Chapter 20

Market Manipulation

Joseph A. Cherian
School of Management, Boston University, Boston, MA 02215, U.S.A.

Robert A. Jarrow
Johnson Graduate School of Management, Malott Hall, Cornell University, Ithaca, NY 14853-4201, U.S.A.

1. Introduction

A recent area of analysis in financial economics has been in the area of market manipulation. Roughly speaking, market manipulation occurs when an individual (or a group of individuals) trades a firm’s shares in a manner such that the share price is influenced to his advantage. An immediate implication of market manipulation is the inappropriateness of the standard, perfect competition Walrasian equilibrium as a description of United States capital markets.

From a chronological perspective, research on market manipulations in futures markets predates that in U.S. equity and bond markets. There is also substantial regulation in futures markets which restricts the ability of individuals to influence futures prices. Admittedly, although the problem has not been entirely eliminated, traditional forms of manipulation in futures markets have been significantly reduced. In contrast, a literature investigating manipulations in the primary equity and bond markets has only recently been evolving. Part of the reason for this is the long-held belief that the Securities Exchange Act of 1934 had virtually eliminated manipulation in these markets. However, recent incidents of manipulation in equity and Treasury markets have dispelled this misconception.

This paper generates an analytical classification scheme for surveying the recent papers on market manipulations in primary markets, specifically equity markets. The model generating the classification scheme draws primarily from the paper by Jarrow [1992]. A sub-class of classifications is also derived using the model of Cherian & Kuriyan [1995], which extends Jarrow’s work by introducing an intermediary akin to the market makers of U.S. capital markets. The survey is not meant to be exhaustive. Instead, the aim of the present work is to provide a definition of manipulation and enough theory so that the reader understands the issues and key results of the literature. Furthermore, the insights generated by viewing market manipulation in this context should, hopefully, spawn ideas for
subsequent research. For the interested reader, a review of market manipulation in the context of corporate finance is provided in an article by Chatterjee, Cherian, & Jarrow [1993]. A new perspective on firm corporate policy is obtained by viewing the corporation as an active, strategic manipulator of its shares. The purpose of such corporation behavior is twofold: (i) to maximize its share price, and (ii) to prevent its shares from being manipulated by others. The analysis generated within this framework provides insights into a number of frequently occurring phenomena in the corporate world.

An outline of the paper is as follows. The next section provides the classification scheme for market manipulation. This includes the necessary definitions, assumptions, and conditions leading to known results. Section 3 surveys a selected subset of papers, which in the context of the classification scheme, unifies much of the burgeoning literature on market manipulations in primary markets. Section 4 presents an additional example and briefly reviews models of manipulation with derivative markets. Section 5 summarizes and concludes the paper.

2. A classification scheme

As stated in the introduction, the classification scheme draws heavily on the paper by Jarrow [1992]. In his paper, Jarrow examines the conditions under which a large trader, whose trades affect prices, can risklessly profit by implementing certain trading strategies. While Jarrow restricts his attention to manipulation in the absence of any proprietary or inside information on the intrinsic value of the asset, we generalize the model to include additional categories of manipulation. The purpose of such a generalization is to provide a unifying, classification scheme for studying the literature on market manipulation in primary markets. We exclude from our analysis market manipulation strategies involving a market corner and short squeeze. A market corner occurs when a trader controls more than the actual or floating supply of the securities available. A short squeeze happens when the trader calls in the shorts. In such a typical squeeze, the short sellers have to cover their positions at inflated prices. Our understanding of such market manipulating trading strategies is reasonably complete. As the analysis is straightforward, it is not considered here. On the other hand, manipulation in the presence of derivative securities is not well understood. It significantly complicates the current analysis, and is briefly discussed in Section 4.2 below.

2.1. The model

This section presents a description of the economy under which market manipulation trading strategies (to be defined) are considered. The approach taken herein parallels that of the options literature in that we exogenously specify a price process. The merit of such an approach is that the price process can be chosen to be consistent with a number of different equilibrium price constructs.
The reasonableness of this approach lies in the richness of the results obtained, without being bogged down by intricate, microeconomic details. The price process we specify depends, among other things, upon the manipulator's trades over time.

We examine a multi-period economy with discrete trading dates denoted by the set $\tau = \{0, 1, 2, \ldots, T\}$. Uncertainty in the economy at date $T$ is represented by a measurable space $(\Omega, \mathcal{F})$ where $\Omega$ is the state space and $\mathcal{F}$ is a sigma-algebra of subsets of $\Omega$. Information prior to date $T$ about the 'true' state is represented by the filtration $(\mathcal{F}_t)_{t \in \tau}$, which is an increasing sequence of sub-$\sigma$-algebras of $\mathcal{F}$ satisfying the usual conditions.\(^1\)

Let one risky security of limited liability, called a stock, and a riskless security, called a money market account, trade in this economy. The stock price process is represented by the non-negative stochastic process $\{S_t : t \in \tau\}$ adapted to $(\mathcal{F}_t)_{t \in \tau}$. This means that the stock price is part of the information set $\mathcal{F}_t$ available at date $t$. The money market account is represented by a stochastic process $\{B_t : t \in \tau\}$ predictable with respect to $(\mathcal{F}_t)_{t \in \tau}$. This means that the value of the money market account at time $t$ is known at time $t - 1$. This captures the notion that the money market account provides a riskless return over the 'next' trading interval. Assume that it is initialized with a dollar investment, i.e., $B_0 \equiv 1$ for all $\omega \in \Omega$, and that 'interest rates' are non-negative, i.e., $B_t \geq B_{t-1}$ for all $t \in \tau$ and $\omega \in \Omega$. For convenience, the remaining analysis is in terms of relative prices, with the money market account serving as the numeraire. Define

$$Z_t(\omega) = \frac{S_t(\omega)}{B_t(\omega)}, \quad \forall t \in \tau \text{ and } \omega \in \Omega$$

as the relative stock price. By definition, the relative price of the money market account is 1 for all $t \in \tau$ and $\omega \in \Omega$. In order to reduce notation in the subsequent analysis, we require that dates, $t$, are always drawn from the set $\tau$, and elements of the state space, $\omega$, are always drawn from the set $\Omega$, unless otherwise specified.

The economy is made up of one potentially manipulative trader called the manipulator and the 'rest' of the market, represented by an index set $I$. The manipulator could be a single trader or a cohort of traders acting in concert. He is characterized by the pair $(P, (\mathcal{F}_t)_{t \in \tau})$ where $P : \Omega \to [0, 1]$ is his probability belief and $(\mathcal{F}_t)_{t \in \tau}$ is his information set. The rest of the market could be a singleton or an interval (a continuum of atomistic traders). Each trader $i \in I$ is endowed with a probability belief $P^i : \mathcal{F} \to [0, 1]$, and an information set $(\mathcal{F}^i_t)_{t \in \tau}$.

The manipulator's holdings of the stock and money market account are given by a two-dimensional $(\mathcal{F}_t)_{t \in \tau}$-adapted stochastic process $\{\alpha_t, \beta_t : t \in \tau\}$ where $\alpha_t$ is the number of shares of stock held at time $t$ and $\beta_t$ is the number of shares of the money market account held at time $t$. Under the assumed information structure, $(\mathcal{F}_t)_{t \in \tau}$ corresponds to the information set of the manipulator. We emphasize that the information sets of the manipulator and the rest of the market

\(^1\) See chapter 1 of Karatzas & Shreve [1991] for a description of the use of probability spaces in financial economics.
need not coincide. To simplify notation, let the vectors \( \alpha^t \equiv (\alpha_1, \alpha_{t-1}, \ldots, \alpha_0) \) and \( \beta^t \equiv (\beta_1, \beta_{t-1}, \ldots, \beta_0) \) represent the history of the manipulator's holdings of the two traded assets up to time \( t \). Our notational convention is this: a superscript corresponds to a history and a subscript corresponds to a particular date \( t \).

In order to obtain a reasonable price process in the context of market manipulation, we need to introduce two additional parameters. The first is a broadly-defined action parameter, \( a \), which consists of a particular set of nontrade related and observable actions taken by the manipulator that can alter the perceived or intrinsic value of the stock. The second is the intrinsic value of the stock, \( u \), which will only be revealed at time \( T \), when the 'true' state is known. By the preceding considerations, \( u \) could be a function of \( a \). The importance of the information parameter will be obvious when the price process is specified. In order for the price process to respond to the manipulator's trades, it must be the case that the price response is either due to the size of the trade or to the fact that the 'rest' of the market believes (with some probability) that the manipulator is informed about \( u \). The possibility that it could be due to both is not ruled out.

We proceed under the general assumption that the manipulator operates under frictionless markets. This means he faces no transaction costs or short sale restrictions. The more formal assumptions are delineated as follows and invoked as needed in the subsequent analysis.

**Assumption 1** (The relative stock price process). There exists a sequence of functions \( \{G_t\}_{t \in \tau} \) with \( G_t : \Omega \times [R]^{2(t+2)} \rightarrow R \) such that for any trading strategy \( \{\alpha_t, \beta_t : t \in \tau\} \) of the manipulator, the composition mapping \( Z_t : \Omega \times \tau \rightarrow R \) defined by

\[
Z_t(\omega) = G_t(\omega, v(\omega), \alpha^t(\omega), \beta^t(\omega), a)
\]  

represents the stochastic process for the relative stock price, with \( v : \Omega \rightarrow R \) an \( \mathcal{F} \)-measurable function representing the stock's intrinsic value, and \( a \in R \) an action selection by the manipulator.

This assumption summarizes the relationship between relative prices and the manipulator's trades, his set of non-trade related actions which are perfectly observable by the market, and the intrinsic value of the asset. The specific functional form \( \{G_t\}_{t \in \tau} \) assumes depends on the particular economy under consideration. Two justifications for the assumption in expression (1) are as follows. First, the manipulator, due to sizeable wealth, may affect the demand and supply curves of the market, thus causing prices to react to his trades. Second, he could also affect prices because he is informed or the rest of the market believes he is informed about \( u \).

To motivate the next assumption, we introduce the concept of a self-financing trading strategy for the manipulator. For convenience, assume that the manipulator enters the market with zero holdings of both securities, i.e., \( \alpha_{-1} \equiv 0, \beta_{-1} \equiv 0 \). A self-financing trading strategy is one where there are no net cash inflows or outflows from the portfolio, except, perhaps, at time \( T \). In the context of our
economy, this implies that

$$\beta_{t-1}(\omega) + \alpha_{t-1}(\omega)Z_t(\omega) \equiv \beta_t(\omega) + \alpha_t(\omega)Z_t(\omega) \quad \text{a.e. } P \tag{2}$$

The above identity indicates that the manipulator finances his portfolio rebalancing from time $t-1$ to $t$ solely through the realization of his gains and losses in the stock and money market account. The self-financing relationship (2) implies that $\beta_t$ can be explicitly expressed as a function of $\alpha^t$. Hence, for self-financing trading strategies we can define a new function $g_t : \Omega \times \mathbb{R} \rightarrow R$ such that

$$g_t(\omega, v(\omega), \alpha^t(\omega), a) = G_t(\omega, v(\omega), \alpha^t(\omega), \beta^t(\omega), a) \tag{3}$$

Define $\Phi$ to be the set of all self-financing trading strategies of the manipulator. To capture the notion that the manipulator’s trades dominate the price setting process, we impose:

**Assumption 2** (Manipulator has market power). For all $\{\alpha_t, \beta_t : t \in \tau\} \in \Phi$, $a \in R$, and a.e. $P$,

(a) if $\alpha_t(\omega) > \alpha_{t-1}(\omega)$
then $g_t(\omega, v(\omega), \alpha^t(\omega), a) > g_t(\omega, v(\omega), \alpha_{t-1}(\omega), \alpha^{t-1}(\omega), a)$

(b) if $\alpha_t(\omega) < \alpha_{t-1}(\omega)$
then $g_t(\omega, v(\omega), \alpha^t(\omega), a) < g_t(\omega, v(\omega), \alpha_{t-1}(\omega), \alpha^{t-1}(\omega), a)$.

Condition 2a states that relative prices increase with increases in the manipulator’s holdings (or equivalently with manipulator demands), while condition 2b states that relative prices decrease with decreases in the manipulator’s holdings (or equivalently with manipulator sales), everything else held constant. This assumption can be justified under two common economic settings. In the first, the standard Walrasian equilibrium concept of aggregating supply and demand curves is used to determine the market clearing price. Excess demand due to the manipulator increasing his holdings causes an upward shift in the aggregate demand curve, thus increasing the price of the security. A symmetric argument holds on the sell side. In the second, prices are set by a market maker in the standard manner of the market microstructure literature [see Easley & O’Hara’s review in this volume]. In the information-effects model of market making, the size and sign of a trade may reflect informed trading; a net buy order is either information-based or a noise trade. If the market maker assigns a positive probability to the former event, then a buy order is transacted at a higher price than the previous transaction, with large orders being executed at less favorable prices than small orders. Since the market maker cannot distinguish between traders, the manipulator will find that his buy orders are executed at higher prices, as depicted in Assumption 2a.\(^2\) Again, a similar argument holds on the sell side.

The next assumption is invoked only when dealing in situations of informationless manipulation. That is, when the manipulator has no proprietary information

\(^2\) This second argument is central to the analysis of Cherian & Kuriyan [1995].
on the intrinsic value of the firm, $v$. It captures the condition that given the manipulator's information set, the market contains no arbitrage opportunities.

**Assumption 3** (No arbitrage opportunities based on the manipulator's information).

(a) For all $A \in \mathcal{F}$ and $i \in I$, $P^i(A) = 0$ if and only if $P(A) = 0$.

(b) There exists a probability measure $\tilde{P} : \mathcal{F} \to [0, 1]$ equivalent to $P$ (i.e., $P$ and $\tilde{P}$ have the same null sets on $\mathcal{F}$) such that for all $\{\alpha_t, \beta_t : t \in \tau\} \in \Phi$, $a \in R$, if $\alpha_{t+1} = \alpha_t$ a.e. $P$ then,

$$\tilde{E}\{g_{t+1}(v, \alpha^{t+1}, a) | \mathcal{F}_t\} = g_{t}(v, \alpha^t, a) \text{ a.e. } \tilde{P}.$$  \hfill (4)

Condition 3b says that for constant manipulator holdings over $[t, t+1]$, relative stock prices are a martingale with respect to his information set, thus making short-term buy and hold strategies a fair game. The mutual absolute continuity condition of 3a rules out the possibility of the manipulator being specially informed as it ensures that all traders agree on zero probability events.

To complete our set of assumptions, we include,

**Assumption 4** (Price process independence of the manipulator's past holdings). For all $\{\alpha_t, \beta_t : t \in \tau\}, \{\alpha^*_t, \beta^*_t : t \in \tau\} \in \Phi$, $a \in R$, if $\alpha_t(\omega) = \alpha^*_t(\omega)$ then $g_t(\omega, v(\omega), \alpha^t(\omega), a) = g_t(\omega, v(\omega), \alpha^*_t(\omega), a)$.

This assumption states that prices are independent of the history of the manipulator's trades. Equivalently, the price process is only a function of his current position, $\alpha_t$, i.e.,

$$g_t(\omega, v(\omega), \alpha^t(\omega), a) = g_t(\omega, v(\omega), \alpha_t(\omega), a).$$  \hfill (5)

**Assumption 5** (Price process independence of the manipulator's actions). For all $\{\alpha_t, \beta_t : t \in \tau\} \in \Phi$, $a \in R$,

$$g_t(\omega, v(\omega), \alpha^t(\omega), a) = g_t(\omega, v(\omega), \alpha^t(\omega)).$$  \hfill (6)

This assumption imposes the condition that the manipulator cannot undertake an observable action $a \in R$ which will change the equilibrium price process. Assumptions 1–5 are the possible assumptions. These are not maintained hypotheses, but only invoked when needed.

We now introduce the concept of a market manipulation trading strategy. First, we need to distinguish between paper wealth and real wealth. This is necessary when evaluating the profits (or wealth) of imperfectly competitive traders. The manipulator's paper wealth is defined to be the value of his holdings evaluated using the price of the last trade. This is common practice in market efficiency studies of profitable trading strategy rules, in the market value accounting procedure used by accountants, and in a financial risk management technique called 'marking-to-market'. Real wealth, in contrast, is defined to be the value of the
manipulator’s portfolio in the terms of the numeraire (money market account) upon liquidation of his stock holdings.

**Definition 1** (Paper wealth). The time \( t \) paper wealth of the portfolio position \( \{\alpha_t, \beta_t : t \in \tau\} \in \Phi \) and action \( a \in R \) is defined by

\[
W_t(\omega) = \alpha_{t-1}(\omega) g_t(\omega, v(\omega), \alpha_{t-1}(\omega), \alpha^{t-1}(\omega), a) + \beta_{t-1}(\omega)
\]

(7)

This corresponds to the manipulator’s time \( t - 1 \) holdings evaluated at time \( t \) relative prices and given that he has not altered his holdings over \([t - 1, t] \).

**Definition 2** (Real wealth). The time \( t \) real wealth of the portfolio position \( \{\alpha_t, \beta_t : t \in \tau\} \in \Phi \) is defined by

\[
V_t(\omega) = \alpha_{t-1}(\omega) g_t(\omega, v(\omega), 0, \alpha^{t-1}(\omega), a) + \beta_{t-1}(\omega)
\]

(8)

This corresponds to the manipulator’s time \( t - 1 \) holdings evaluated at time \( t \) relative prices and given that he has liquidated his stock holdings, i.e., \( \alpha_t = 0 \) a.e. \( P \).

The relationship between real wealth and paper wealth is easily derived by subtracting equations (7) from (8).

\[
V_t(\omega) = W_t(\omega) + \alpha_{t-1}(\omega) \left[ g_t(\omega, v(\omega), 0, \alpha^{t-1}(\omega), a) - g_t(\omega, v(\omega), \alpha_{t-1}(\omega), \alpha^{t-1}(\omega), a) \right]
\]

(9)

The following lemma follows directly from Assumption 2 and equation (9).

**Lemma 1.** Given Assumptions 1 and 2 and \( \{\alpha_t, \beta_t : t \in \tau\} \in \Phi, a \in R \),

\[
V_t(\omega) < W_t(\omega) \text{ if and only if } \alpha_{t-1}(\omega) \neq 0 \text{ a.e. } P,
\]

Lemma 1 demonstrates that real wealth and paper wealth are distinct for a large trader (as defined in Assumption 2). In some situations, it will be more convenient to analyze market manipulation trading strategies by calculating the manipulator’s cumulative capital gain in the risky asset.

**Definition 3** (Gains process). The time \( t \) gains process of the portfolio position \( \{\alpha_t, \beta_t : t \in \tau\} \in \Phi \) and action \( a \in R \) is defined by

\[
G_t(\omega) = \alpha_{t-1}(\omega) \left[ g_t(\omega, v(\omega), \alpha^{t}(\omega), a) - g_{t-1}(\omega, v(\omega), \alpha^{t-1}(\omega), a) \right] + G_{t-1}(\omega)
\]

\[
= \sum_{j=1}^{t} \alpha_{j-1} \left[ g_j(\omega, v(\omega), \alpha^{j}(\omega), a) - g_{j-1}(\omega, v(\omega), \alpha^{j-1}(\omega), a) \right] + G_0
\]

(10)

where \( G_0 \equiv 0 \) and \( t > 0 \).
The following result dictates that, under the right conditions, the gains process can be used to calculate paper wealth and real wealth.

**Lemma 2.** Given Assumption 1 and \( \{\alpha_t, \beta_t : t \in \tau\} \in \Phi, a \in R \)

1. If \( \alpha_t = \alpha_{t-1} \) then \( W_t(\omega) = \mathcal{G}_t(\omega) \) a.e. \( P \), and
2. If \( \alpha_t = 0 \) then \( V_t(\omega) = \mathcal{G}_t(\omega) \) a.e. \( P \).

**Proof.** For the first part, note that if \( \alpha_t = \alpha_{t-1} \), then \( \alpha^t = (\alpha_{t-1}, \alpha^{t-1}) \). This implies that

\[
\alpha_{t-1}(\omega)[g_t(\omega, v(\omega), \alpha_{t-1}(\omega), \alpha^{t-1}(\omega), a)] = W_t(\omega) - \beta_{t-1}(\omega)
\]

by Definition 1. Furthermore, by the self-financing condition (2),

\[
\alpha_j(\omega)[g_j(\omega, v(\omega), \alpha^{j}(\omega), a)] = \beta_{j-1}(\omega) + \alpha_{j-1}(\omega)[g_j(\omega, v(\omega), \alpha^{j-1}(\omega), a)] - \beta_j(\omega)
\]

for \( 0 < j \leq t - 1 \). Substitution of the above into \( \mathcal{G}_t(\omega) \) results in the telescoping sum on the right hand side of equation (10) collapsing to \( W_t(\omega) \). The second part of the proof is similar except that Definition 2 \( (\alpha_t = 0) \) is used instead of Definition 1. \( \Box \)

Armed with the above definitions and results, a market manipulation trading strategy can now be defined.

**Definition 4** (A market manipulation trading strategy). A **market manipulation trading strategy** is defined to be any zero initial wealth, self-financing trading strategy \( \{\alpha_t, \beta_t : t \in \tau\} \in \Phi, \) such that

\[
V_T \geq 0 \text{ a.e. } P,
\]

and

\[
P(V_T > 0) > 0.
\]

Hence, we define a market manipulation trading strategy to be an arbitrage opportunity in real wealth. An arbitrage opportunity, as common to option valuation, is any self-financing trading strategy such that the paper wealth at liquidation, \( W_T \), is non-negative for sure, and strictly positive with positive probability. The distinction in this definition lies in the fact that we replaced paper wealth, \( W_T \), with real wealth, \( V_T \). As Lemma 1 reveals, the distinction can be quite important.

**2.2. Main results**

The primary aim of this section is to investigate the existence of market manipulation trading strategies under various economic scenarios. The analysis will be carried out by either invoking or violating some of the assumptions spelled out in
the previous section. We first show the strength of Assumptions 3 and 5 in eliminating market manipulation for price takers. This generates Proposition 1. This is the standard setting used in the construction of competitive equilibrium models for asset pricing, like the CAPM. Then we show the existence of three types of market manipulations under the relaxation of these assumptions: Example 1 gives an information-based manipulation, Example 2 a trade-based manipulation, and Example 3 an action-based manipulation. This is consistent with the categorization scheme for market manipulations proposed by Allen & Gale [1992]. Finally, Proposition 2 shows that Assumptions 1–5 are sufficient to simultaneously rule out all three types of manipulation when the manipulator has market power. This is a generalization of the standard setting in Proposition 1, useful for game theoretic models of asset pricing, like in the market microstructure literature.

Given the absence of information-based arbitrage (Assumption 3), market manipulations can only exist, if at all, either because of the manipulator’s market power (Assumption 2) or because of his non-trade based actions, \( a \). We exclude action-based manipulation by imposing Assumption 5. This is standard practice in equilibrium asset pricing models. Next, for a price taking based manipulator, Assumption 2 is replaced by the condition that \( g_t(v, \alpha_t, \alpha_{t-1}, \ldots, \alpha_0) \) is independent of \( (\alpha_t, \alpha_{t-1}, \ldots, \alpha_0) \) i.e.,

\[
g_t(\omega, v(\omega), \alpha^t(\omega)) = g_t(\omega, v(\omega)) \tag{13}
\]

From equation (9), this implies that real wealth is equal to paper wealth, i.e., \( V_t = W_t \) for all \( t \in \tau \). The price taking condition (13) used in conjunction with Assumption 3 and 5 implies that no market manipulation trading strategies exist. We formalize this in the next result.

**Proposition 1** (Nonexistence of manipulation for price takers). Under Assumptions 1, 3, and 5 where for all \( t \in \tau \), \( \{\alpha_t, \beta_t : t \in \tau \} \in \Phi \), \( a \in \mathbb{R} \), and given the price taking condition

\[
g_t(\omega, v(\omega), \alpha^t(\omega)) = g_t(\omega, v(\omega)),
\]

no market manipulation trading strategies exist.

**Proof.** This follows from the well-known result that the existence of an equivalent martingale measure implies the non-existence of arbitrage opportunities for price takers. \( \square \)

This proposition provides the standard setting for most equilibrium asset pricing models, e.g., the CAPM. Under this scenario, manipulation cannot occur. However, by relaxing any of these assumptions, manipulation is possible.

The existence of market manipulation trading strategies based on the possession of inside information is possible if Assumption 3 is relaxed. This is probably the most profitable form of manipulation and is, judging from recent newspaper
accounts, still rife in equity markets. A simple example is provided to illustrate this form of manipulation.\textsuperscript{3} This example relaxes Assumption 3.

**Example 1** (Information-based manipulation). Consider a three period economy with $T = 2$. Let the state space $\Omega = \{uu, ud, du, dd\}$. Assume that the stock price process follows a multiplicative binomial process with recombination, i.e., that the rate of return on the stock over each period could either be $u - 1$ with probability $p$, or $d - 1$ with probability $1 - p$, where $u, d$ are positive constants, with $u > d$ and $d = 1/u$.\textsuperscript{4} This implies that the price taking, non-action based condition (13) for the stock price process holds. Hence, if the stock price at time 0 is $Z_0$, the stock price at time 1 is given by either $Z_0u$ or $Z_0d$. Proceeding in a similar manner, the possible stock prices at time 2 is given by $\{Z_0uu, Z_0ud, Z_0du, Z_0dd\}$ where $Z_0ud = Z_0du = Z_0$. The reader is referred to Figure 1 for a diagram of the price process. Further assume that the intrinsic value of the stock, $v$, is revealed at time 2 and has the structure $\{v(uu), v(ud), v(du), v(dd)\}$. By construction we have,

$$
\begin{align*}
v(uu) &= Z_2(uu) = Z_0uu \\
v(ud) &= v(du) = Z_2(ud) = Z_2(du) = Z_0 \\
v(dd) &= Z_2(dd) = Z_0dd.
\end{align*}
$$

The information structure is modelled as follows. The manipulator’s information set evolves as:

$$
\begin{align*}
\mathcal{F}_0 &= \mathcal{F}_1 = \{\{uu, ud\}, \{du, dd\}\} \\
\mathcal{F}_2 &= \{\{uu\}, \{ud\}, \{du\}, \{dd\}\}.
\end{align*}
$$

The rest of the market’s information set is given as:

$$
\begin{align*}
\mathcal{F}_0^{\text{market}} &= \{\{uu, ud, du, dd\}\} \\
\mathcal{F}_1^{\text{market}} &= \mathcal{F}_0 = \mathcal{F}_1 \\
\mathcal{F}_2^{\text{market}} &= \mathcal{F}_2.
\end{align*}
$$

\textsuperscript{3} This example parallels the one found in Cherian & Kuriyan [1995].

\textsuperscript{4} We use $u$ and $d$ as possible stock returns and as elements of $\Omega$ for notational convenience. The distinction in use should be obvious.
It is obvious that the manipulator has a more refined information set than the rest of the market. The manipulator knows at time 0 whether an up (u) or a down (d) will occur at time 1. The market knows nothing. This is a violation of the mutual absolute continuity condition in Assumption 3. A manipulator with the information set \((\mathcal{F}_t)_{t \in \tau}\) as specified will make arbitrage profits by buying the stock (at time 0) at the market price \(Z_0\) if \(\mathcal{F}_0\) reveals that the stock price is going up the next period or selling if \(\mathcal{F}_0\) reveals that it is going down.

Example 1 shows that even a price taking (or non-strategic) informed trader can make arbitrage profits by trading on proprietary information. Some may argue that an informed trader is not considered a manipulator unless he trades strategically on his private information. This occurs for example when, like a typical monopolist, he takes into account the price impact of his trades by scaling down his orders in order to obtain more favorable prices. Example 1 can easily be generalized to incorporate this scenario. But, as it necessarily involves the introduction of additional notation, we leave it to the reader as a healthy exercise.

The next example incorporates a price process where the manipulator has market power, thereby relaxing the price taking assumption. The example simultaneously satisfies Assumptions 1–3 and 5. It is then shown that for specific parameter values, an asymmetric price response condition can generate profitable manipulation.

**Example 2** (Trade-based manipulation). Let \(c : \Omega \times \tau \to R\) and \(v : \Omega \to R\) be \(\mathbf{F}\)-measurable. Define

\[
g_t(\omega, v(\omega), \alpha(\omega), a) = \exp \left\{ \sum_{j=0}^{t} c_j(\omega)[\alpha_j(\omega) - \alpha_{j-1}(\omega)] \right\} + v(\omega) \tag{14}
\]

for \(\{\alpha_t, \beta_t : t \in \tau\} \in \Phi, a \in R\), where \(\{c_t : t \in \tau\}\) is adapted and strictly positive a.e. \(P\), and \(v\) is \(\mathbf{F}\)-measurable and non-negative a.e. \(P\).

The coefficient process, \(\{c_t : t \in \tau\}\), determines the price sensitivity to the manipulator's orders. It is easy to see that this specification is consistent with Assumptions 1–3 and 5. Assumptions 1, 2, and 5 are true by inspection as \(\{c_t : t \in \tau\}\) is strictly positive. Next, assuming that there exists a probability \(\hat{P}\) making \(v(\omega)\) a martingale and with \(\hat{P}\) and \(P\) mutually absolutely continuous guarantees the satisfaction of Assumption 3 (using the linearity of the expectation operator). The existence of such a probability \(\hat{P}\) is easy to obtain. For example, the process in Figure 1 (if defined to be \(v(\omega)\)) has such a probability and it is

\[
\frac{1 - d}{u - d}.
\]

To illustrate the market manipulation trading strategy, it is sufficient to consider only a three period economy \((T = 2)\). We further specialize the price process of expression (14) as follows. For any \(\{\alpha_t, \beta_t : t \in \tau\} \in \Phi\) and \(t \in \tau\),
(a) if $\alpha_i(\omega) > \alpha_{i-1}(\omega)$ then $c_j(\omega) = c_+ (\omega)$
(b) if $\alpha_i(\omega) < \alpha_{i-1}(\omega)$ then $c_j(\omega) = c_- (\omega)$

where $c_+ > c_- > 0$. For convenience, set $c_+ \equiv 1$ and $0 < c_- (\omega) < 1$. This says that the price sensitivity to a manipulator purchase is higher than for a sale. The rationale behind such a specification draws from the information-based models of market microstructure, i.e., uninformed buys are more likely to occur when traders can minimize their losses to insiders, whereas uninformed sellers, due to pressing cash needs, do not share this luxury. This tends to increase the perceived information content of purchases. The price process specified is also consistent with trend creating strategies such as finite horizon bubbles, price destabilizing speculation, and positive feedback trading. Under this specification, the manipulator can potentially generate manipulative profits by bidding the price up ($0 < \alpha_0 < \alpha_1$) before liquidating his position ($\alpha_2 = 0$). To see this, we evaluate the gains process for the manipulator when $\alpha_0 = 1, \alpha_1 = 3, \alpha_2 = 0$, and $c_- = 1/30$. Further assume that $v(\omega) \equiv 0$. From Definition 3,

$$G_2 = \sum_{j=1}^{2} \alpha_{j-1} [g_j(\omega, v(\omega), \alpha^j(\omega), a) - g_{j-1}(\omega, v(\omega), \alpha^{j-1}(\omega), a)]$$

$$= \alpha_0 [g_1(\omega) - g_0(\omega)] + \alpha_1 [g_2(\omega) - g_1(\omega)].$$

By construction

$$g_0(\omega) = e^{\alpha_0} = 2.718$$
$$g_1(\omega) = e^{\alpha_1} = 20.086$$
$$g_2(\omega) = e^{c_-(\alpha_2 - \alpha_1) + \alpha_1} = 18.174$$

Substitution into the gains process gives $G_2 = 23.10 > 0$.

The following example shows how market manipulation trading strategies can arise when the manipulator takes certain actions which affect the price process. This example relaxes Assumption 5.

**Example 3 (Action-based manipulation).** We retain the three period economy and the basic functional form of the price process as in Example 2, except that we add that the manipulator's publicly observable action parameter, $a \in R$, has a linear effect on prices, i.e.:

$$g_i(\omega, v(\omega), \alpha^i(\omega), a) =$$

$$= \exp \left\{ \sum_{j=0}^{i} c_j(\omega)[\alpha_j(\omega) - \alpha_{j-1}(\omega)] \right\} + v(\omega) + a \cdot I_{|a| = 2}$$

(15)

where $I_{\Theta}$ is the indicator function over the set $\Theta$ and such that

$$\exp \left\{ \sum_{j=0}^{2} c_j(\omega)[\alpha_j(\omega) - \alpha_{j-1}(\omega)] \right\} + v(\omega) \geq |a|. $$
The latter condition ensures that prices are nonnegative. Notice that, by construction, the manipulator takes a publicly observable action which is reflected in prices at time 2. Although the manipulator knows the timing of his action in advance, we assume the rest of the market is aware of it only when it becomes public knowledge. For simplicity, assume that \( c_j(\omega) \equiv 1 \) for all \( j \in \tau \) and \( v(\omega) \equiv 0 \). Hence, there isn't an asymmetric price response condition in this example. A positive action parameter effect \( (a > 0) \) temporarily induces a 'premium' in the price process, while a negative action parameter effect \( (a < 0) \) temporarily induces a 'discount'. It is now easy to construct trading strategies where a manipulator can make manipulative profits by taking advantage of the effect his action has on prices. Let the strategy he follows be \( \alpha_0 = \alpha_1 > 0 \), and \( \alpha_2 = 0 \). By evaluating the gains process as in Example 2, it is easy to see that manipulative profits are available when the action the manipulator takes is such that \( a > e^{\alpha_1} - 1 > 0 \).

We now study conditions sufficient to rule out market manipulation trading strategies given that the manipulator has market power and is not a price taker. As such, this is a generalization of Proposition 1. Before doing that, we need the following result.

**Lemma 3** (Prices are martingales for constant manipulator holdings). Given Assumptions 1–5 and any self-financing trading strategy \( \{\alpha_t, \beta_t: t \in \tau\} \in \Phi \) then, \( E(g_t(\alpha_s) \mid \mathcal{F}_s) = g_s(\alpha_s) \) a.e \( P \) for all \( 0 \leq s \leq t \leq T \).

**Proof.** This follows from Assumption 4 by taking conditional expectations and using the law of iterated expectations, see Jarrow [1992]. \( \square \)

This lemma states that, for constant manipulator holdings, the expected future price is the same as the current price, in other words, the market provides a fair gamble to the manipulator. This precludes market manipulation trading strategies, as a tedious proof in Jarrow [1992] shows.

**Proposition 2** (Nonexistence of manipulation where traders have market power). Given Assumptions 1–5 and self-financing trading strategies \( \{\alpha_t, \beta_t: t \in \tau\} \in \Phi \), there exist no market manipulation trading strategies.

This proposition extends the competitive equilibrium setting to one where traders have market power. As such, it is a sufficient set of conditions useful for excluding manipulation in the game theoretic models common to the market microstructure literature. This completes the presentation of the model. In the next section we review a selected set of the market manipulation literature and relate them to our results and examples. As stated in the introduction, an exhaustive survey is not provided. Instead, we focus on models which illustrate the previous results by deriving the price process endogenously within the context of equilibrium constructs.
3. A review

The categorization scheme employed by Allen & Gale [1992] is useful for the subsequent survey. We have already used this earlier. They divide market manipulations into three categories:

1. **Information-based manipulation**: Manipulation based on trading strategically on inside information or spreading false rumours (our Example 1);

2. **Trade-based manipulation**: Manipulation due to buying or selling stocks without taking any actions or possessing any special information. This category also excludes trading on the release of false information (our Example 2); and

3. **Action-based manipulation**: Manipulation based on actions that change the actual or perceived value of the stock price (our Example 3).

The distinctions between the three different categories of manipulation are not always obvious, but are nonetheless useful.

Strategic, information-based manipulation of the sort described in Example 1 include the models by Kyle [1985] and Easley & O'Hara [1987]. In the Kyle model, the monopolistic, informed trader acting optimally, submits orders which increase with noise trading, as noise helps diffuse the information content of his trades. In a slightly different setting, Easley & O'Hara [1987] also allows the informed trader to strategically choose between small market orders and large block trades. In both models, the strategic component to an informed manipulator’s trading strategy tends to make prices less informationally-revealing, thus enabling him to extract higher monopolistic information rents from the rest of the market. The reader is referred to the review of market microstructure in this volume by Easley & O'Hara [1995] for further examples of strategic, information-based manipulation.

In an example of trade-based manipulation akin to our Example 2, Allen & Gorton [1992] argue that an asymmetric price response to order flows can generate market manipulation trading strategies, even if the manipulator does not possess any proprietary information. In their example, a higher price sensitivity to purchases than sales, due to the presence of asymmetric noise traders, enables the manipulator to repeatedly buy stock, causing a relatively large effect on prices, and then sell, having relatively little effect on prices, and generating a profit. In a similar model, Allen & Gale [1992] demonstrate how an uninformed trader mimics an informed trader with positive information about the stock to raise the stock price and then sell his shares at a profit.

In another example of trade-based manipulation, Fishman & Hagerty [1991] demonstrate how an uninformed insider can take advantage of the mandatory disclosure (or post-announcement) requirement for insiders as found in the Securities Exchange Act. They find that the manipulator can take advantage of the market's inability to infer the information content of his disclosed trade. For example, al-

---

5 As stated in Example 1, the strategic dimension to the example can be easily incorporated by adjusting the price process to be a function of the manipulator's holdings, as in the subsequent examples.
though he has no information, he discloses his sale causing the stock price to drop because the market believes he may be informed. The uninformed manipulator then buys his shares back at the lower price. Assumptions 1 and 2 and Example 2 succinctly describe a price process which is susceptible to this form of manipulation.

As stated, the definitions provided for the three different categories of manipulation may sometimes be confusing, especially when categorizing the models. A case in point is the paper by Gerard & Nanda [1993]. In their model, strategic informed traders short sell a firm’s stock just prior to a seasoned equity offering in order to cause downward price pressures on the stock. The manipulators will then more than cover their positions by purchasing stocks in the offering at a reduced price. The discount available at the offering is assumed to be a function of the ‘winner’s curse’ problem faced by new shareholders. The aggressive pre-issue short selling tends to exacerbate the size of the induced discounts. When the stock is eventually restored back to its fair value, the manipulators liquidate their positions at a profit. The model can either be viewed as trade-based manipulation as in Example 2 adjusted for pricing sensitivities, or as action-based manipulation with a negative action parameter effect ($a < 0$) which induces temporary discounts (see Example 3).

Vila [1989] has two models of action-based manipulation (our Example 3). In the first, Vila considers an equilibrium where a ‘raider’s’ purchase of a stock before a takeover attempt increases the price of the stock. Even if the raider is not actually in the market and a takeover is not forthcoming, a manipulator can mimic the raider by purchasing the stock under similar conditions with the intent of misleading the market into thinking that he is genuinely bidding for the firm. He liquidates his position just in time with the profits obtained from the resulting appreciation on the share price. In a more elaborate model of takeovers, Bagnoli & Lipman [1990] have a situation where a large trader announces a takeover bid to manipulate the target corporation's shares. It differs from Vila's model in the sense that Vila doesn't incorporate such an announcement. The bidder-manipulator imitates a serious bidder by taking a substantial position in the stock. This causes an appreciation in share prices as the market cannot tell if the bid is serious. The manipulator then sells his holdings at a profit and drops the bid. Such actions are profitable because the manipulator credibly pools his trades with the raider's trades. Example 3 is consistent with this form of manipulation. When the action-based parameter of Example 3 has a positive effect on the price process ($a > 0$), it temporarily induces a premium in the price process, thus enabling profitable manipulation.

In the second model, Vila [1989] considers the opposite effect. A manipulator first short sells the stock, then releases false information which temporarily depresses the stock price, and then buys back the stock at the reduced price. This sort of manipulation, again, was covered in the negative action parameter effect of Example 3. Famous market manipulation incidents involving 'trading pools' and 'bear raids' during the 1920s lend credibility to Vila's example.

Benabou & Laroque [1992] consider a situation where possessors of private information can manipulate the market through strategically distorted announce-
ments. Insiders, market gurus, and even journalists can manipulate stock prices through misleading forecasts or announcements, earning a profit in the process. The credibility of such announcements hinges on the fact that the manipulator intertemporally varies his forecasts, blaming the incorrect ones on honest mistakes. Thus a privately informed manipulator stands to gain more by speculating and making false announcements than by just trading on his private information. This could either be the premiums or discounts story of Example 3, depending on the circumstance.

4. Further examples

We study one more example of a market manipulation trading strategy in primary markets which is similar to Example 2 and then review briefly the more complicated topic of market manipulation with derivative markets. The following examples do not necessarily satisfy the assumptions of the previous section. They are included to illustrate other possible scenarios of manipulation.

4.1. Equity markets — a reprise

We consider an economy where there exist ‘positive feedback’ traders. These are traders who submit trades in the direction of current price movements, hence the term positive feedback. This trading strategy is not alien in financial markets. Strategies like stop-loss orders, portfolio insurance, technical analysis, etc., are examples of the positive feedback type.

Example 4 (Market maker economy). This simple example draws on Cherian & Kuriyan [1995]. In their model, the price process responds to the entire order flow processed by an intermediary like a market maker as opposed to just the manipulator’s trades. However, by assuming that the manipulator (as a large trader) dominates the order flow, they derive a price process condition similar to Assumption 2.

Let the entire order flow be defined as $v_t$, the manipulator’s position be $\alpha_t$, and the rest of the market’s, $u_t$. We thus have

$$v_t = \alpha_t + u_t.$$  

The modified relative stock price process for self-financing trading strategies is defined by

$$Z_t(\omega) = g_t(\omega, v(\omega), v_t(\omega), v_{t-1}(\omega), \ldots, v_0(\omega), a)$$

Based on the information-effects model common to market microstructure [see Easley & O’Hara, 1995], Assumption 2 is replaced by the condition that a net buy order cannot lower relative prices, while a net sell order cannot raise prices, i.e.,

---

6 For the sake of brevity we skip notational complexities and concentrate on the results.
(a) if \( v_t(\omega) > v_{t-1}(\omega) \)
    then \( g_t(\omega, v(\omega), v'(\omega), a) > g_t(\omega, v(\omega), v_{t-1}(\omega), v'^{-1}(\omega), a) \)
(b) if \( v_t(\omega) < v_{t-1}(\omega) \)
    then \( g_t(\omega, v(\omega), v'(\omega), a) < g_t(\omega, v(\omega), v_{t-1}(\omega), v'^{-1}(\omega), a) \).

The market power assumption 2 still holds depending on who is dominating the order flow. For example, if the rest of the market is dominating the order flow around time \( t \), the above condition becomes

(a) if \( u_t(\omega) > u_{t-1}(\omega) \)
    then \( g_t(\omega, v(\omega), v'(\omega), a) > g_t(\omega, v(\omega), u_{t-1}(\omega), v'^{-1}(\omega), a) \)
(b) if \( u_t(\omega) < u_{t-1}(\omega) \)
    then \( g_t(\omega, v(\omega), v'(\omega), a) < g_t(\omega, v(\omega), u_{t-1}(\omega), v'^{-1}(\omega), a) \).

Consider a three period economy \( (T = 2) \) where the manipulator dominates the order flow at time 1, whereas the rest of the market takes control of the order flow at time 2 due to the positive feedback effect. A simple way to capture positive feedback trading formally is to define

\[
u_t = d_t (Z_{t-1} - Z_{t-2})\]

where \( d_t \) is a positive proportionality constant. Assume that the positive feedback trading is ‘explosive’, i.e.,

\[
d_2 |Z_1 - Z_0| > |\alpha_1|.
\]

The manipulator can make arbitrage profits by choosing to buy a large quantity of the stock at time 1 and immediately liquidating his position at time 2. Thus, his sequence of holdings \([\alpha_0, \alpha_1, \alpha_2]\) is given by \([0, \alpha_1, 0]\) where \( \alpha_1 > 0 \). To see this, we look at the gains process for the manipulator. From Lemma 2, the gains process is equivalent to the gains process for the manipulator’s real wealth if he liquidates his position \((\alpha_2 = 0)\). Thus, we have

\[
\alpha_2 = \sum_{j=1}^{2} \alpha_{j-1} \left[ g_j(\omega, v(\omega), v'(\omega), a) - g_{j-1}(\omega, v(\omega), v'^{-1}(\omega), a) \right]
\]

\[
= \alpha_0 [g_1(\omega) - g_0(\omega)] + \alpha_1 [g_2(\omega) - g_1(\omega)] > 0
\]

as \( g_2(\omega) > g_1(\omega) \) by Condition (16). This is a market manipulation trading strategy.

4.2. Manipulation with derivative markets

In a second paper, Jarrow [1994] studies the profitability of manipulation when a third asset, like a derivative security, trades. He finds that riskless arbitrage profits are possible in derivative markets with imperfect information flows. For example, if the stock price process does not respond instantaneously to the manipulator’s position in the derivative security by the equivalent synthetic amount in stock, riskless profitable strategies can exist.
In a recent paper, Chatterjea & Jarrow [1993] develop an equilibrium model of U.S. Treasury auctions where there are profitable manipulation opportunities by trading across the primary auction and the secondary when-issued markets. Their model captures the alleged 1991 Salomon Brothers Treasury scandal where Salomon ended up controlling a substantial portion of the May 1991 auction of two-year notes as well as the secondary when-issued market, resulting in a squeeze on the short sellers of those instruments.

Kumar & Seppi [1992] use a Kyle [1985] variant to demonstrate how uninformed traders can manipulate futures markets which have 'cash-settled' contracts. The manipulator, who has a substantial long futures contract position, is willing to take a temporary loss in the spot market by aggressively bidding up the spot price in order to end up with a more favorable settlement price. In the two period model they employ, the manipulator can earn positive expected profits at the settlement date, as the market cannot distinguish his trades from the informed trader's. In order to illustrate this form of manipulation within the context of our model, we present the next example.

**Example 5** (Manipulation with derivatives). Consider the self-financing trading strategy \( \{\alpha_0, \alpha_1, \alpha_2\} \) with \( \alpha_0 < \alpha_1 \) and \( \alpha_2 = 0 \), in a three period model with a futures contract on the stock trading. We assume conditions 1–3 hold even in the presence of the futures contract. The manipulator enters into a long futures contract agreement at time 0, with settlement at time 1. Let his futures position be represented by \( \gamma_0 \) and the futures price be \( F(\omega) \). For convenience, assume \( F(\omega) \equiv g_0(\omega) \) a.e. \( P \). For

\[
y_0 > \alpha_1 \frac{g_1(\omega) - g_2(\omega)}{g_1(\omega) - g_0(\omega)} - \alpha_0 \quad \text{a.e. } P,
\]

it can be shown that there are market manipulation trading strategies possible. To see this, consider the manipulator's modified gains process:

\[
G_2 = \sum_{j=1}^{2} \alpha_{j-1} \left[ g_j(\omega, \nu(\omega), \alpha^j(\omega), a) - g_{j-1}(\omega, \nu(\omega), \alpha^{j-1}(\omega), a) \right] + \gamma_0 [g_1(\omega) - F]
= \alpha_0 [g_1(\omega) - g_0(\omega)] + \alpha_1 [g_2(\omega) - g_1(\omega)] + \gamma_0 [g_1(\omega) - F].
\]

The additional term in the expression reflects the futures settlement which takes place at time 1. Since \( \alpha_0 < \alpha_1 \), this implies by Assumption 2 and Condition (17) that manipulation is profitable in this case.

5. **Summary and conclusion**

We generate an analytical classification scheme for surveying the recent papers on market manipulations in primary markets, specifically equity markets. The focus has been to illustrate the types of market manipulation trading strategies
possible, with examples similar in spirit to equilibrium models contained in
the literature. We also briefly illustrated the possibility of additional market
manipulations in markets with derivative securities.

There are many ways to combat undesirable manipulation of the forms de-
scribed in this paper. As Gerard & Nanda [1993] observe, disallowing manipu-
lators to cover their short positions in the pre-issue market with stock purchased at
the offering reduces manipulation around seasoned equity offerings. In the Jarrow
[1994] and Kumar & Seppi [1992] models, better information flows between mar-
kets would curtail manipulation as prices act as a natural market-based safeguard
against it. Furthermore, all three models agree that free, unrestricted competition
between the manipulators tends to drive their profits to zero. A similar suggestion
arises in the paper by Holden & Subrahmanyam [1992] who discover that competi-
tion between informed traders causes prices to be more informationally-efficient,
thus alleviating information-based manipulation.

The firm can also prevent an accrual of unfair informational advantage within
certain segments of the market by releasing information in a systematic and
timely fashion. Fishman & Hagerty's [1991] results are especially important as
mandatory disclosure of trades by insiders may be counter-productive as it could
lead to manipulation. They suggest two approaches to circumvent manipulation
around disclosures. If disclosure is mandatory, then the 'short-swing profit' rule,
which currently only requires corporate insiders to give up profits from short-term
trading profits, should be applied to all insiders who face disclosure requirements.
Alternatively, they suggest removing the mandatory disclosure requirement since
their analysis reveals that voluntary disclosure is generally not forthcoming. We
go a step further by either requiring insiders to pre-announce (or pre-disclose) all
their trades or, in the face of mandatory post-announcement disclosure, requiring
them to do it more promptly so that prices can reflect insiders' trades, motives,
and information.

The different approaches just suggested will not entirely eliminate profitable
manipulation. However, it would make it more difficult for traders to mis-
chievously indulge in manipulatory tactics. Since regulation can be cumbersome
and costly, market-based safeguards should be encouraged to protect against
manipulation.

References

paper, Carnegie Mellon University.
gurus, and credibility. Q. J. Econ. August, 921–958.


