# Performing prices: The case of price discovery automation in the financial markets[1]

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## 1. Financial markets as "mechanisms" and the sociological approach

At least since the 80s, economic institutions and economic behavior have been a topic of acknowledged relevance in the academic field of sociology. Growing attention has been drawn to what we may call the "social aspects" of markets and economic organizations from several points of view, such as the sociology of organizations, network analysis, cultural anthropology, and economic sociology itself.[2] Most of those research programs aimed at confronting the monopolistic presence of economics in the study of economic life. Some of them clearly attempted to criticize the widespread neoclassical assumption of markets as mechanisms in

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[2] Granovetter/Swedberg 1992; Swedberg 1993; Smelser/Swedberg; 1994 Lie 1997.

which no historical or cultural phenomena are involved. In some cases, the critique of the intellectual categories of economics can lead to a radical opposition to the *homo œconomicus* paradigm.[3] The opposition between economics and the sociological approach can thus be summarized as follows: for economics markets are mechanisms, while for sociology markets are transactions. Mechanisms focused on their main phenomena (prices) for economics, and historically and culturally informed interactions for sociology. Concerning auctions, for instance, we can observe neat contrast between the schematized views of auction theory and the detailed descriptions of anthropology[4].

In the work presented here, we face a peculiar reality where actual mechanisms are designed to fit into real markets. It is the case of electronic trading systems in the financial markets. A double auction mechanism is replacing open-outcry negotiation in the markets we are studying. How can we deal with such institutions from a sociological point of view?

Economic sociology seems to have been quite reluctant to enter the specific subject of financial markets and has preferred to devote greater attention to, let us say, more "social" markets, or to economic issues in which neoclassical evidence have been more contested: such is the case for phenomena like labor, hierarchies, mass consumption, cultural goods or local markets. In financial markets, little attention has been paid to social aspects with the exception of some early articles (Adler and Adler 1984; Baker 1984; Smith 1981). But recently, the widespread assumption that a sociological approach was legitimate in any subject involving matters of power, social communication or human decision has opened financial markets to the scrutiny of the sociologist. The most relevant reference in this area is the work on Wall Street by Mitchel Abolafia[5]. What is called "the social construction" of a market, an institution or a fact in sociology seems to fit the analysis of traders' culture proposed by Abolafia. We should note, however, that in this new field, sociological

[3] Bourdieu 1997.

[4] Auction theory is a field within game theory, with extensive connections to experimental economics, computational economics and information economics. For an overview of the literature, see Klemperer 1999. For an example of a rich ethnographic analysis of auctions, see Smith 1989.

[5] Abolafia 1996a; 1996b.



analysis has the same difficulty talking about "prices" and showing the impact of culture in price formation phenomena than in other markets[6]. Another difficulty consists in tracing the role of economics and financial engineering in the construction of such a financial culture[7]. And contemporary financial markets appear to be precisely the best place to try to discuss the relevance of a sociological analysis. How can one deal with the hard content of those markets without doing economics? And how can one integrate economics itself into fieldwork as knowledge and techniques in which those markets happen to be embedded to a large extent?

It is hard to imagine a classical ethnographic methodology applied to the analysis of negotiation practices in an environment such as a fully automated stock exchange, in which orders are electronically matched by a double auction algorithm. Such is the case, for example, at the Paris Bourse and many other exchanges. The activity of traders and specialists surrounded by screens and technology on the NYSE (New York Stock Exchange) floor is a common image of financial markets in the media. But for markets like the NASDAQ, there is not even a trading floor. In Paris, the floor at the Palais Brongniart, used for derivatives open-outcry trading until 1998, is now absolutely empty: there is nothing and no one. The observer could look for "the social" a little far from the "heart" of price discovery, and take his or her ethnographic tools to the investment banks and the brokerage firms. Traders are still there and their cognitive skills, cultural practices and social organization can be analyzed. But the fabrication of prices no longer allows the classical ethnographic approach. To our knowledge, empirical sociological research has never entered the analysis of those "non-human" order matching or price discovery practices.

Meanwhile, automated trading is becoming a relevant subject for economics. The study of the differences between several kinds of market institutions has become a major topic in contemporary economics and academic finance, mainly through the specific and relatively young disci-

[6] In his article on crowd dynamics in an open outery-market, Wayne E. Baker shows the impact of the structure of interactions in price volatility, providing an example of an analysis that links both price and interaction phenomena (Baker 1984).

[7] Several authors (mainly economists) have already shown how economics has transformed the domain of contemporary financial markets: see Bouleau 1998 or Bernstein 1993 on the influence of economics in the derivatives markets.

pline of market microstructure theory and its empirical literature.[8] In that kind of analysis, market patterns are related to the formal characteristics of different market institutions. Key issues of such literature are, for instance, the opposition between dealer markets and auction markets, the controversies on different auction models, and the explanation of liquidity, volatility, information or efficient allocation phenomena in a concrete market model. And, of course, automation.

It is possible to trace a strong link between these kind of research activities and the academic field of game theory, and find similar preoccupations in auction theory, information economics, mechanism design, experimental economics and computational economics: for an example see Friedman and Rust.[9] Also, it is not hard to see the link between this literature and the recent development of electronic trading systems. The academic field is becoming more and more aware of the specificity and importance of an electronic environment.[10] The empirical development of the discipline is encouraged by the development of those systems, since they can produce a large quantity of detailed and precise price data. Monthly historical price data are available on CD-ROM from the Paris Bourse, for example. The computational framing of electronic markets supposes, in fact, the construction of an *in vivo* experimental setting into which the empirical ambitions of market microstructure fit the best. Can we consider electronic trading systems as the extension of "laboratory conditions" to the external world, observing movements like the ones Bruno Latour showed regarding the conditions in Pasteur's laboratory and the "domestication" of the anthrax virus in farms?[11] Why are electronic financial markets one of the best settings for exploring neoclassical evidence[12]? We will discuss here in what way those settings correspond

[8] O'Hara 1995; Biais/Foucault/Hillion 1997.

[9] Friedman/Rust 1993.

[10] See Lee 1998 for an extensive overview and Pirrong 1996, Bollerslev/Domowitz/Wang 1997 and Wang 1999 for some concrete examples.

[11] Latour 1983.

[12] Financial markets in general are probably the main feature in the study of efficiency or microeconomic equilibrium. Economists commonly agree on this, despite the inner empirical or theoretical difficulties found in those markets. The stock exchange is also commonly used to illustrate the concept of equilibrium to students. The specificity of an electronic environment is not a condition for the success of neoclassical frameworks, but it allows a better adjustment between the models and the empirical situation.



to an economically informed framing, that is, to the extension of the conditions of "the laboratory of economies" to the external world through computational and technological means.

How, then, are market models and simulation techniques enrolled in the actual design of trading alternatives? To our knowledge, too little has been said on this concrete relation between the scientific domain of market analysis and the construction of actual trading systems in financial markets. A relation that turns out to be, in our opinion, a real two-sided bind between economics and the economy, far from the widespread notion that economics is a science solely devoted to the observation of external economic phenomena. The perspective that economics and other forms of technical and theoretical knowledge play a "performative" role in the construction and sustaining of economic entities, be they calculative agencies, markets or economic institutions, is best expressed in Michel Callon's proposal.[13]

We somehow think that this perspective, that should lead us to follow the concrete reasons for a market design innovation in a concrete market, is not so far from what has been attempted in the field of market microstructure. Some scholars have used the expression "black box" in defining the objective of their discipline (O'Hara 1995: 1): the task is to open the "black boxes" of price formation, that is to stop treating the institution "market" as a neutral frame or considering price patterns as com-

[13] Callon 1998b. This proposal finds its direct origins in the concepts and methods of the sociology of science and technology. The term "performative" comes from the field of pragmatics – see the key reference in Austin 1962 –: a performative statement does not merely imply the description of an object that preexists, but typically constructs its reference in the designation process. The use of the term "performative" proposed here should be understood in a larger sense, since it deals not only with the statement and its context, but with all the mediations and delegations that link economics to its objects. In a similar way, other authors have noted the role played by economics and other associated forms of knowledge as government technologies in advanced liberal societies (Miller and Rose 1990), or agree with Callon's approach in the sense that an anthropology of the economy must pass through an anthropology of economics (Carrier/Miller 1998). See also Izquierdo 1999.

pletely exogenous phenomena, and to examine the concrete construction of market architecture and trading rules[14].

It is quite a coincidence that the "black box" metaphor has been applied in a completely different academic field: that is in science studies and in the sociology of science and technology.[15] One of the most striking methodological differences between the two uses of the metaphor is that in science studies, the operation of "opening the black box" should not stop at the description of the set of rules that govern this specific communication device known as the exchange, or at an account of their abstract properties and statistical consequences. In science studies this operation deals with the actual controversies that had to be "closed" in order to make such a device operational. It deals with making visible all the "embedded theories" involved in the design of the machine, the tool or the entity studied in order to comprehend its actual form.

How can we describe a market form that is a "real" mechanism without considering it as "a model" that speaks for itself ? Let us try to take account of its "script"[16] through a description of the technological and practical mediations that become involved in a specific exchange institution. From a methodological point of view, research of this kind turns out to be closer to a sociological study since it deals with the actual negotiations and the concrete boundaries that all the actors (from engineers to traders, from economists to firms) must face in the construction and maintenance of a specific trading system.

## 2. A case study at the Paris Bourse: building a "perfect market"

The Parisian stock exchange, Paris Bourse, was converted into a fully automated marketplace in 1989 with the installation of the CAC system ("*Cotation Assistée en Continu*")[17]. CAC was, in fact, the direct importation of Toronto Stock Exchange's technology, CATS ("Computer Assisted Trading System"), known to be the first fully automated order matching system in the world. This kind of system completely replaces open-outcry with an auction algorithm. Apart from slight differences between several systems, the auction algorithm is, in general, a set of matching priority rules concerning price, time of entry, volume and type of order.[18]

This sudden decision to modernize the Paris exchange was forced, in part, by the hard competition between trading poles in the European context: a relevant volume of several French securities was traded in London in the mid-80s. Several system reforms (improvement of the execution algorithm and of computational capacities, innovations in order routing and information dissemination) led to the definitive creation of a new system in the late 90s, the NSC ("*Nouveau Système de Cotation*"), now running in the French derivatives markets MATIF and MONEP as well. The Parisian system was also exported to other foreign stock exchanges (arrangements with Brussels and Toronto in 1995, Sao Paulo in 1996, and with Lisbon and Warsaw in 1997) and to derivatives markets (Chicago Mercantile Exchange in 1997 and Singapore Mercantile Exchange in 1999 as a result of the GLOBEX Alliance, the first global network for derivatives trading). We should note that there is global competition between electronic trading systems, a real "markets' market", and that the future unification of European trading poles is fueling a struggle between technological standards (Paris's NSC, Frankfurt's XETRA, London's SETS or Madrid's SIBE).

The Parisian system has been a field for many empirical investigations and comparisons in market microstructure[19]. Transparency in what economists call "price discovery" has been one of the major issues in the discussions on the system. We can read an example of the assumptions on market transparency in the proceedings of a conference held at the Paris Bourse, that was a fruitful meeting between exchange representa-

[14] A quite similar proposal can be found in recent developments in computational economics (Mirowski/Somefun 1998).

[15] Latour 1987.

[16] Akrich 1992.

[17] The reform began in 1986. We will not explore here the historical evolution of this reform, its social costs and the deep transformation it caused.

[18] Domowitz/Wang 1994. Ian Domowitz has explored the design and economic characteristics of electronic trading systems in several articles. See also Domowitz 1993a; 1993b.

[19] We will not cite all the references here (papers in the academic field, Paris Bourse's own surveys, published articles): an introduction to the literature can be found in Biais/Foucault/Hillion 1997, Biais/Davydoff/Jacquillat 1997b and Steil 1996.

tives and several relevant personalitics from the American academic field (such as Robert Schwartz, Lawrence Harris and Maureen O'Hara):

> "In such a context, markets' organization and quality raise difficult and important questions regarding transparency, liquidity, price discovery, order flow consolidation and transaction eosts:
>
> – a market is transparent if information on last transaction (price and volume) and on proposed bids ands asks is available for everyone in real time;
>
> – the notion of market liquidity is related to some charaeteristics that could be difficult to match: a stoek is liquid as much as it is possible to buy or sell it quickly (immediateness), dealing with low transaction costs and at a reasonable priee;
>
> – price discovery is the process through which market traders converge towards the equilibrium price of a stock. This priee should reflect in a proper way supply and demand, which reflect the anticipation of all traders. This price discovery process is difficult since equilibrium priee itself suffers from rapid variations;
>
> – order flow consolidation is understood both at a geographical (eentralized negotiation in a single marketplace or a single system) and temporal level (orders consolidation at one or several times during the day or in continuous trading);
>
> – Transaction eosts include technical costs regarding order routing, execution, settlement, and stocks delivery and conservation, but also costs coming from economical factors such as liquidity, agents' behavior, asymmetric information, or transaction organization."[20]

All of these ideal characteristics are presented as the realities an efficient organization system can bring to light. Market efficiency seems to be about designing market forms that make it possible to discover, without any interference, an equilibrium price corresponding to the "nature" of the market, the state of concentrated supply and demand at a time *t*. But all those characteristics happen to be the result of an artifact. Without the machine it would be hard, or even impossible, to have "prices available for everyone in real time" or to attain the matching rhythm required for

[20] Biais/Davydoff/Jacquillat 1997a, 3-4 (translated by F.M.).



liquidity, or to concentrate transactions geographically and at a single moment in time, or to "reflect in a proper way the state of supply and demand". It would also be difficult to try to achieve lower transaction costs.

Let us note that here, lowering transaction costs through electronic mediation seems to be the economic reverse of erasing the social efforts needed to create a transaction. To produce a price is "expensive", especially when the price must be an "equilibrium price". A number of displacements must be performed: displacements of persons, commodities or their representations must be institutionalized in order to create the effect of space and time convergenee into a marketplace and to produce the possibility of measurability. Within a context of social differentiation, where no common ground guarantees the terms of a discussion on the value of an object *per se*, a set of "machine-like" trading rules must be institutionalized: auction protocols are the historical example of such institutions[21].

What we would like to point out here is that most of the neoclassical images of economic theory seem to more precisely fit the institutions in which economically informed intervention had played a major role in designing. As some historians of economics put it, since the 40s and the birth of game theory, the abstract and problematic scheme of the Walrasian auctioneer tended to be replaced by the image of the machine, giving new support to the neoclassical dream of markets as distributed transparency devices and its model of economic order: the computer[22]. Con-

[21] See Smith 1989. In an outstanding sociological analysis of the creation of a Dutch auction for a local strawberries market, Marie-France Garcia shows all the human and technical effort that had to be made in order to make the market look like a "perfect market". She focuses, for example, on the design of the auction setting and on how the separation of a clearly defined supply and demand, that should meet only through the electronic auction device, was "performed" by the architecture of the auction site (Garcia 1986). The topic of "machine-like action" and the building of artificial expert systems has been explored by Harry Collins (Collins 1990).

[22] At an aggregate level, general equilibrium needs the presence of an imaginary character, the Walrasian auctioneer, who informs and coordinates economic actors and finds the equilibrium price. For an analysis of this peculiar *personnage* in economic theory, see Ingrao/Israel 1990. The mechanical and computational metaphors in these kinds of intellectual constructions, and the transformation of economics with the birth of the computer, have been explored by Philip Mirowski: see

structing "machine-like" institutions like electronic trading systems would then be the way to render markets "reasonable" in the eyes of economists, be they scholars or practitioners.

Let us try to find some evidence for this in the complex field of financial markets. A concrete analysis of a particular modification in the trading protocol could help to defend our approach.

For that specific purpose, we have chosen to take a close look at the recent implementation of a call auction for market closing at the Paris Bourse. The Paris market runs on a continuous double auction algorithm for most liquid stocks. The introduction of automated trading in 1986 in fact represented the introduction of continuous trading. A continuous algorithm works as follow:

*Figure 1. Representation of the order book for a stock in a continuous double auction.*

| BIDS | | ASKS | |
|---|---|---|---|
| **Qty** | **Price** | **Price** | **Qty** |
| 96 | 86.30 | 86.35 | 228 |
| 946 | 86.25 | 86.40 | 276 |
| 406 | 86.20 | 86.50 | 37 |
| 554 | 86.15 | 86.55 | 340 |
| 328 | 85.95 | 86.70 | 662 |

The continuous double auction algorithm is, in general, a system that queues submitted orders and executes them according to a set of matching priority rules concerning price, time of entry, volume and order type. In the example, the electronic order book is the memory in which limit orders (orders submitted with a price) are stored, waiting for a matching opportunity. Orders at market price (orders directly matching the present price) are executed directly. In our example, the bid-ask spread (the distance between the best buying offer and the best selling offer) is 86.30 – 86.35. If a trader enters an order to sell 96 at market price, or "at best" or

Mirowski 1989; 1994, and also Mirowski/Somefun 1998 and Mirowski (forthcoming).



a limit order at 86.30, the order is executed and the bid-ask spread automatically moves to 86.25 – 86.35. For a liquid stock, the order book will move very quickly in "real time".

Several details characterize the actual form of this matching protocol from one system to another. Each trading system can introduce different types of specific orders ("stop orders", "hidden quantity orders", etc.). Some thresholds can be defined to prevent large price movements during the trading period. There can be rules allowing a single security trade (quantity = 1) or determining batches or minimum quantities per order. Predetermined quotation steps can also be introduced. The continuous double auction algorithm can switch to a call auction algorithm under some circumstances.

The emergence of such "details" can be followed through the controversies and constraints that all actors (engineers, practitioners, traders, economists, decision-makers and authorities) have to face in their transformation of the market. Let us focus on the case of the closing call auction implementation. In Paris, less liquid stocks are governed through a call auction system called "fixing". A "fixing" is also used each morning for all stocks, after a preopening period, to produce an opening price.

*Figure 2. Representation of the order book for a stock in a call auction.*

| BIDS | | ASKS | |
|---|---|---|---|
| **Qty** | **Price** | **Price** | **Qty** |
| 1544 | (open) | (open) | 4090 |
| 2980 | 40.20 | 40.20 | 9831 |
| 10778 | 40.15 | 40.25 | 11790 |
| 8907 | 40.10 | 40.30 | 1370 |
| 8123 | 40.05 | 40.35 | 6300 |

During the preopening period, limit orders and market orders are submitted to the market but no transactions are executed. During this period, traders learn the theoretical price at which orders would be matched and modify their orders accordingly. Once this period is concluded, the system does not admit any more orders. To empty the market, the call auction runs according to an algorithm that follows certain principles. Again,

we will note interesting differences between call auction algorithms used in different markets. The algorithm can, for example, maximize treated quantities and minimize unexecuted orders at a given limit, but other principles can be introduced.[23]

According to some empirical investigations and some theoretical considerations, the preopening period in a stock exchange seems to get quite close to the theoretical Walrasian *tâtonnement* process.[24] In 1996, a set of liquid stocks started to enter into a call auetion at the end of each session to obtain the closing prices, too. In June 1998, the closing call auction (*"fixing de clôture"*) was implcmented for all the stocks negotiated in the continuous system, running a preopening period between 5:00 and 5:05 p.m., at the close of the exchange day.

Why a call auction at the close of the Paris Bourse? The concrete reasons for such a reform are heterogeneous. For the Paris Bourse, it is not a matter of real innovation, but a simple parameter change in the order matching protocol. The main explanation is the need to avoid a quite well-known phenomenon: the increase of price volatility in the last trading minutes. The closing price of a stock is very important data: it is a key reference for the media or for the investors that wish to compare the execution price of the orders submitted during the day with a standard reference. It is a key figure for evaluating the performance of portfolio

[23] Some of those principles are not public. The details of the Parisian NSC algorithm cannot be shown in this presentation. Several algorithmic logics are possible anyway. The algorithm should solve two distinct problems: price determination (which price will be taken?) and orders allocation (how should matching orders be distributed?). The priority principle known as "First in, first out" (FIFO) has been used in Paris since the NSC reform to allocate commodities. It is important to note that this principle introduces the relevance of time (time of entry of an order), as opposed to an alternate principle that could be based on proportionality in the allocation process.

[24] Biais/Hillion/Spatt 1995; 1997; Vives 1995; Medrano/Vives 1997. The Walrasian *tatônnement* is a key element for the explanation of Léon Walras' construction. The *tatônnement* process is the action through which actors discover the equilibrium price. We should note that Walras himself found an illustration for his ideas in the opening behavior at the Parisian stock exchange. In fact, before automation, trading was performed in Paris according to a "fixing" principle. Some could believe that the automated call auction "reproduces" the rules existing before the introduction of the continuous system. This is false to a large extent: rules are different and automation supposes a completely different environment.



management in the investment banks. Also, it is input information used in several asset pricing and statistical calculations, and it plays a major role for derivatives contracts.

For those and other reasons, traders can be willing to obtain a specific closing price for a specific stock. And they can produce several computational tools to "win this game". In Paris' continuous system, the closing price was, in fact, the price of the last trade, whatever the volume of this trade was[25]. Firms, as well as other actors and practitioners, can complain about the closing price of a stock, because it could suffer from considerable variations as a result of one single trade whose volume is not *"reasonable"*[26] enough to *"justify"* the price variation in the market. With the call auction, *"manipulation"* of closing prices is a *"free game"* no longer, since a *"reasonable"* volume is required to get a desired price, and execution of all submitted orders is effectively done. So it appears that, with this reform there is a transformation of traders' behavior and volatility actually decreases.[27]

For an economist from the academic field, the closing reform refers to the well-known controversy on the call market.[28] Perfect market condi-

[25] This is true now, after the recent reform that abolished the batch system. We are dealing with an environment where rules are modified very fast. So the reader should note that all the reforms and rules described here can change in the short term.

[26] Words or expressions in italics between quotation marks refer to fieldwork interviews with several actors.

[27] A statistical test should provide evidence for this phenomenon. Our study does not provide such kind of data. Our "qualitative" analysis of the call auction justification is based on interviews with market direction and market surveillance. We should point out that several economists show their interest in volatility and gaming phenomena at exchange close, including the Parisian case. See, as an example, Hong/Wang 1995, Cushing/Madhavan 1999, Hillion/Suominen 1998; 1999 and Thomas 1998.

[28] Cohen/Schwartz 1989; Economides/Schwartz 1995. The superiority of call auction over continuous double auction has been discussed in auction design and market microstructure. Professor Robert Schwartz is an authority on electronie trading systems in the academic field of market microstructure. He has edited and contributed to many volumes on this topic (Bloch/Schwartz 1979; Amihud/Ho/Schwartz 1985; Lucas/Schwartz 1989; Schwartz 1995). He is known as a leading voice in defense of the single price call market. For an example of an exchange completely based on a call auction algorithm, see the comments by Steven Wunsch, director of the Arizona Stock Exchange, at http://www.azx.com/.

tions seem to be improved by this kind of institution over the continuous double auction, as it reproduces at best the theoretical conditions of supply and demand "*meeting at a single point in time and space*" and perfectly informed of the market's state before the execution price is run by the automated auctioneer:

> "The ideal economic environment is one where all interested traders simultaneously submit their complete demand-to-bold curves for each asset, and where an auctioneer finds the single price that clears all crossing orders. Following the economist's standard way of analyzing trading and price determination, we assume that investors have downward-sloping demand eurves to hold shares of a risky asset. We also assume, however, that because of transaction costs and other trading frictions, invcstors do not transmit their entire demand curves to the marketplace, but instead submit direct orders. They do so with reference to their demand curves, the prices at which they expect to be able to trade, and their knowledge of how orders are handled and translated into trades in the marketplace.
>
> For the ideal solution to be attained in this contcxt, it is necessary for investors to monitor the market as it is being formed and update their orders appropriately. Doing so requires an appreciable amount of floor information, as well as the ability to specify, transmit, and update orders with great speed. In addition, investors must be able to avoid transacting at disequilibrium prices; doing so is not easy, however, when equilibrium values are not known at the time the orders are placed.
>
> An important aspect of the call arrangement we here propose is that it provides a fast, broad, and equitable distribution of floor information, sets prices that are realistically based on this information, and clears all crossing orders at a single price (which facilitates avoiding trades at disequilibrium prices)."[29]

But several solutions to the price manipulation problem at maket close are possible, and the call auction is only one of them. Bolsa de Madrid, the main Spanish stock exchange, implemented a completely different solution. The solution, actually also used in other stock exchanges, consists of obtaining the closing price by calculating the weighted mean of a

[29] Cohen/Schwartz 1989, 22-23.



set of last trades. The composition of the set can be altered based on surveillance decisions[30].

Most of actors involved present the Parisian solution as a more "*Walrasian*" and more "*transparent*" one. The idea was "*to have last price not caused by last trade, but caused by a sort of focalization of traders' wills at a given time*". The price produced at the "fixing" is sometimes defined as a "*true*" pricc, in opposition to the weighted mean, as it is actually "*given by the market*". Madrid's closing price is "*artificial*": it is "*calculated*" by market administration and no transaction takes place at this price, whereas the French system provides a representation of the state of the market, without calculating intervention.

We do not discuss a comparison here of both systems' empirical aehievements in giving a solution to the volatility problem. Our point is to explore how different visions of the market can inform the design of a specific exchange. The "Walrasian" solution is not the result of market self-expression, but the end of a negotiation process which enrolls several elements: the actors in market administration, some computational constraints, the firms whose stocks are negotiated, the traders at the banks and the brokerage firms, models of theoretical solutions, and statistical evidence of price volatility.

We can find "visions of the market" embedded in some of these elements. "Visions of the market" in several senses. First of all, we find visibility devices and techniques that can "show" the market and make problems visible. It is important to note that the problem of volatility at market close becomes a "problem" after a certain amount of effort has been made to make it visible. Seeing this specific phenomena in market data requires a very detailed partition of time series at market close. A five or ten-minute partition, commonly used in microstructure tests, is not sufficient for making this failure appear. A markct surveillance relationship to data is less analytical but more detailed, even more qualitative, than tests usually conducted in market microstructure. Market administration and practitioners are aware of the phenomenon, but a statistical analysis of prices times series can show the "size" of the problem, it

[30] The parameters used to switch from one calculating protocol to another in Madrid are not publicly available, but they are not arbitrary at all. If price variation goes over a specific threshold in the last trading minutes, the system automatically changes its calculating criteria.

can allow comparisons with other sources and it can point out consequences regarding "normality", "efficiency" and "equilibrium".

Other "visions": how to consider the role of volatility, the role of closing prices, and the role of the exchange itself. The vocabulary of "price manipulation at close" is a delicate matter. When is a price variation justified or not? Should prices express "market forces"? Are "market forces" not supply and demand's ambition to modify prices? With the weighted mean, manipulation at close is practically impossible because the closing price is not really a "price", it does not correspond with a transaction. For the supporters of the call auction, "*manipulation*" can be legitimate[31] if the volume traded is *"fair enough"*. The important matter is to produce a price actually *"given by the market"*, under complete *"transparency conditions"*. In the call auction we recognize the economic utopias of the perfect market: a device that will freeze the market state and summarize it as a single equilibrium price.

## 3. Performing price discovery, informing algorithms

Following this presentation, we are now able to discuss the nature of the "performative" character of economics we wish to introduce. As we can note, "performation" does not refer to the direct influence of a scholar's ideas over market practitioners, as if both worlds were completely separate. A glance at the practitioners' *curricula* can show how deeply embedded they are in the educational system of finance and economics. The academic field of economics does not only produce "ideas", it produces persons too: informed actors in the financial markets. The economic knowledge applied in the Paris closing solution does not have to be imported from the "outside" world of academia.

But let us concentrate on the issue of "performation". What we mean by "performance" is the actual operation of "framing" that has to be carried out to render "reasonable", or let us say "rational", the behavior in a specific market architecture.[32] In our example, "framing" can be understood as the construction of sets of rules: regulations, but also operations embedded in the algorithm design. "Framing" is an expensive operation: it requires technological investments (data networks, computational capacities, innovation), commercial investments (promotion, services to traders and investors), and a whole organization devoted to control and development. "Framing" is also an "informed" operation: it needs a quantity of empirical price data tests that render visible a number of problems or market failures, and a set of design alternatives or models. In the "framing" operation, and in the "information" needed to feed and evaluate such an operation, there is an intervention from economics: economics as specific scientific knowledge that supplies economic behavior with a model and allows it to be tested against statistics.

Economics should be understood here in a broad sense: not only as a theoretical modeling science – in our case auction theory and market microstructure theory play an important role as "behavioral framing sciences" – but also as a practical technique, as is shown by the role played by econometric analysis in the investigation of market data and by other "visibility devices" linked to the electronic system.

Is this a way of analyzing the complex links between economics and the economy? We know how the rhetoric of economics operates, how it schematizes and renders reasonable the words it depicts[33]. But the epistemological discussion on the accuracy of economics should face the fact that the efficacy of economics goes beyond its mere "virtualism"[34]. Economics does not only shape the world in books, models and figures, it also does it for real, back to the facts. The key element to comprehending this is to consider economics not only as theoretical knowledge monopolized by its academic representatives, the economists, but as a set of heterogeneous discourses and techniques, including practical disciplines like management, accounting, marketing, financial engineering or econometrics.

We have tried to show here that an apparently neutral market algorithm can be embedded in an economically informed framing process through which market behavior can be related to the decisions and alter-

[31] We are dealing here with trading activity under normal conditions. "Manipulation" does not refer to illegal activities like insider trading, but to irregular activities and tricks to obtain a specific price.

[32] For the use of the concept of framing, see Callon 1998a.

[33] For an introduction to the problems of the rhetoric of economics, see Mirowski 1990.

[34] "Virtualism" is the leitmotiv of James Carrier and Daniel Miller's recent proposal (Carrier/Miller 1998).

natives involved in market design. In our example, we observed the quantity of rules and mediations that constitute the exchange. Volatility, rationality or transparency are, to a large extent, the attributes of those rules, those protocols, those frames. And those frames are not spontaneous, not universal: they have a contingent history that links them to the networks of people, resources, constraints and interests involved in market design. We have also shown that the academic economic categories can play a role as a resource in the justification of a certain kind of frame over another one, and in the defense of what an exchange should be.

What can be pointed out in our closing price case study is that specific knowledge on the "justification" of a price or of behavior informs the framing process[35]. The objectives of the call auction reform could be summarized as follows: it is the implementation of a set of rules, or a "frame", to achieve a more rational behavior in the price discovery process. What does "rational" mean here? We think that the answer must refer to each specific market design and to the architectural ideas that promoted it. In our case study, "rational" refers to a kind of neoclassical intuition of lowering strategic behavior: that is, minimizing the chances for price manipulation (a behavior judged to be more or less "illegitimate" at weak volumes), and compelling traders to concentrate on enforcing their own individual wills[36]. Is this a simple reflection of literary utopias?

> "It appears that the market for a single stock is most efficient if all orders for the stock come in at a single point, so that all potential buyers can be exposed to all sell orders, and all potential sellers can be exposed to all buy orders."[37]

> "We can make all these things more precise by drawing on the economist's notion of a 'perfect market'. A perfect market for a stock is one in which there are no profits to be made by people who have no special information about the company, and in which it is difficult even for people who do have special information to make profits, because the price adjusts so rapidly as the information becomes available. One characteristic of this type of perfect market is that prices follow a 'random walk'."[38]

[35] We do not analyze here how these justification practices fit into a specific ideal regime (Boltanski/Thévenot 1991).

[36] "To force traders to be rational" can be the objective of market architecture. Another example of a trading device whose aim is to render behavior "reasonable" in a certain way is the Vickrey auction (Vickrey 1961): a device that tends to get rid of strategic or anticipating behavior. A detailed comparison with the call auction we are analyzing here could show how these two different frames construct different ways of being rational.

[37] Black 1971, 29.



Of course "market architects" are engaged in continuous negotiations with the "market" itself. They are aware of the trader's tendency to find strategies and to bypass the "transparency device" (traders can develop new trading strategies or computational techniques to obtain a closing priee). They have to deal with those tendencies in a delicate compromise between "market quality" and "service to clients". The market is not only the result of the framing process, but both of the framing and the "overflowing" it generates. Paris' closing call auction, for instance, is a device that would tolerate volatility and would admit traders' new gaming strategies, but only at *"justified volumes"*. The objective is not to prohibit a game, but to make the game more *"economic"*.

The "market", this bizarre entity that expresses itself as an autonomous being even if it is the result of collective and local adjustments[39], can be seen as the aggregation of the heterogeneous processes of framing and overflowing. The complexity and heterogeneity of trading architectures show how "market behavior" cannot simply be reduced to a schematized version of what traders have got in their heads. It also has to deal with engineering, knowledge and architectural frameworks such as the ones described here. Prices are then "performed" within this frame: they are the result of translations, negotiations and efforts of all kinds that give them their specific "form". Our case study shows how volatility and liquidity, two of the main attributes of price formation in a market (two attributes usually seen as opposed to each other), are performed categories. They depend to a large extent on the negotiation setting: the call auction setting can concentrate order matching in a single point (increasing liquidity) and avoid the spread of the disorder of the continuous

[38] Black 1971, 32.

[39] There is a vocabulary of market "reactions" that reifies it as a transcendent, subjective being. Refer to Urs Bruegger's contribution to this volume for illustrations of this vocabulary.

setting (decreasing volatility). Trading architectures perform economic categories[40].

But when we try to understand those frames, those architectures, those algorithms from a sociological point of view, we find that these phenomena cannot be subsumed under the mere heading of "algorithm behavior". We have seen how an electronic trading system goes beyond "simplification". Would we say that turning an institution into an algorithm is a way of obtaining a more complex one? We have seen how the "set of rules" (the frame) that govern a real automated exchange is dense, expensive and complicated: auction protocols, types of orders, surveillance rules, traders identification, etc. It is also doubled with an extensive history of negotiations, proof, controversies, battles, contingencies, etc.

The construction and implementation of a small innovation at the Parisian NSC represents an extensive amount of activity: projects, tests, simulations, negotiation with the members, errors, corrections. A simple observation of a week-end simulation of the system's performance can show how the "black box" of market architecture could not be reduced to the schematized views of economics[41]. The neoclassical dreams of economic theory leaves its marks on market automation, but exchange reality is not a mere copy of the model. It is a new environment whose richness and complexity go beyond the mechanistic expectations of economical utopias. Performing prices on economic bases, rendering them more "economical", is not solely an "economic" operation. It is a social operation that can be traced sociologically. After sociological scrutiny, "real" market mechanisms can hardly be taken for "literal" mechanisms.

[40] In this case, we are dealing with a computational architecture. But the same analysis could be engaged with a "human-scale" architecture or with environments built prior to any intervention from engineering or economics. Our investigation project includes such comparisons. It also includes a more detailed analysis of the framing of these (volatility and liquidity) but also of other categories (the issue of "transparency" framing is the main one).

[41] We will not discuss the "accuracy" of economics. "Simplifying" is not an epistemological error in and of itself. It is indeed a powerful tool for economics, as it represents its objects as material for modification and design (and this fits with the "performative" ambition that one should recognize in economics). From the standpoint of our research project, we have focused here on the presentation of the auction algorithm as a "simple" feature. Further fieldwork, like the observation of simulations and tests or insight into user strategies, should take account of the "complexity" this new environment generates.



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# ÖKONOMIE UND GESELLSCHAFT

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## Facts and figures

Economic representations and practices

Guest-Editors

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## Contents

# Editorial note

It is hardly the rule to publish a yearbook devoted to economics that contains articles written entirely outside of the discipline. This is even more remarkable since the authors of this volume also do not adhere to what has become known as conventional economic sociology and economic anthropology. Therefore this publication transgresses all existing disciplinary boundaries and hence appears somewhat venturesome. The point of departure for this yearbook was an international conference on the topic of "Facts and Figures" held in Frankfurt (Oder) in December 1999, where anthropologists, sociologists, organization theorists and economists from France, Germany, Sweden, Switzerland, the United Kingdom and the United States met to discuss the relationship between economic practices and representations. A selection of the papers from this conference is presented here, supplemented by two additional papers.

We would first of all like to thank all of the authors for their contributions and the editors of the "Yearbook Economy and Society" for publishing them. In particular, we wish to thank Dagmar von Bargen and Peter Weise for their suggestions and for their patience while this volume was being brought into its final form. We also would like to thank the Frankfurt Institute for Transformation Studies at European University Viadrina for their financial support of the conference. Ulrike Niedner and Anke Tobien, both students at European University Viadrina, provided their committed support for the organization of the conference and the management of this volume. Finally, our thanks go to Rebecca van Dyck, who assisted us in eliminating all the errors non-native speakers can produce.

Frankfurt (Oder), June 2000

Herbert Kalthoff
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