a language as an institution is precisely to maintain these series of differences in parallel… the language itself is a form, not a substance. (Saussure, 1915.)

A further, crucial point is that those differences which are significant within the language are specific to each language. For example, even in the domain of phonology,

the value of a sound in a language – that is, the phoneme to which it corresponds – is determined by the whole system of phonemes in the language. Certain distinctions have a value in some languages but not in others. For example, the distinction between fortis and lenis plosives (e.g. the difference between the sound of the letter 'd' in the words 'damn' and 'badness') has a value in Bengali, but not in English; whereas the voiced/voiceless distinction (e.g. 't' versus 'd') is relevant when distinguishing phonemes in both languages.

An example from semantics is given by color words: it is well known that there is in general no one-to-one correspondence between color words in different languages, but that color words in each language form their own autonomous systems. For example, the Chinese word *qīng*, frequently translated as "blue" or "green", has no mapping as an individual word into the English system of color words: its sense as, e.g., the color of forest-covered mountains on the horizon, only emerges when it is viewed as part of the Chinese system, within which it might not be used to describe a stone which was green or blue.

The structuralist approach to linguistics was extended to poesy by Jakobson, who also cited Gerard Manley Hopkins' definition of verse as "speech wholly or partially repeating the same figure of sound" as being critical because its level of abstraction opened the way to structural analysis. It was Lévi-Strauss, Barthes and Lacan who took the more controversial steps of extending the structuralist method to anthropology, literary criticism, and psychoanalysis.

4.2.2 Lévi-Strauss on the Œdipus myth

A paradigmatic structuralist analysis is the interpretation of the Œdipus myth which appeared in Lévi-Strauss (1955), and which is summarized in a chart reproduced as Appendix B of this paper. Read synchronically, the key elements of the myth fall into groups, expressing two oppositions: contradictory attitudes towards blood relations, and contradictory attitudes towards the autochthonous origin of humans. Thus, blood relations are overrated when Œdipus marries his mother, and underrated when he slays his father; the autochthonous origin of humans is denied when Œdipus kills the Sphinx, but affirmed by the etymological references to lameness in the names of the male protagonists – lameness, across many cultures, being associated with the idea that humans are born from the earth.

Thus the myth is "about" the inability to reconcile primitive theories of the autochthonous origin of humans with the patent fact that people are born of parents. Lévi-Strauss goes on to make three interesting points. First, the myth is an expression of this tension, rather than proposing a resolution to it. Second, the underlying structures appear in the mythologies of many cultures, even on different continents (such as Pueblo mythology). Third, it is in the nature of structuralist analysis that "our interpretation may take into account, and is certainly applicable to, the Freudian use of the Œdipus myth."

4.2.3 Further examples from structural anthropology

Structural anthropology does not apply solely to myths, but to other cultural phenomena, as Lévi-Strauss subsequently demonstrated. For example, in his work on totemism he notes that the appearance of animals as totems makes little sense when they are considered individually, but make perfect sense when the system of totems is considered in its totality, taking due note of similarities and oppositions.

> The Australian tribes of the Darling River, in NSW, are divided into matrilineal exogamous moieties called Eaglehawk and Crow… The Haida, of the Queen Charlotte islands in British Columbia, are divided into matrilineal exogamous moieties called Eagle and Raven… Australian exogamous moieties… are frequently designated by the names of birds. (Lévi-Strauss, 1962.)

The point is that animals appear in pairs, where the members of each pair have something in common that makes comparison possible (here, the fact that they are carnivorous birds), and also have distinguishing characteristics that enable them to function as different values (here, the fact that the eagle is a bird of prey while the crow is a carrion-eater). Lévi-Strauss also notes that both societies have similar myths: for example, the raven steals the eagle's water, spilling it to create lakes and rivers.

The conclusion is that social relations, in this case the rules regulating intermarriage, are structured to mirror oppositions in nature, which in some sense serve as a template. Interestingly, Lévi-Strauss claims that certain Australian aboriginal tribes are consciously aware of this process, and will adopt elements drawn from other tribes' schemata when convenient.

The relation to nature is a recurring theme in structuralist analysis. A different kind of example of how it shapes social practices is given by Clastres (1974) in his studies of South American forest cultures. He notes that the institution of chieftainship in

these cultures is characterized by oratorical talent, extreme generosity and polygyny; and that language, goods and women, the objects of these three practices, happen to be the three principal objects of social exchange; in other words, chieftainship subverts the processes of social exchange. He also notes, crucially, that the chief has no authority in the tribe, and cannot give orders but can only persuade.

> Thus power enjoys a privileged relationship towards those elements whose reciprocal movement founds the very structure of society… this relationship… institutes the political sphere not only as external to the structure of the group, but further still, as negating that structure…And as this power is – to put it schematically – nothing, the group thereby reveals its radical rejection of authority, an utter negation of power… in essence, power is no more than the furtive manifestation of nature in *its* power [i.e. as the negation of culture]. (Clastres, 1974.)

In other words, social structures appearing in a whole range of native cultures across South America have a structural interpretation: they express different correspondences, or different tensions, in the relationship between society and nature.

4.2.4 Example from Barthes

Moving on to cultural criticism, the next example is drawn from the commentary by Barthes (1957) on professional wrestling and its vivid, clear-cut distinction between "good guys" and "bad guys":

> …in wrestling… it is each moment which is intelligible, not the passage of time… The physique of the wrestlers therefore constitutes a basic sign… what is expected is the intelligible representation of moral situations which are usually private… the great spectacle of Suffering, Defeat and Justice… what wrestling is above all meant to portray is a purely moral concept: that of justice… [exaggerated and instantaneously identifieable signifiers of foul and fair play]… the euphoria of men raised for a while above the constitutive ambiguity of everyday situations and placed before the panoramic view of a univocal Nature, in which signs at last correspond to causes, without obstacle, without evasion, without contradiction. (Barthes, 1957.)

So in this case, the concrete opposition between good and bad in wrestling reflects the yearning for an unambiguous notion of justice in the face of the persistent appearance of moral ambiguity in the actual social world. Note that in this case, "Nature" does not unproblematically refer to the natural world as distinguished from society and culture; rather, Nature appears in an idealized form, as a symbolic realm.

4.2.5 Lévi-Strauss' theoretical framework

Lévi-Strauss (1964) describes his own method as follows: "there is a kind of logic in tangible qualities" like the raw and the cooked, which can only be discovered by studying *systems* of myths rather than individual myths. So far the relation to structural linguistics seems quite direct. But in extending these methods beyond linguistics, a number of additional aspects become important, and explain why structuralism comes to be perceived in philosophical terms rather than purely as a set of methods or analytical techniques.

First, cognition is analyzed, not in terms of individual thinking subjects, but as something going on at the level of discourse. Lévi-Strauss quotes with approval Ricœur's description of the structuralist project as:

> Kantism without a transcendental subject… since, my ambition being to discover the conditions in which systems of truths become mutually convertible and therefore simultaneously acceptable to several different subjects, the pattern of those conditions takes on the character of an autonomous object, independent of any subject… it would perhaps be better to go still further and, disregarding the thinking subject completely, proceed as if the thinking process were taking place in the myths, in their reflection upon themselves and their interrelation. (Lévi-Strauss, 1964.)

Second, Lévi-Strauss warns that the process of structural analysis does not transcend myth, but in fact takes the same form as myth itself, and explicitly rules out the possibility of a "center" in Derrida's sense:

> …there is no real end to mythological analysis, no hidden unity to be grasped once the breaking-down process has been completed…[the function of the unity of myth] is to endow the myth with synthetic form and to prevent its disintegration into a confusion of opposites. (Lévi-Strauss, 1964.)

Third, structuralism has a complex relation to historicity. Although structuralist analysis is synchronic, it does not deny historicity; rather,

> …it then becomes a matter of determining, according to the symbolic systems employed, according to the prescribed rules, according to the functional norms chosen and laid down, what sort of historical development each culture is susceptible of… (Foucault, 1966.)

That is, structure does not determine history, but it does constrain it, and one purpose of structuralist analysis is to clarify in what way historical development may be

constrained. Thus Clastres (1974) used structuralist methods to help explain the ways in which South American forest cultures responded to European colonization, without suggesting that their response be regarded as mechanistic.

4.3 "Center": Derrida

In the last three decades of the 20th century, structuralism underwent many transformations and was the subject of a heated debate. On one side it developed into more formal theories, on the other side it evolved into a more complex and less defined post-structuralist movement. Let's briefly outline these developments.

The formal aspects of structuralism have their roots in the development of rigorous mathematical theories of structures, in the development of formal logic, and, ultimately, in the diffusion of computers. During the 20th century entire new areas of mathematics were developed. In particular, the mathematics of complex structures such as algebra, geometry, and the development of formal languages, made enormous progress. The grandiose project of Bourbaki[2] aimed at a unification of mathematical structures. A structuralist view of mathematics was developed by Paul Benacerraf (1965) and, to some extent, also by Bourbaki. Linguistic structuralism took a formal twist with the development of formal grammars proposed by Noam Chomsky (1957).

Structuralism, however, was also the subject of sharp criticisms. In particular, in the social sciences structuralism was criticized on the ground that human societies evolve and are capable of adaptation and self improvement. The idea that there are permanent structures in human societies seemed at odds with the notion of human progress. Post structuralism is the evolution of structuralism.

Post structuralism is largely associated with the name of Jacques Derrida.. Derrida is a rather controversial intellectual figure who became very influential in many philosophical and literary circles. In 1966, he was invited to lecture at the John Hopkins University. In these lectures Derrida introduced the new concept of "deconstruction" that gave him international notoriety and became the starting point of the post-structuralist movement.

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[2] Bourbaki is not an individual but it is the collective allonym of a group of leading French mathematicians including Jean Dieudonnè, Laurent Schwartz, and Andrè Weil. The Bourbaki group published a sort of unified encyclopedia of mathematics.

5. Structuralism and Markets

Servet (1998) observes that "primitive coinage" – shell collars, pearls, teeth, feather rolls, stone disks – what he refers to as "palaeocurrencies" in circulation within native cultures, formed part of protocols of exchange which were far more complex than those which govern the use of hard currency in Western society. Many non-interchangeable forms of currency coexisted, each associated with different forms of social exchange: marriages, injuries, the breaking of taboos, conflicts, and alliances. Currencies "function as a direct instrument of social control and regulation" in the same way as, say, systems of totemic associations. In Western cultures, while vestiges of such practices remain (such as Maundy money in England), the concept and function of money seems to have undergone an almost total transformation.

But as structure disappears in one theater of human activity, it reappears in another. Just as Lévi-Strauss argued that the decline of myth's importance in Western society was accompanied by the rise of polyphonic music, in which structures of comparable complexity are expressed, so it might be argued that accompanying the decline of palaeocurrency was the emergence, from the Renaissance onwards, of sophisticated financial markets and the increasingly complex interpretive practices of market participants. It is these practices that should logically form the subject of a structuralist analysis.

In the world of the financial markets, the examples of interpretive frameworks listed in the preceding section ─complex as they might seem ─ are merely building blocks of more complex narratives whose essential nature is composite. If one transcribed the conversations and telephone calls taking place in a single busy day on a typical trading desk, one would see a rapid and bewildering alternation of points of view. But on closer inspection, this apparent chaos does reveal some structure.

5.1 The Old Trader and the Yen

Here is an initial attempt at a structural analysis of a story from a well known trader and former professor at the University of Chicago, Victor Niederhoffer (1997): the narrator's description of a morning spent trading the dollar:yen is a fascinating illustration of how conflicting interpretive theories are intertwined in the second-by-second activity of the

markets. The atmosphere, and the constant collision of interpretations, is here described quite vividly. One must look to market participants for this kind of account, which is almost never found in the work of academics; similarly instructive stories may be found in Lefèvre (1923) and Bronson (1995).

The narrative is too long to reproduce, so the reader is urged to refer to the text. However, appendix C to this paper extracts some notable passages, in chronological order as they appear in the story – but here arranged in columns, in an attempt at the kind of structural analysis that Lévi-Strauss applied to the Œdipus myth.

There are again four columns, diagramming two opposing series. The first pair – "chart patterns" versus "behavioral patterns" – contrasts predictive theories based on price behavior in the immediate past with predictive theories based on the habitual behavior of certain groups of investors. The second pair – "primacy of fundamentals" versus "manipulation of expectations" – contrasts theories asserting that prices move in response to changes in underlying economic circumstances with theories asserting that prices move when investors' expectations change, and that these expectations are subject to manipulation by the authorities.

In this case the tension seems to be between two opposing classes of interpretations of price dynamics: *market prices as determined by objective facts* (price behavior, economic circumstances) versus *market prices as determined by psychological states* (habits, expectations). This underlying tension can also be perceived in many other examples of interpretive narratives, when they are subjected to the same kind of analysis.

5.2 Oppositions Revisited

Returning to the list of opposing pairs of interpretations presented in Section 2, it becomes clear that each pair can be read as instantiating this "fundamental tension," provided it is expressed in a more general way: as the tension between rationality and sentiment, objectivity and subjectivity, or equilibrium and arbitrariness. Tentatively:

- Investment strategies based on economic fundamentals rely on some clearly defined assumptions about the relationship between predetermined economic variables; strategies which focus on political or social factors allow for much more indeterminism.

- Range traders base their trading decisions on some notion of equilibrium value; for momentum traders, trading decisions are based on the idea that trends exist, that they begin and end for whatever reason.
- Value investing focuses on objective accounting measures of value, observable in the present, while growth investing relies on assessments of future prospects, which are frequently more subjective.
- Believers in an independent notion of "fair value" assert that there are objective criteria for valuation independent of the assessments of other investors; investors who believe that the actual market price is the best estimate of value assert that the (constantly shifting) judgments of investors taken as a whole, combining all their differing analyses (including those of investors who are inconsistent, ill-informed or irrational), is decisive.
- Random walk theorists assume that prices behave as if they were determined by an ideal investor who can process all relevant information perfectly and instantaneously; chart readers assume that price formation is a function of investors' subjectively determined habits, so that the current price does not incorporate all relevant information, permitting price histories to have predictive power.
- Traders who focus on fundamentals regard other traders' attitudes as irrelevant; traders who focus on flows emphasize other participants' state of mind.
- Theories of rational expectations eliminate expectations as an independent input into price formation by identifying them with the self-fulfilling predictions of an internally consistent macroeconomic theory; traditional Keynesian theories reflect an assumption that expectations are autonomous – or at least exogenously determined – and introduce a source of arbitrariness into valuations.
- The process of formulating a response to a currency crisis may ignore, or may focus entirely on, foreign investors' subjective assessment of that response.
- Economic theories which assume constant returns to scale make predictions about optimal investment decisions; in theories which allow for increasing returns to scale, the decision to invest plays a more complex and autonomous role in determining outcomes, and in part springs from Keynes' notion of investors' "animal spirits."

But on close examination, the nature of this fundamental tension seems to elude an absolutely precise definition that makes sense when applied to each example: it is slippery. Another restatement of the "fundamental tension" might be: *the tension between denying and embracing the essential indeterminacy of the market* – an indeterminacy which became inevitable with the introduction of money in its modern form.

Derrida (1998) draws attention to Aristotle's distinction between "economics" and "chrematistics". The former relates to the acquisition and exchange of goods in relation to well-determined needs; the latter, to the art of acquiring goods or riches for their own sake, according to the laws of the market: what in modern times came to be known as "money fetishism." Derrida observes that the introduction of money as a symbolic abstraction of value, subject to substitution, repetition and neutralization, eliminates this boundary between economics and chrematistics, with incalculable consequences. Value, no longer determined by concrete needs, becomes arbitrary. The existence of money permits the creation of financial markets which generate arbitrary fluctuations in value. Yet at the same time markets, as they become increasingly important, govern people's lives: these arbitrary fluctuations have real consequences.

Theory formation may be said to have a *therapeutic function* similar to that of myth in native cultures, as a means of coping with indeterminacy and the resulting anxiety. Interestingly, theory formation also has an *ideological function*, as when financial markets are proposed, by certain academics and policy-makers, as a model for society itself. In other words, theory formation becomes a form of social regulation.

Another interesting example is provided by the evolving treatment of expectations in macroeconomic theory. It is particularly noteworthy because here, paradoxically, play emerges as a direct result of an attempt to eliminate indeterminacy. Up to the 1960s, the textbook treatment of macroeconomics was "neo-classical synthesis Keynesian". For example, economic forecasts and policy prescriptions were based on the so-called Phillips curve, which asserted a relationship between unemployment and inflation that could be empirically estimated. But it was pointed out that, used as a policy tool, this kind of model was subject to the Lucas critique: the theory assumes that expectations are a matter of convention, and if a change in policy modifies expectations, the parameters of the model (in this case, the position of the Phillips curve) may change – in an indeterminate fashion, since the model does not explicitly account for the ways in which expectations are formed and modified.

The response was the theory of rational expectations, as described earlier: a theory which is founded on the notion of self-consistency. But the interesting thing about the rational expectations approach is that, in attempting to constrain indeterminacy by specifying the form which expectations may legitimately take, in releasing expectation formation from historical determination, it actually makes interpretation completely subject to the play of theory. *Any* logical framework in which expectations can be formulated to be consistent with outcomes, thus qualifies as an admissible theory. The proliferation of theories is limited only by the ingenuity of their originators.

The term "supplement" also has its place in an account of the hermeneutics of markets: for example, in recasting of the role of "utility" in the theory of consumer choice, or of "volatility" in the theory of option pricing, or indeed of "market sentiment" in any discussion of technical factors in the market. All of these terms function perfectly well in their respective theories without requiring concrete significations, and which indeed evade all attempts to assign them concrete, rigorous significations.

So the discourse of financial markets seems positively to invite a post-structuralist analysis. In this paper, it has only been possible to begin to point the way.

5.5 Practical Implications

Why would a practitioner be interested in all this? The first advantage of the critical analysis presented here is that it emphasizes the richness of discourse in financial markets, a richness which is not evident in mainstream academic work on finance. Furthermore, it emphasizes – as George Soros' writings do – that discourse is not just *about* the markets, that the circulation of interpretations cannot be separated from the markets, but that these things themselves determine the course of the markets (see, for example, MacKenzie, 2000.) As a corollary, the analysis also shifts attention away from attempts to decide which theories are correct or incorrect, and towards the project of understanding how differing interpretations interact with outcomes.

A number of comments are in order. Classical science can indeed tackle the problem of an entity that interacts and modifies the environment. For example, a ship in the open sea is not subject to feedbacks generated by its own movement. However, a ship traveling in a canal generates waves that are reflected by the walls of the canal and affect the ship movement. Thus, the ship influences the environment which, in turn, influences the ship movement , thus creating a sort of infinite regress. These problems, however, can

be solved within the framework of classical science. The financial equivalent is the analysis of the impact of trades. The analysis assumes that the trader affects the market. The market changes, in turn, affect the trader decision. As long as the market-trader interaction can be mathematically represented, the problem can be solved with classical methods and optimizers can be used.

Modern quantum mechanics has introduced a more complex relationship between the observer and the observed insofar as an observation resolves the superposition of states. However, it is questionable if there is any financial or economic analogue of quantum observation. (Some attempts have been made to draw a connection – see Piotrowski, Sładkowski and Syska (2002) – but these are far from mainstream.)

The self referentiality of markets *a la* George Soros finds its physical analogue in the modern theory of complex evolving systems. The modern theory of complex systems deals with systems able to create a (partial) representation of their environment. The dynamics of these systems can be analyzed provided that one knows how representations are formed. For example, artificial markets such the Santa Fe artificial market, are often built using software agents with learning capabilities.[3] These agents learn by forming an internal representation of their environment. Self-referentiality is a natural property of these systems.

When applying these concepts to economics, the crucial difference is that in the case of humans, we do not really know how representations are formed. The problem of a scientific study of economics is not self referentiality per se, a problem that science knows how to solve, but how self referentiality is formed. For example, behavioral finance attempts to describe the many biases in the process of formation of agent market representation.

For example, a classical approach to equity valuation is the dividend discount model, which states that the fair price of a share is the present value of all the future dividends that the firm is expected to pay, discounted at an appropriate market interest rate. In a corporate environment where earnings forecasts have become increasingly subjective, and where earnings are as likely to be applied to acquisitions or stock buy-backs as dividends, the dividend discount model has undergone many transformations.

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[3] Other artificial markets, however, use the so-called "zero-intelligence agents," that is, agents that decide on the basis of almost random behavior. The objective of zero intelligence agents is to show that basic properties of real markets such as the fat-tailed behavior of asset returns are the consequence of elementary properties of the trading mechanism.

Acknowledging that it is one interpretive framework among many, rather than a universally and exclusively applicable theory of security value, is a promising starting point in determining what role the model has to play in forecasting share prices, in combination with other theories.

A more concrete domain of application is the management of risk. In recent years, risk management and formal risk modeling have gained increasing prominence, and an enormous amount of research has gone into developing mathematical model of risk. A formal metatheory of risk measure has also been developed. In a seminal paper, Artzner, Delbaen, Eber, and Heath (1999) formalized the conditions that any reasonable risk measures must satisfy. One condition not satisfied by the popular risk measure value-at-risk (VaR), a worst case dollar loss for a given probabilistic confidence level, is sub-additivity. Sub-addivity requires that the aggregated risk of two or more entities cannot exceed the sum of the measures of risk of each entity. A coherent risk measure must be sub-additive and satisfy additional conditions.

But the limitations of formal market risk modeling were vividly exposed in the bond market crisis of August-September 1998, when major investment banks and hedge funds experience losses far in excess of those which their models predicted were possible. More interestingly, *reliance on the models was itself a source of risk*, since risks were created when market participants permitted themselves to accumulate huge positions on the basis that, according to the models, they remained within the limits of prudence and because the response to dramatic market movements prescribed by the models served to exacerbate those movements (see MacKenzie, 2000.) A critical analysis which allows space for different models and explores the relationship between models and decision-making is of use in understanding how the notion of "risk" transcends any specific formalization of risk, and how risk itself is a function of market participants' theories about risk.

A particularly problematic issue is the relevant definition of risk. On the surface, the literature of risk management is structured around a number of clearly defined, standard probabilistic notions of risk: e.g. for banks, VaR; for pension funds, tracking error (standard deviation of returns relative to a suitable benchmark); of course, numerous variations and technical refinements of these concepts exist. Among the refinements are the coherence conditions mentioned above as well as the consideration of

the shape of the distribution. In fact, measures of risk that apply to approximately normal distributions typically underestimate the risk inherent in fat-tailed distributions.

But behind the mathematical rigor lies an essential arbitrariness, in the precise choice of "confidence level," which is undetermined, or rather determined by reference to an imprecise, subjective notion of "risk tolerance," which emerges from a process of discussion among stakeholders. Similarly the methodological assumption that different forms of risk can be aggregated conflicts with the (psychological and institutional) tendency to compartmentalize risk – for example into market risk and credit risk, which seem peculiarly resistant to aggregation; one traces this to different ways of talking and acting in the face of different risks.

An investigation of the nature of this "discourse of risk tolerance," which is the hidden keystone of risk management policy, falls outside the domain of mathematical finance. Two areas of specific interest are the interplay between banks and bank regulators on definitions of risk, and the corresponding interplay between pension funds, their investment managers, and their asset consultants.

Critical analysis can also be used to identify specific sources of risk. Liquidity risk is an important case: the liquidity of a complex asset such as a mortgage-backed security, particularly an esoteric tranche of a collateralized mortgage obligation, is, in theory, a function of its intrinsic risk. In practice, it is also a function of (1) how well each individual investor understands the risk of the asset, and (2) how well investors believe other investors (i.e., other potential buyers, understand those risks). In other words, the models investors use to understand an asset, and the confidence they place in those models, and in the models of others, are essential determinants of liquidity.

Therefore, an analysis of liquidity risk must take into account the models in use, the circumstances which might lead to a loss of faith in the models, and the likely changes that might trigger in market dynamics and in the models that investors choose to use. In certain circumstances, the correctness of the models might actually become irrelevant: a one-off unexpected surge in mortgage refinancings may have no implications for the medium- to long-term validity of prepayment models in use, but if it affects investor confidence in the models, then it will have a radical impact on price dynamics – before the shock, investors may have been willing to pay what their models suggested a security was worth, whereas afterwards one might (for example) observe that (1) investors place an arbitrary absolute ceiling on the security price, independent on their

models' results, and (2) whenever the security price approaches the ceiling, liquidity declines. This was arguably what occurred in the case of mortgage-backed securities trading at a premium above par during periods in 1998.

An additional application of critical analysis is to identify and avoid dead ends in research. For example, theories of option valuation make the price of an option a function of (among other things) the expected volatility of the underlying asset: the more uncertainty there is about the future price of the asset, the greater the theoretical value of the option. But the theory can be turned around: since many options have actual prices, the formula can be inverted to derive an "implied volatility," i.e. a measure of how much uncertainty prevails "in the market" about the future price of the asset.

Now many different options may be traded, whose payoff is based on the same underlying asset. And applying the inverted formula, one typically obtains different estimates of "implied volatility" – indicating that observed option prices are inconsistent with option pricing theory in its simplest form. Many intricate refinements of option pricing models have been proposed, in an attempt to eliminate this inconsistency. But the inconsistency appears to exist only if one assumes that observed prices must be consistent with theory. A richer analysis incorporating other interpretations of price formation in option markets, and how they interact in option traders' decision-making, should help determine when and in what sense this research is really likely to yield useful results and when its results will be spurious. For example, this occurs in certain analyses of observed cap/floor/swaption prices, where inverse problems are numerically solved to generate wholly implausible "volatility surfaces".

Closely related is the task of identifying conceptual "holes" in models: elements which are not explicitly incorporated in models, but which can, at times, become significant enough to cause the models to break down. For example, a standard approach to corporate bond valuation might suggest that the fair price of a corporate bond is equal to the price of a Treasury bond promising the same cash flows, minus an "insurance premium" proportional to the risk that the bond will default and the investor will suffer credit losses. But this approach ignores such factors as the psychological aversion of investors to credit losses, which may be influenced by events, and the impact of changes in corporate bond valuations on the overall availability of corporate credit, which may affect default probabilities themselves. Such factors, and the probable lines of causation between them, can only be identified by looking at competing models, and one can only

judge when and how these various factors may come into play by trying to understand how these models function alongside each other as part of the activity of the markets.

To summarize, a post-structuralist analysis of markets, and interpretations of markets, will not provide clear-cut recipes for predicting price movements or quantifying risk; but it will promote informed open-mindedness towards conflicting theories, provide a clearer understanding of the applicability of specific theories, and suggest more nuanced ways of deploying them.

6. The Framework of the "Hard Sciences"

One might object that the above structuralist analysis applies to a “soft science” view of economics. Economics, it might be objected, is just in a phase of transition from a “dismal science” whose conclusions can hardly be proved to a “hard science” firmly rooted in empirical facts so that its conclusions and its theoretical foundations can be empirically proved as those of the physical sciences. However, this is unlikely to happen. Even at a more mature stage of development, the above analysis will still be applicable. To corroborate this view, we will present a brief analysis of the conceptual problems of the physical sciences. Perhaps surprisingly, many of the above considerations have counterparts in the physical sciences.

In modern physics, “matter” is something very elusive, certainly not solid and well localized. Mainstream physics today embraces the point of view of the Copenhagen School: physical laws are recipes to connect experiments without any interpretations. Atoms and sub-atomic particles are not small pieces of matter but theoretical terms that do not bear any of the familiar properties of matter and that serve only to compute the outcome of experiments. Phylosophically inclined scientists such as Bernard d'Espagnat (1987), discuss possible ways out of this gloomy and cold universal metaphysical skepticism. However, there is no consensus on how to interpret physical theories.

The philosophical analysis that started with logical positivism and with Russell and Whitehead has lead to a notion of philosophical relativism. The most accomplished expression of this view is probably Willard van Orman Quine. According to Quine (1960), theories are systems of symbols that are related with experience only at the periphery. Theories confront experience only *in toto*. No individual statement is really meaningful. Recall that one of the principles of structuralism is that only a system of myths makes sense. No individual myth is meaningful. Quine argues that individual

scientific statements are not meaningful and cannot be considered true or false. It is only an entire theory that can be somehow subject to empirical judgment.

Not only theories are globally responsible to explain empirical data, but it is even impossible to compare different theories. Quine argues that translation from one language to another cannot be fully accomplished. Here language and translation have to be intended in a broad sense: a physical theory is a language which cannot be fully translated in the language of another theory. Thus, a new theory does not fully respond to old questions but it gives new answers to new questions.

In his famous essay *Two Dogmas of Empiricism*, Quine argues that the distinction between analytical (that is, logical) and factual truth is illusory. The distinction between logical and factual truth is effectively one of the cornerstones of empiricism. Scientist rely on mathematics and logic as a safe framework for the uncertainties related to empirical experiences. Quine argues that this distinction is too crude because no analytical truth is ultimately completely analytic, as concepts are formed through experience.

The ideas of philosophical relativism are also implicit in the political and social analysis of science proposed by Thomas Kuhn. Kuhn argues that scientific development is not an abstract quest for truth but it is deeply affected by social and political motivations. In his *The Logic of Scientific Discovery*, Kuhn shows through many historical analyses how scientific discoveries were ultimately produced by political and social pressure.

In a number of books and articles, Feyerabend has taken these ideas much further. A physicist with a vast cultural background, Feyerabend argued that any system of beliefs is ultimately arbitrary and that there is no way to demonstrate the ultimate superiority of a scientific system.

Brock and Durlauf (1999) developed a formal model of theory choice in the spirit of the theory of decisions. They do not explicitly contradict the assertions of Kuhn and Quine that theories can be incommensurable; instead, they assume that scientists are able to assign a utility value to different theories, and thus to make decisions on theory acceptance, based on a number of different factors including social factors.

The image of science that is now mainstream is that of a system of beliefs or of statements with wide interpersonal validation in term of numerical correspondence to experiments and empirical data but with no consensus as regards its interpretation. Not

only is there no consensus on the interpretation of the microscopic laws of physics, but there is no consensus on questions related to the thermodynamics of large systems. For example, there is no definite consensus on why time seems to be irreversible.

If we move to the science of complex systems, there is even less consensus on the interpretation. Can we maintain a strict reductionistic view of physics, that is, do we believe that macroscopic laws can strictly be interpreted in terms of microscopic laws? Or do we need *bridging principles*, such as laws that make the application of probability meaningful? If we move to the science of cognition, the philosophical ground is even shakier.

6.1 An Example from Finance: Estimating Volatility

Given the above analysis, even if economics gets much closer to the hard sciences in terms of reliance on empirical data, its interpretation is likely to remain largely subjective. While econometric models might become more accurate and more reliable, their interpretation will hardly be unique. As a consequence, we will continue to have competing theories. Not only that, but new theories will be produced and there will be no way to accurately translate old theories in the language of the new ones. Let's now discuss the example of volatility models.

Volatility is a key term in financial theory. It measures the level of uncertainty about market movement. Directly or indirectly, financial decision making depends on volatility. It is, however, a theoretical term insofar as volatility is the magnitude of residuals of our models. Therefore, volatility is a hidden variable in our models. We cannot define volatility without a model.

Consider three typical financial models: an arithmetic random walk, a generalized autoregressive conditional heteroskedacity (GARCH) process, and a stochastic volatility model. The arithmetic random walk is a simple (approximate) model of the logarithms of equity prices where volatility is a constant that quantifies the magnitude of the error term. That is, we assume that returns have a constant mean plus a random fluctuation around the mean. If fluctuations have finite variance, volatility is the square root of variance. If returns are independent, we can estimate volatility through the empirical variance of the time series of returns. The accuracy of volatility estimate increases with the length of the empirical time series.

If the distribution of errors has fat tails, volatility might not exist insofar as the variance of the error term might be infinite. In this case, the empirical variance will not converge but will keep on growing with the length of the empirical time series. The uncertainty about future returns is infinite if we use volatility as a measure of risk.

Next consider a GARCH process. This process is similar to a random walk insofar as returns are uncorrelated variables. However, the magnitude of the error terms is not fixed but it is variable, determined by the size of past error terms and past values of the process. Volatility, in a GARCH process, cannot be directly estimated, as it is a stochastic process itself. Estimation implies estimating the parameters of a GARCH process.

Suppose that the error terms of a GARCH process are conditionally normally distributed. That is, conditional on past realizations of the process, the GARCH error terms are normally distributed with time-varying variance. However, the unconditional distribution of error terms is fat tailed.

Finally, consider a stochastic volatility model. A stochastic volatility model is again similar to a random walk, insofar as the process is formed by a sequence of independent error terms whose magnitude, however, is determined by a separate hidden stochastic process. With respect to a GARCH process, we have now an additional source of uncertainty. Suppose error terms are normally distributed conditionally to the realization of the volatility process. Then the unconditional error terms are fat tailed.

Is volatility the same concept in the three models? On the surface, yes. In the three cases, conditional volatility is the standard deviation of the error distribution conditional on information available at time t. In the random walk case, volatility is a constant, in the GARCH case volatility is variable but its size is known at time t, in the stochastic volatility case, volatility is uncertain at time t. The error distribution, however, depends on the model. Suppose we are given a realization of a time series. We fit a random walk, a GARCH process, and a stochastic volatility process. We obtain three different volatility processes.

The three volatilities are obtained through different estimation processes and carries different levels of model uncertainty. Comparison of the level of volatility for the three models depends on the global estimation of a model. We have here a simple instance of the fact that theories are global statements: a single statement about volatility does not make sense unless it is taken in the context of the model under which it is

estimated. The starting point are empirical data. From empirical data we construct three different theories: a random walk, a GARCH process, and a stochastic volatility process. These theories are different, each carry a different level of uncertainty and different concepts.

7. Conclusions

Even if the arguments that we have presented in this paper have often seemed brief and superficial, they have hopefully helped make the case for an eclectic hermeneutics of financial markets based on structuralist and post-structuralist methods. The spirit of such a project might be conveyed, impressionistically, in the following passage:

> States of things are neither unities nor totalities, but *multiplicities*… the noun *multiplicity* [a mathematical term more accurately rendered as 'manifold' in English]…designates a set of lines or dimensions which are irreducible to one another… Of course a multiplicity includes focuses of unification, centers of totalization, points of subjectivation, but as factors which can prevent its growth and stop its lines. These factors are in the multiplicity to which they belong, and not the reverse. In a multiplicity what counts are not the terms or the elements, but what there is 'between', the between, a set of relations which are not separable from each other… To extract the concepts which correspond to a multiplicity is to trace the lines of which it is made up… to see how they become entangled… These lines are true *becomings*… (Deleuze, 1986.)

Which may be an appropriate point to suspend our analysis.

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APPENDIX A: Causal explanations in monetary policy, after Mishkin

Higher level causal link

Money supply↓ ⇒ Production↓

Alternative lower level theories

Interest rate channel

Money supply↓ ⇒ Interest rates ⇒ Investment↓ ⇒ Production↓

Exchange rate channel

Money supply↓ ⇒ Interest rates ⇒ Exchange rate

⇒ Net exports↓ ⇒ Production↓

Equity share price channel (two variant theories)

Money supply↓ ⇒ Equity prices↓

⇒ Ratio of market value to replacement value for capital assets↓

⇒ Investment↓ ⇒ Production↓

Money supply↓ ⇒ Equity prices↓ ⇒ Wealth↓

⇒ Consumption↓ ⇒ Production↓

Credit channel (four variant theories)

Money supply↓ ⇒ Bank deposits↓ ⇒ Bank loans↓

⇒ Investment↓ ⇒ Production↓

Money supply↓ ⇒ Equity prices↓ ⇒ Corporate lending risk

⇒ Corporate lending↓ ⇒ Investment↓ ⇒ Production↓

Money supply↓ ⇒ Interest rates ⇒ Corporate lending risk

⇒ Corporate lending↓ ⇒ Investment↓ ⇒ Production↓

Money supply↓ ⇒ Interest rates and/or Equity prices↓ ⇒ Consumer lending risk

⇒ Consumer lending↓ ⇒ Consumption↓ ⇒ Production↓

APPENDIX B: Lévi-Strauss' structural analysis of the Œdipus myth

Overrating of blood relations	Underrating of blood relations	Denial of autochthonous origin of man	Persistence of autochthnonous origin of man
Kadmos seeks his sister Europa ravished by Zeus			
		Kadmos kills the dragon	
	The Spartoi kill each other		
			Labdacos (Laios' father) = *lame* (?)
	Œdipus kills his father Laios		Laios (Œdipus' father) = *left-sided* (?)
		Œdipus kills the Sphinx	
Œdipus marries his mother Jocasta			
	Eteocles kills his brother Polynices		Œdipus = *swollen-foot* (?)
Antigone buries her brother Polynices despite prohibition			

APPENDIX C: Structural analysis of Niederhoffer's narrative "The Old Trader and the Yen"

Chart patterns	Behavioral patterns	Primacy of fundamentals	Manipulation of expectations
…the patterns are bearish.			
			…they learn what is going to be announced and when they will be buying and selling
		If the surplus is lower, there will be no need for the US to bash the dollar down to save American jobs in the Rust Belt. The dollar will rise…	
			The BoJ [Bank of Japan] is said to leak news of this to cushion the blow of the announcement.
	The Malaysians like to stampede the market at 7 p.m. New York time.		
I see the dollar:mark drop sharply… 1.50, 1.49, 1.48… Mark:yen must follow. The yen is cheap.			
	When the brokers call on my behalf, the banks change their course and trade ahead of me before I can catch them.		
		I know that you want to go down, dollar:yen. The earthquake created tremendous demand for dollars to buy foreign goods… your economy is in recession because the West cannot afford to buy your goods…	
	The Japanese trend		

	followers will all jump in if the dollar goes above 95.00… The Japanese are very brilliant… But they run in herds.		
			The dollar will go down if rates are high. But the Japanese traditionally deny that they will decrease it three times before lowering.
	"Victor, do you have any stops?" my broker asks. If I tell him, them immediately the price will go to that level and I will be dead.		
		The Chairman of the Eminent Persons Council… calls for an *equilibrium* dollar of 80. [emphasis added]	
The dollar drops to 94, 93, 92. Yes! Dollar holders are desperate to get out.			
			Shortly after I covered, the BoE, the Bundesbank and the Federal Reserve (acting for the Treasury) all intervened to buy the dollar.