

LABORATORY STUDIES IN ASSET TRADING:
PART I--A PROGRAM OF RESEARCH

by

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DEFINITIONS AND OBJECTIVES

This report outlines a broad program of research into the structural aspects of asset trading. We begin its description with a few definitions. By the term "asset" we shall understand a claim to a stochastic (and thus ^{not} deterministic) stream of income over time. "Trading" is taken to be the process of asset exchange between individuals within the structure of a market, i.e., an organized collection of exchange mechanisms. We shall interpret the term "structure" quite broadly to mean the rules of bargaining, information access, and participation in such a market.

Broadly stated, the end goal of the proposed program of research is to discover the impact of various structural alternatives of asset markets upon the general social welfare. Since this is such an all-encompassing topic, however, our goals will necessarily be subject to refinement as the research proceeds. The present report will attempt only to indicate some of the main areas of emphasis and the general methodology contemplated.

In reaching toward the above-stated goal, a number of intermediate steps are necessary, and these steps must be organized into a well-integrated framework. For example, we must first determine the dependence of market behavior upon market structure before value judgements can be applied to that behavior. We must characterize more fully the term "market structure" itself, and so on. Figure 1 pictures an overall conceptualization for the study of market structure as it affects social welfare.

A MARKET STRUCTURE FRAMEWORK

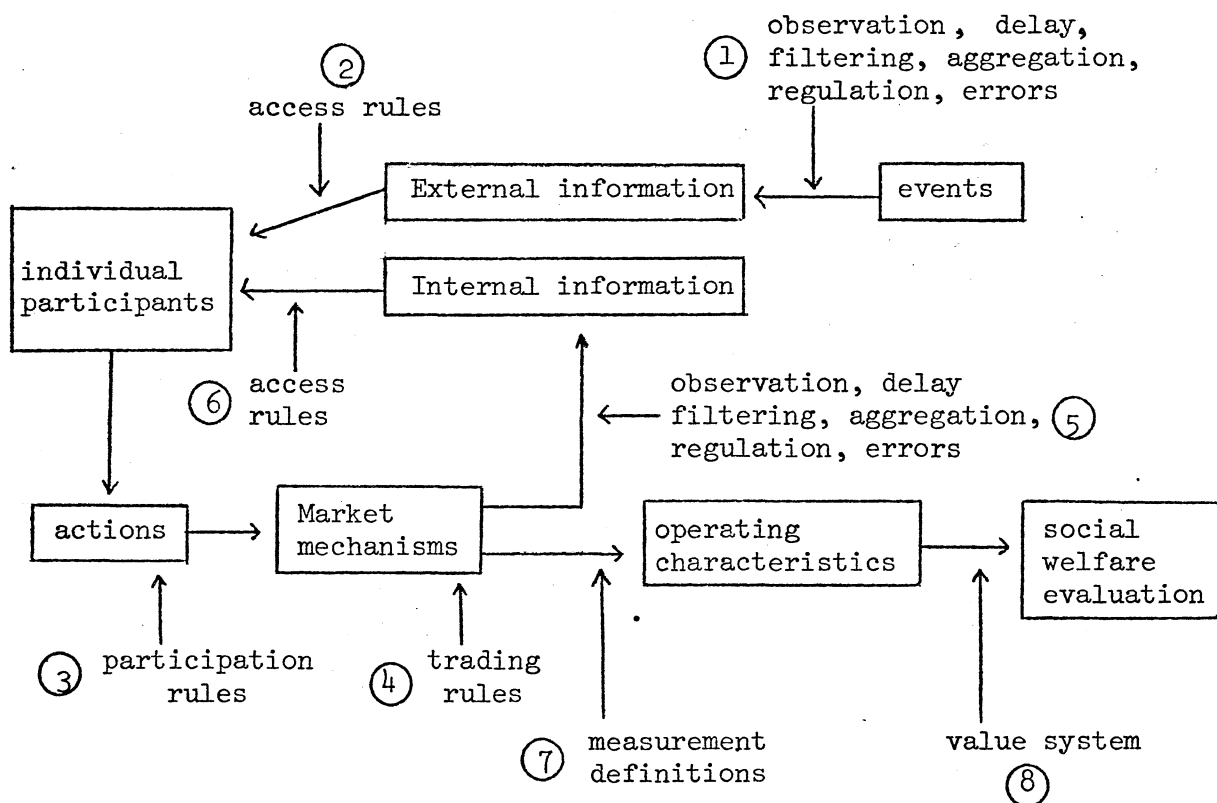


figure 1

The chain of market causality begins with the upper right-hand corner of figure 1, the "events." These are assumed to encompass all occurrences which are relevant to the particular assets traded in the market. Events themselves may not be directly observable by market participants, and often only inexact surrogates of these are available.

External information is the representation of events derived via the activities labeled ① in figure 1: observation, delay, filtering, aggregation, regulation, introduction of errors, and other processes which convert those underlying events into observable quantities.

Individual participants in the market may then be capable of accessing this

external information; limitations on access, which might vary between participants, is labeled in figure 1 as (2), "access rules."

As a result of computations, analysis, etc., individual participants may affect the state of the market via their actions, e.g., by bidding, canceling orders, and so forth. Exactly what actions are available to which subsets of participants are termed via label (3), "participation rules." Label (4), "trading rules," refers to the rules in which the individual actions of the participants are jointly combined to effect changes in the state of the market. (E.g., the relative priorities of participant demands)

The internal state of the market is usually thought of as important information to investors, or market participants. But again, this information is usually not available in a pure physical form, being subject to the activities of label (5), observation, delay, filtering, aggregation, regulation, and errors (e.g., the ticker tape). Also, access rules (labeled (6)) limit the ability of individual participants to avail themselves of this internal--i.e., market--information. (E.g., a stock market specialist has sole access to his book of orders.)

We shall refer to (1) and (2) as the external market structural determinants, and to (3), (4), (5), and (6) as the internal market structural determinants. These structural determinants, taken together along with the individual and group psychologies of the participants and the nature of external events, jointly determine the behavior of the market.

Now we shall wish to make normative judgements as to various forms of market behavior. In this case, it is necessary first to measure that behavior and then to determine a "reasonable" social welfare function which has those

measurements as independent variables. To perform these two steps, we must impose a set of operational measurement definitions (label ⑦) and then a value system (label ⑧) by which to compare specific measurements. Presuming that we can treat the individual and group psychology of participants and external events as given, the central normative question is how we can select the structural determinants of a market in such a fashion as to maximize the social welfare.

A REFINED FOCUS

Having given in figure 1 a framework for classifying our various considerations, we shall now attempt to bring these into focus vis-à-vis real-world asset markets. To avoid needless repetition, we shall key the discussions given below to labels of figure 1.

- ① A major form of description of company-specific events is via the financial accounting system employed by the company. Since the regulation of these financial accounting systems is largely imposed (the Financial Accounting Standards Board, etc.) it is of interest to determine which financial accounting systems are "best" in a social welfare theoretic sense.
- ② In the real world, not everyone has the same forms of access to external information. Various legislative attempts and forms of administrative law (e.g., SEC rules, etc.) deal with the regulation of "insider" information, disclosure of news items, and so forth. It's probably fair to say that the thrust of such attempts is to provide access that is symmetric amongst the market participants, i.e., to permit everyone equal opportunity of access to external information.
- ③ Participation rules are set forth in the by-laws of the various organized securities exchanges. Forms of participation are often differentiated as to members (specialists, brokers, floor traders, etc.), associated members, and the general public. No attempt is usually made to provide equal or symmetric access to trading mechanisms; indeed, numerous entry barriers and restrictive rules exist to preserve discrimination amongst various types of potential participants. A basic question here is whether such discrimination is socially optimal.

- ④ In the organized securities exchanges, a great many trading rules now govern such things as the priority of queued orders, the conditions under which short sales are permitted, the types of orders that are acceptable (e.g., "all-or-none" orders), order execution mechanisms, and so forth. These rules have grown in an evolutionary fashion, usually in response to perceived possibilities for various abuses. Normative aspects of such rules thus present themselves: that is what set of trading rules is the "best" set?
- ⑤ In real-world markets, the collection and transmission of data regarding the "market state" to market participants is normally quite limited in scope. Only a small percentage of the possible measures of market status possible are in fact generated. These include the familiar ticker tapes, quotation devices, and (with some delays) the short interest, insider asset inventories; volume aggregates, and so forth. But how does type, nature, and timing of the creation of such internal information affect market behavior (and thus social welfare)?
- ⑥ Moreover, who should have access to internal information? A typical restriction in most real-world securities exchanges is that no one but the specialist himself may see the specialist's "book," which contains information relevant to future price movements. Is this a socially optimal situation, or should some form of symmetric access to internal information exist between market participants?
- ⑦ Label ⑦ has a good deal of overlap with label ⑥ in pertaining to internal information. But some internal information is apparently created in certain capital markets with the express intention of measuring market "performance" rather than for its value to investors. The New York Stock

Exchange (NYSE) defines at least three such measures, among others:

- a) depth,
- b) price continuity,
- c) stability ratio.

"Depth" refers to the volume of shares traded at a specific price.

"Price continuity" is measured by the percentage of transactions that take place within $1/8$ and $1/4$ of a point away from the last transaction price. The "stability ratio" is the percentage of exchange member transactions in which the exchange member buys for his own account after a down-tick or sells from his own account after an up-tick.^{1/} These quantities are apparently believed by the NYSE to be reasonable measures by which to judge the behavior of the market. Actual judgement comes via label (8), the value system. For the NYSE measures, it is supposedly self-evident that high numeric values of the depth, continuity, and stability measures are preferable to low values, and the higher the better. But is this in fact self-evident? What social welfare functions are implicitly assumed?

^{1/}An up-tick is a transaction at a higher price than the last transaction price; a down-tick is the opposite.

GENERAL METHODOLOGY

In the above discussions, I have attempted to refine the focus of the proposed research. I now turn to the general issues of methodology. Four modes of investigation suggest themselves in this line of inquiry:

- 1) empirical studies,
- 2) laboratory studies,
- 3) theoretical studies,
- 4) simulation studies.

Empirical studies could examine data as it exists, deriving from real-world securities markets. The empirical approach is capable of high external validity, but unfortunately, much important data is unavailable due to lack of reporting mechanisms or secrecy requirements. On the other hand, the laboratory approach tends to sacrifice external validity in favor of data accessibility, control, and internal validity. Theoretical models of market behavior are also useful, not only to provide the underpinnings of field and laboratory studies, but also in their own right as analysis tools. Simulation models are similar to theoretical models in their purpose, but exchange analytic capability for increased power in describing complexity.

We shall employ each of these four approaches to a greater or lesser degree in the proposed program of research. More specifically, we shall center our investigations about the laboratory approach and use the other three methods for complementary validation. Trading Floor /1 (TF/1), which is a computer-based laboratory environment for asset trading, will form the nucleus of the research system. TF/1 was reported by the author in an earlier work.^{2/}

^{2/}"Trading Floor /1: A Prototype of an Automated Securities Exchange," IBER Working Paper No. 7, Graduate School of Business Administration, U.C. Berkeley, July 1972.

Since that report, the TF/1 programs have been expanded to allow trading in three risky assets, a feature which permits treatment of the important "portfolio" aspects of asset trading.^{3/} It will next be employed in conjunction with human subjects within an experimental design to be specified in a succeeding paper in this series.

Certain other computer-based tools will be drawn upon in the course of the proposed research, namely, an APL program which simulates the activities of a single specialist, and a statistical simulation (in FORTRAN) of market behavior.^{4/} Also, the possibility of a field trip to the NYSE for data gathering purposes has been contemplated, as have certain empirical studies of existing data.

Some new theoretical development is expected to be proposed in the course of the proposed research. In particular, at least three areas will be addressed immediately:

- 1) new measures of market operating characteristics,
- 2) statistical models of market-making,
- 3) social welfare aspects of financial accounting reports.

Other topics may be treated later as the research program evolves.

^{3/} Due to the efforts of Bob Gray.

^{4/} Due to the efforts of Bob Scott and Mike Megas, respectively.

HYPOTHESES

In order to more fully communicate the thrust of the proposed research, I shall give below a list of null hypotheses. The list is neither mutually exclusive or exhaustive, but is representative of the kinds of questions that may be addressed in the context of laboratory experimentation.

H1: The presence of the specialist has no effect on measures of social welfare.

H1.1 The specialist does not effect the spread in market bid-ask prices.

H1.2 The specialist does not affect price continuity.

H1.3 The specialist does not affect stability.

H1.4 The specialist does not affect market liquidity.

H1.5 The specialist does not affect the kurtosis of market price change distributions.

H2: The form of financial accounting statements recording identical events has no effect on market price behavior.

H2.1 Tax deferral treatment has no impact on market efficiency.

H2.2 Inventory evaluation method has no impact on market efficiency.

H2.3 Tax deferral treatment has no effect on price levels.

H2.4 Inventory evaluation method has no effect on price levels.

H3: Symmetric access to information in the specialist's book by all participants has no effect on measures of social welfare.

H4: Market efficiency in the "strong form" exists.

H5: The "tick-test" restriction has no effect on measures of market behavior.

H6: Order arrival processes are adequately described via Poisson distributions.

- H7: Prices cannot be manipulated for personal gain, even by individuals having a large proportion of the total capital.
- H8: External information delays for subsets of participants do not affect measures of social welfare.
- H9: The existence of limit orders has no impact on serial dependence, kurtosis, or other measures of transaction price change distributions.