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## Article

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# Technology and Boundary-marking in Financial Markets

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## Introduction

Contemporary financial markets are grafted onto complex technological structures, which affect transactions rules and roles, in ways in which go well beyond increased velocity or improved access to data. This has led several scholars to talk about the technological constitution of financial markets (e.g., Knorr Cetina 2005; Muniesa 2003; Zaloom 2006; Knorr Cetina and Bruegger 2002; MacKenzie and Millo 2003).

Intrinsic to this constitution is boundary-marking: i.e., the procedures (Gieryn 1999) through which markets are classified with respect to other social institutions. I will attempt here to explore this aspect by examining an empirical case: the role played by price-recording technologies in the constitution of a national securities market in the US. In the first step, I examine the concept of boundary and relate it to the agential features of technology. The second step deals with the boundaries of financial exchanges existing before the introduction of the first custom-tailored price-recording technologies. The third step shows how technology use triggered definitional shifts which reverberated in legal and political domains.

## Boundary-marking and Technology

Boundaries are procedures employed by actors in delineating domains of activity and in making legitimate identity claims. The system of professions, for instance, consists in a set of boundaries, which mark interrelated jurisdictions. They comprise categories of activity, knowledge, and skills, together with privileged and socially controlled access to these activities (Abbott 1988). Boundaries establish domains within which the status of a body of knowledge appears as legitimate; epistemic claims are subjected to particular, domain-specific verification procedures, acknowledged by the community as appropriate (e.g., Knorr Cetina 1999: 111).

In some cases, boundary-marking implies the mobilization of heterogeneous actors, with different interests, skills, and standpoints (Leigh Starr 1989). This occurs, among others, when definitional uncertainties arise. Sometimes, classifications and categories resulting from this process become legal categories (Jasanoff 1995).

Boundary-marking is not exclusively grounded in the production of legal or scientific texts, or in debates. In many instances, boundary-marking implies a mix of discursive and non-discursive procedures, of explicit argument and tacit skills, as well as the mobilization of technology (Bowker and Leigh Star 1999). This can become the basis for definitional arrangements and for the mobilization of groups involved in classifications and in boundary-marking.

Michel Callon and Fabian Muniesa (2005: 1229) have argued that markets are collective calculative devices, which operate under uncertainty and generate compromises about the nature of goods and their value. Accordingly, markets are technological arrangements, comprising formulae and artifacts which project paths of action. These arguments highlight the agential features of technology, its standardizing capabilities, and definitional power: technologies introduce distinctions and classifications which endow exchange items with specific properties.

In certain situations at least, uncertainties and/or ambiguities can arise with respect to an institution as a whole. Institutions like stock exchanges do not always have clear-cut social and legal statuses. They can be several things at once – e.g., private associations, yet openly accessible trading places. They can lack a precise legal definition, or have a legal status at odds with access and control issues. This can entail both legal and practical problems with respect to the character, status, and validity of contracts, to exchange procedures, and to the roles taken by market actors.

Definitional uncertainties can be expressed in unclear legal statuses, or in clashes and controversies surrounding financial transactions. The absence of a legal frame (or an ambiguous one) would lead to controversies about the status of transactions, access to financial data, and data owner-

ship, among others. Such clashes would entail the mobilization of non-financial groups and institutions in the definitional process, like courts of law and legal scholars. When technology becomes a resource in boundary marking, engineers and technology firms become engaged in the process of maintaining and consolidating institutional definitions and boundaries, along with regulators, legal scholars, and brokers. Definitional processes mobilize legal, technical, and professional authorities, which are brought together in a “trading zone” (Galison 1996).

What is then the link between technology and the definitional problems facing stock exchanges? I will turn now to examining this starting from a short discussion of the legal aspects of financial transactions, and of the way technology intervened in these problems.

The data I use in this analysis come from legal cases and commentaries, reports of the New York Stock Exchange (NYSE), reports of the Securities Exchange Commission (SEC), and technology firms, covering the period 1905-1963.

## The Status of Stock Exchanges

We expect transactions to be reinforced not only by mutual bonds of trust, but to have some legal backing as well: that is, to be acknowledged as commercial contracts and reinforced (if need may arise) by courts of law. Most times, it would not even cross our minds that financial transactions could not have the status of commercial contracts. What we do not realize is how recent this status is: in the UK, transactions on the stock exchange were acknowledged as commercial contracts by the Finance Act of 1909-1910 (Poley 1926: 154). In the US, financial transactions on the stock exchange were not regulated by federal law until the Securities Exchange Act of 1934. At state level, the State of New York acknowledged stock exchange transactions as commercial contracts only in the Personal Property Law of 1909, which defined a financial security as an instrument evidencing a right with respect to a property or a share (Article 7-B, Section 251, Def. 1-2). A previous law, adopted in 1812, declared void all contracts for the sale of securities which the seller did not own at the time of the contract (effectively banning short selling and options trading). This law was repealed in 1858 and not replaced by a new provision (Campbell 1922: 35).

Several aspects impeded on the recognition of transactions as contracts. First, it was not clear that financial securities were similar in nature with other goods. Second, transactions on the stock exchange were oral; usually, they were not followed by a written contract. During the 19th century, brokers did not always keep transaction ledgers; they only wrote orders on slips of papers, which could be easily destroyed, lost, or forged. A certificate of stock, endorsed in blank, was not a negotiable instrument at common law (Campbell 1922: 83). Until 1922 at least, transactions could be repudiated by brokers before clearing or comparison tickets were exchanged (Campbell 1922: 11), a process which could take several days. If repudiated, a financial transaction could not be reinforced in a court of law. The main (if not the only) enforcing mechanism was provided by the statutes and rules of stock exchanges, including codes of honor. Third, NYSE (and many other exchanges too) was organized as a private, self-governing association of voluntary members. Many legal scholars considered that such an association could not be regulated at the federal level. When the Securities Exchange Act (SEA) was passed in 1934, it was considered unconstitutional by some exactly on this premise (Meyer 1934: 28).

Although during the 19th century we encounter litigations concerning unfulfilled orders, or transactions which ran counter to the client's order, there was no firm legal basis or prevailing legal opinion for deciding them. This was due to continuing uncertainties concerning the status of securities, the nature of transactions, and the possibility of regulating a private, voluntary association. NYSE, however, took a prominent place in the public sphere. It was publicly accessible both by potential investors and by tourists; its transactions affected a large number of individuals and institutions; it was constantly observed by and reported in the media.

## Technological Innovations and Institutional Boundaries

From 1867 to the early 1960s, NYSE introduced a series of consequential technological innovations with respect to price-recording and price-displaying. The first was the stock ticker (1867), followed by cinema screens in 1923, teletypes in the 1940s, and several computerized price-recording systems in the early 1960s.

The ticker brought together three groups of actors: official brokers, engineers, and telegraph companies. While bro-

kers installed the technology in their offices, the tickers were owned by telegraph companies. Western Union had a monopoly on lines and machines, supplying them only to approved brokerage offices. Nevertheless, telegraph companies did not own price data. The public display of and access to data stood in contrast to the fact that they were privately owned and controlled by the NYSE.

In 1914, NYSE established a Committee on Quotations (imitated later by the New York Curb Exchange). The aim was to enforce the monopoly on price data and to “exert more efficiently all possible powers in their [the bucket shops’] extermination” (Meeker 1922: 339).

Price-recording technologies led to the reorganization, role differentiation, and specialization on the floor of the NYSE, a process which was copied by other exchanges. Specialized trading posts were installed around stock tickers, which displayed only certain classes of securities. Specialist traders concentrated price information. Central quotation boards were installed: they aggregated the specialized price information generated around each trading post. Additionally (and crucially) specialist traders had exclusive control of their order book, which contained information about transactions and investors no one else could have. Specialist traders also acquired a trading monopoly on limit orders (Neill 1950: 315): they were the only ones who had a near real-time grasp on the flow of data enabling the execution of such an order.

In 1934, the Teleregister<sup>2</sup> Service was introduced in New York brokerage houses; it tabulated and displayed price data, replacing conventional quotations boards (The New York Curb Exchange 1946: 29). The data were recorded on paper sheets; retrieving them was still a manual operation, performed by armies of operators, who worked in the quotations department, in groups differentiated according to classes of securities. Each group was assigned a telephone number. The broker wanting the price history of a certain security dialed the respective number and got the data from the operator (New York Curb 1931: 31).

There was at least a double monopoly on price information: internally, specialist traders monopolized information of certain classes of securities. Externally, NYSE had a monopoly on authoritative price data and on overall access to price-recording technologies. Brokers who were not members of the NYSE and who operated from unofficial, smaller, or less reputable brokerage houses had to restrict themselves to unlisted securities. In 1911, Arthur B. Elliott

founded the National Quotation Bureau (NQB), which compiled price and volume data from various brokerage offices operating in unlisted securities. The NQB centralized this data and produced price and volume lists (the Pink Sheets), sold to brokers operating over the counter (Babson 1935: 138). The Pink Sheets could be accessed in brokerage offices or could be subscribed to, but were not publicly displayed. They were privately used and owned, although centralizing a considerable amount of data. In 1938, the Maloney Amendment to the Securities Exchange Act of 1934 created the National Association of Securities Dealers as the self-regulatory organization of over the counter brokers.

An effect of electromechanical price recording and of data centralization on the NYSE was that it was now possible to produce and compile statistics about price variations and volume of trading. Regular<sup>3</sup> transactions in listed securities on the NYSE were now recorded. This opened up the possibility of self-monitoring, but also that of being monitored by third parties.

To sum up: we encounter here several boundaries that were reinforced by price-recording technologies. First, there was an institutional boundary between official and unofficial brokers, official and unofficial exchange systems, which did not exist in this form before. Second, there was a boundary concerning the character of price data: while publicly displayed, they remained privately owned and reinforced the private character of transactions. The technology reinforced stock exchanges as institutions which display to the public; yet, these institutions remained private associations and therefore beyond public regulation. Public access to price data was meant to provide the means for and encourage participation in stock exchange transactions; public participation, however, could not be accompanied by public intervention in how transactions were conducted.

## Technology and Definitional Shifts

In 1905, the case of the Board of Trade of the City of Chicago v. Christie Grain and Stock Co. was brought to the US Supreme Court (198 U.S. 236). Christie Grain and Stock Co. was a bucket shop trading in options on agricultural commodities, among others. It should have had no access to the ticker prices of the Board of Trade; yet, it managed to get and publish them (most probably by tapping into telegraph wires). The Board introduced a lawsuit, which

went up to the US Supreme Court, where the final legal opinion was delivered by Justice Oliver Wendell Holmes, Jr.

Christie & Co. made its case on two grounds: first, while it was specialized in options trading, this sort of trading was widely practiced by the official members of the Board of Trade themselves. Therefore, while Christie's activities may have been illegal, some activities of the Board of Trade were too (the Statutes of Illinois' Criminal Law declared options contracts as void)<sup>4</sup>. Second, ticker prices had a public use, because they influenced the decisions of businessmen. Therefore, Christie's access to price data was legitimate. The defense's argument was that: "if, under other circumstances, there could be property in the quotations, which hardly is admitted, the subject matter is so infected with the plaintiff's own illegal conduct that it is caput lupinum, and may be carried off by any one at will."

In his opinion, Justice Holmes stated that members of the Board of Trade dealt in options only as a means of "self-protection in business." "The contracts made in the pits are contracts between the members" and fall within the Charter of the Board of Trade. They differ from contracts made with the public. "In a modern market, contracts are not confined to sales for immediate delivery. People will endeavour to forecast the future, and to make agreements according to their prophecy. Speculation of this kind by competent men is the self-adjustment of society to the probable. [...] This court has upheld sales of stock for future delivery and the substitution of parties, provided for by the rules of the Chicago Stock Exchange." (198 U.S. 236). Consequently, trades by (official) members of the exchange have a special character: they require special competencies and serve the greater society.

Justice Holmes's other argument concerned the character of price data generated by the ticker. This had nothing to do with the alleged illegality of some operations conducted by members of the Board:

*It seems to us an extraordinary and unlikely proposition that the dealings which give its character to the great market for future sales in this country are to be regarded as mere wagers or as "pretended" buying or selling, without any intention of receiving and paying for the property bought, or of delivering the property sold, within the meaning of the Illinois act. Such a view seems to us hardly consistent with the admitted fact that the quotations of prices from the market are of outmost importance to the business world, and not least to the farmers; so important, indeed, that it is argued here and has been held*

*in Illinois that the quotations are clothed with a public use (198 U.S. 236).*

At the same time, "the plaintiff's collection of quotations is entitled to the protection of the law. It stands like a trade secret. The plaintiff has the right to keep the work which it has done, or paid for doing, to itself. The fact that others might do similar work, if they might, does not authorize them to steal the plaintiff's. [...] But so far as these contracts [between the Board of Trade and telegraph companies] limit the communication of what the plaintiff might have refrained from communicating to anyone, there is no monopoly or attempt at monopoly, and no contract in restraint of trade, either under the statute or at common law."

While price quotations remain private property, they are "clothed with public use." Stock exchanges do not exercise any monopoly on price data. These are private property and confidential communication; the exchange might choose to make them available only to a restricted group. This opinion introduces a boundary between data ownership and data use, grounded in the technology-based character of price data. Justice Holmes explicitly refers to "quotations of the prices continuously offered and accepted, [...] collected at the plaintiff's expense, and handed to the telegraph companies which have their instruments close at hand, and by the latter [are] sent to a great number of offices." These data affect the business world and have public use, which does not preclude charging a price or selecting users.

The legal acknowledgment of ticker-generated price data as having public use played a significant role in subsequent attempts to regulate financial exchanges. In 1909, when the Hughes Committee (set up by the US Congress) investigated allegations of monopoly, fraud, and manipulation on the NYSE, it refused to recommend incorporation (which would have opened the way for federal regulation, and which was bitterly opposed by the Regular Board). The Hughes Committee, however, acknowledged the New York Stock Exchange as a "national market" on the basis of tracking transactions: it established that 48% of all transactions conducted on the NYSE did not originate in New York City. The role of the "fully developed wire house" in the transformation from a local institution to a "national market" was also acknowledged (Meeker 1922: 329). This sort of statistics – taken as evidence for a definitional shift – would not have been possible without a price-recording and transmission technology.

In 1934, when the SEA was passed, these distinctions played a significant role. Federal regulation of stock exchanges as private associations would not have been constitutional, and they strongly resisted incorporation. The way to regulate stock exchanges at the federal level was through interstate commerce and mail.<sup>5</sup> But stock exchanges had to be redefined as conducting interstate commerce and as subject to mail regulations. This redefinition had two components. On the one hand, they were redefined as national securities exchanges and required to register as such. Only registered exchanges were allowed to conduct business through mail and across state borders. Registration as a national securities exchange also meant that transactions had to be recorded (Meyer 1934: 15) and (if necessary) reported to the newly created SEC.

This also meant redefining stock exchanges as “affected with a national public interest” (Meyer 1934: 28). This public interest could come only from the character of price data. Prices “are generally disseminated and quoted throughout the United States and foreign countries and constitute a basis for determining and establishing the prices at which securities are bought and sold, the amount of certain taxes owing to the United States and to the several states by owners, buyers, and sellers of securities, and the value of collateral for bank loans” (Meyer 1934: 28). This passage from the Section 2 of the SEA 1934 spells out how price quotations are of public use and affect public interest. Widely disseminated price data meant that both they and the institutions generating them were subject to federal regulation; indeed, the SEA specified that only registered stock exchanges (or members thereof) could transmit price quotations outside state borders (Meyer 1934: 42). The SEC was empowered to make rules regarding the quotation of transactions and the method on recording them on the ticker tape (Meyer 1934: 99, 124). The SEC was also empowered to make rules concerning over the counter transactions, which did not use tickers and did not fall under the definition of “national markets.” The reason for the regulation of OTC brokerages was to prevent registered exchanges from siphoning off securities to this market.<sup>6</sup>

Interestingly enough, in his statement before the US Congress Committee about the SEA 1934, Richard Whitney, the President of the New York Stock Exchange acknowledged the definition of stock exchanges as public markets, but argued that information disclosure would transfer important market functions to a department of govern-

ment, and implied that these requirements would destroy “a free and open market” (Whitney 1934: 4).

## Technology and Boundary Evolution

Data collection, mandated by the SEA 1934, made possible the analysis of price movements as the consequence of individual or group actions, and to investigate the social structure of the New York Stock Exchange both from a quantitative and a qualitative point of view: that is, to describe not only the role differentiation on the exchange floor, but also the volume of trade controlled by or flowing through certain roles. For instance, it became possible to calculate the volume of specialist trading versus broker trading, the volume of trade in regular lots vs. odd lots. It also became possible to investigate the social structure of investors dealing on the New York Stock Exchange, their gender, age, and professional differences.

Up to the 1960s, the vast majority of NYSE investors were individual, not institutional actors. The analysis of price data and transactions could provide evidence about possible price manipulations undertaken by individuals, as well as about monopolies on the floor of the exchange. Very shortly after its organization, the SEC began surveys of the New York Stock Exchange, with the aim of devising “rules for the regulation of trading on exchanges” and of studying “the effect of such rules on market activities and operations” (SEC 1938: 21). In order to conduct these surveys, the SEC distributed detailed questionnaires to all classes of traders and began surveillance of price data: “The tape quotations of the New York Stock Exchange and the New York Curb Exchange were under continuous observation, and complete lists of daily transactions were required to be furnished by all exchanges” (SEC 1938: 22). The SEC also conducted interviews with customers and assembled data on their social background (SEC 1947). Concomitantly, the New York Stock Exchange began conducting its own surveys, partly in order to build up a counterweight to the SEC’s data.

These surveys were relatively difficult and laborious; the minute analysis of price movements had to be tied to transactions, in order to determine who bought or sold what, and when. A study of the possibilities for expanding computer recording of trading data had been already made in 1956, but was met with resistance by the firms handling odd lot trading (SEC 1963, Part 5, Ch. 6, Part E: 93). In 1960, the NYSE had established the Department of



Operational Planning and Development, charged with pursuing computerized trading. In a survey published in 1963, and occasioned by a market crash in May 1962, NYSE stated that it had set up plans for technological expansion in the early 1950s. The final aim was to develop a "complete data processing system" which "will mechanize virtually all present manual operations in the Exchange's stock ticker and quotations services" (NYSE 1963: 48-49). The plans were to have a system which will "automatically locate the latest trading data, assemble a message from a pre-recorded vocabulary of 126 words, and 'speak' it out over the phone to the caller – all in a few seconds" (NYSE 1963: 49). According to this description, the technology required by NYSE was so unique that it offered "potential designers and manufacturers little opportunity for adapting or modifying it for use in other industries" (NYSE 1963: 48).

NYSE worked closely with Teleregister Co., which had developed the teletype machines. In the early 1960s, a former manager had started the Bunker Ramo Co., a computer firm with links to the air defense industry. Bunker Ramo provided brokerage houses with computer terminals which in 1964 could retrieve 3 or more bits of data simultaneously. Additionally, NYSE had enrolled IBM to develop a computer system for storing and retrieving price data. The cooperation with IBM led to an internal report in 1968, but the IBM plans were never implemented. Instead, NYSE continued the cooperation with Bunker Ramo and with two other firms, Scantlin Electronics and Ultronic Co. (Anonymous 1983: 60).<sup>7</sup>

On its side, the Securities Exchange Commission, which also conducted market surveys, was interested in procedures of data compilation which should allow more comprehensive studies, done in a speedier fashion. In April 1963, the SEC sent to the Committee on Interstate and Foreign Commerce of the US Congress the Report of Special Study of Securities Markets, a document of over 7,000 pages. It contained a factual description of the operations on the NYSE's exchange floor and of OTC brokers, a statistical analysis of trading volumes and price movements, and a series of recommendations to the US Congress. Several sections were dedicated to the "possibilities of automation" in financial markets. The Special Study acknowledged that computer systems for the recording of price and transaction data were implemented in NYSE brokerages, and that OTC trading had also been "slightly touched" by automation. It stated that:

*If securities markets are to be truly public institutions, as they have been under the law for 30 years, the public interest in questions of automation must have a voice. The Commission should equip itself to keep abreast of electronic and computer developments in the securities industry. Otherwise, these may be neglected or suppressed for want of any consideration of the public interest (SEC 1963, Part 5, Ch. 6, Part E: 93).*

The SEC made to Congress the recommendations that the potential impact of automation is affected with public interest (SEC 1963, Part 5, Ch. 6, Part E: 108), and should be used by regulatory bodies as a surveillance technique, in the same way it was used by the NYSE (SEC 1963, Part 5, Ch. 6, Part E: 122; Ch. 12, Part B: 180). Automation was also recommended as a means of regulating OTC trading. Discussing the need to identify the "primary market makers," the Special Study recommended that:

*Beyond this data-supplying function, a system of continuous classification and identification would serve as a basis for whatever degree of further regularization and regulation of over-the-counter markets may seem warranted, now or in the future, in what should be a continuing effort to improve and strengthen such markets generally" (SEC 1963, Ch. 7, Section F: 670).*

The definition of a public market is tied to the comprehensive record of data and to the involvement of regulatory bodies in this process. The old boundary between floor trading and OTC trading, which largely depended on the use of price-recording technologies, is superseded by automation as a defining feature of markets as public institutions, and by the requirement to regulate them based on the data they produce. This marks the beginning of an accelerated market technologization, which will flourish in the late 1970s and early 1980s with the adoption of the first automated trading platforms and the large scale expansion of computer terminals in brokerage services.

## Conclusion

Technologies for recording, displaying, and memorizing price data opened up ways of monitoring and analyzing "market behavior" which otherwise would not have been possible.

The extensive adoption of computer technologies in the late 1970s has been seen by some observers as triggering

the deregulation of financial markets. However, the accelerated expansion of computer technologies was preceded and encouraged by regulatory involvement with data-recording, understood as the continuation of a longer process of definitional transformations.

The legal definition of price data as having public use opened the way for regulatory interventions, including the support for further technological developments in financial exchanges. Technology was not just an external occasion for legal scholars to formulate these definitions. Technology was and continues to be the frame in which these distinctions maintain their validity, as well as a tool for their reproduction. In this sense, among others, technology did constitute markets as we know them today.

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## Endnotes

1 Bucket shops were unofficial brokerage houses, some of which (but not all) dealt in options; there were considerable differences in wealth and reputation among them.

2 The company providing the Teleregister Service was acquired by Martin Marietta (an air defense contractor) in the early 1960s, but continued to provide financial data services to members of the New York Stock Exchange. In 1964, the then-chairman of Martin Marietta, together with a computer engineer, formed the Bunker Ramo Co., which provided computerized data systems to brokerage houses (Anonymous 1983: 60).

3 Regular transactions meant transactions in lots of 100 securities or multiples thereof. Significantly, odd lot transactions were not recorded. All NYSE brokerage firms, bar two, transacted in regular lots.

4 See, for instance, *Pearce v. Rice*, 142 U.S. 28.

5 Official brokers, for instance, were forbidden by the rules of the New York Stock Exchange to advertise business through mail, because this would have opened the door to federal regulation. Unofficial brokers, by contrast, who were not members of an exchange, could and did advertise by mail.

6 This happened by transferring from listed trading securities to the OTC trading. Only regular lot trading was recorded on ticker tapes, while odd lot transactions went unrecorded. A listed security could be withdrawn from regular lot trading, traded in odd lots and thus transferred to the unrecorded OTC trading. This allowed brokers to circumvent the monopoly and control of the Regular Board. Generally, it was considered that OTC brokers dealt only in unlisted securities, but the attention given by the SEA

1934 to this problem indicates otherwise. The Special Study done by the SEC in 1963 found that 10% of the overall trading volume on the New York Stock Exchange was in odd lots and controlled by only 2 brokerage houses (SEC 1963, Ch. 6, part E: 91).

7 Scantlin Electronics was a Western Electric subcontractor, which also built attenuators for the US Navy.

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