

THE REGULATION OF TRADE-BASED MANIPULATION

by

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## **Abstract**

We examine a model in which security price manipulation can lead to the inefficient allocation of resources. The actions of a manipulator can create excess noise in the market which may discourage some investors from participating. We show how a regulator can use trading halts to mitigate the negative impact of manipulation and induce investors back into the market. However, the benefits derived from using halts are somewhat offset by illiquidity costs imposed by the halts on some market participants. Thus, a regulator who must contend with a manipulator is faced with a trade-off between improving allocative efficiency and limiting costs associated with reduced liquidity. Our model demonstrates this trade-off and outlines possible equilibria.

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## **Chapter 1**

### **Introduction**

Manipulation in the market for financial securities is often associated with increased noise in security prices. Manipulative activity can distort the informativeness of a market and lead to artificial prices. To the extent that this noise or misinformation may lead to inefficient allocation of resources, regulation that mitigates the adverse effects of a manipulator may increase economic efficiency. In this paper we will examine a model where a regulator must contend with the possibility of a manipulator in the market. In most models of successful manipulation, the manipulator tries to deceive the market by disguising himself as an informed trader. With the use of trading halts, a regulator can force the manipulator to reveal himself before he is able to profit from his deception. Unfortunately, trading halts are costly as they interrupt the flow of trades, reducing market liquidity. Some are forced to hold a position for longer than they like, while others are unable to enter the market when they like. Thus, when determining policy for dealing with manipulation regulators must recognize the trade-offs that result from their actions.

The remainder of this chapter proceeds as follows. In section I, we discuss the different types of manipulation, while in section II, the costs of manipulation are examined. In section III, the role and objectives of the regulator are considered and the use of trading halts is analyzed. Finally, in section IV, current models of manipulation profitability are described and the importance of asymmetric information is demonstrated. In chapter 2, we present our model of trade-based manipulation and trading halts. In chapter 3, a general

discussion of the model and the equilibria that can result is aided by a numerical example. Finally, in chapter 4, we discuss the model's sensitivity to our assumptions, and in chapter 5, we conclude with policy implications and areas for further research.

## **I. Types of Manipulation**

Manipulation in a securities market is loosely defined by Fishel and Ross (1991) as "profitable trades made with 'bad' intent."<sup>1</sup> By 'bad intent', they mean that the trader feels he can move the price of a security solely by his trading activity, either because he has monopoly power or because he is able to deceive others into believing he has valuable information. There are various forms of manipulation: corners and squeezes, fictitious trades, fraudulent reporting, and trade-based manipulation. Although this paper focuses on trade-based manipulation, it is important to distinguish this form from the others. A manipulator corners the market by purchasing a substantial portion of an asset. Short sellers - those who sell the asset without first purchasing it - have little bargaining power when they are subsequently forced to deal with the manipulator to close out their position. They are therefore squeezed by the manipulator. Corners and squeezes normally occur where there is a large amount of short selling and where the short sellers are faced with costly sanctions if they default.<sup>2</sup> For this reason, corners and squeezes usually occur in futures markets. A famous example of a corner and squeeze involved Cargill, Inc. in May 1963. Cargill manipulated the price of the May wheat futures contract by first purchasing about 85% of

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<sup>1</sup> Fishel and Ross (1991), pg. 510.

<sup>2</sup> See Friedman (1990).

the deliverable supply of wheat, and then buying a large quantity of futures contracts (i.e. buying wheat for future delivery) - totalling about 62% of the long open interest. Most of this was bought on the last day of the May contract. Thus, the short sellers in the futures market, who sold contracts promising to deliver wheat, were faced with a squeeze on the contract's expiry date. They could not buy futures contracts to offset their position, nor could they find deliverable wheat to meet their obligations without inevitably having to deal with Cargill. The short sellers had to close out at \$ 2.285 per bushel. After the settlement was complete, cash wheat in the area of Chicago traded between \$ 2.03 and \$ 2.15. Thus, it was determined that Cargill had intended to squeeze the market, creating artificially high prices.<sup>3</sup> A corner and squeeze is an example of how monopoly power can be used to manipulate a market.

Manipulation can also occur through fictitious trades or by reporting false information. An example of a fictitious trade is a 'wash sale' where the trader trades between two accounts, creating the illusion of market activity. However, no actual change in ownership occurs. The intent is to deceive the market into believing that there is activity in a stock when there really is not, inducing others to trade on false market information. Manipulation is also said to occur when a trader takes a position in a security and then starts false rumours in order to move the security price in a favourable direction. These types of manipulation can be viewed as forms of fraud and treated as such.

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<sup>3</sup> See Easterbrook (1986) and Edwards and Edwards (1984).

Trade-based manipulation, on the other hand, consists of legitimate trades which result in the movement of prices even though there is no new information to affect the security's price. The manipulator is able to make profits either through his market power or by convincing others in the market that he may be informed. For example, a trader may buy a large portion of Company Z's shares. Others in the market may think that this trader knows something good about Company Z and they will then bid the share price up further. The trader then sells out his position before the others in the market realize that no good news is forthcoming. Thus, he is able to make a profit by misleading the other market participants. As we will discuss later in section III, trade-based manipulation is difficult to verify and prosecute; thus, preventive measures such as random trading halts may be more effective than a threat of a lawsuit after the fact.

## **II. Costs of Manipulation**

The manipulation of security prices interferes with the normal functioning of the market and can impose many different costs. Unfortunately, many of these costs are almost impossible to measure. It is however useful to understand these costs in order to make judgements concerning their magnitude or importance.

Since a manipulator does not have any valuable information when he trades, he can drive the price away from its true value causing an artificial price to exist. One social cost created by the existence of a manipulator stems from the artificial prices which manipulation produces. Companies and investors that make investment and portfolio decisions based on

these artificial prices may allocate resources inefficiently. For example, suppose an increase in share price of a computer software company is taken as an indication of higher expected returns. This may cause greater investment in software than is economically warranted. Thus, manipulative activities can disrupt the allocative efficiency of a market. It is difficult, however, to measure the degree of inefficiency that artificial prices may cause. First, it is difficult to measure the degree of artificiality because we can not know for certain the true value of a security at any one time. Second, it is argued by Edwards and Edwards (1984) that, given the market knows the probability and consequences of manipulation, companies and investors who use prices in the futures market to predict future spot prices will be able to adjust their estimates correctly and will not be led to make inefficient decisions. "[O]nly when there are unanticipated changes in permanent futures prices, or when the probability of manipulation's occurring is unknown, will the price discovery function of futures markets be adversely affected."<sup>4</sup> Finally, artificial price changes caused by manipulation are usually short-lived. The manipulator does not stay in the market for very long as it can be costly to maintain the large position needed to deceive the market. These considerations suggest that artificial prices do not have a large effect on total welfare. However, in our model we will show that in certain instances manipulative activity can lead to sub-optimal decisions and inefficiencies.

Manipulation also increases the scepticism of the public as to the fairness of the market, decreasing the incentive to participate. Some investors will be forced to reduce their

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<sup>4</sup> Edwards and Edwards (1984), pg. 348.

trading or will stop trading altogether. This reduces the liquidity of the market for those who continue to trade, increasing the cost of investing. Furthermore, manipulation might increase the variance of security prices as manipulators add an extra source of noise. This will make forecasts by investors more uncertain. An increase in variance also may make it riskier to invest and trade; thus, market participants will demand higher returns to compensate them for the added risk if they are risk averse. This will then increase the costs of capital faced by firms. Our model will capture this increase in volatility and its impact on a risk averse investor's decision to invest.

Finally, the existence of manipulation in the futures market can decrease the correlation between the futures price and the spot price, making hedging less effective.<sup>5</sup> Futures prices must be adjusted for the extra risk attributable to manipulation. This weakens the relation between the spot price and the futures price.<sup>6</sup> In other words, manipulation can adversely affect the risk-shifting role of the futures markets.

All of these repercussions of manipulation make financial markets less useful to legitimate traders who will then have less incentive to enter. The thinner and less liquid markets will affect the investors' required rate of return, and the firms' costs of capital will be higher.

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<sup>5</sup> In Donaldson (1993), it is shown that if the increased variance of the futures price is matched by a change in the distribution of cash prices then the correlation between futures and spot prices will, in absolute terms, increase; however, the hedge ratio increases via a reduction in the cash position and therefore less is produced.

<sup>6</sup> See Easterbrook (1986).

### III. The Regulator

The role of the regulator in a securities market, as in other markets, is presumably to act in the public interest. Policies should encourage the efficient allocation of resources. Furthermore, a *fair* marketplace is seen as necessary in promoting allocative efficiency, on the grounds that a fair 'playing field' promotes confidence and encourages participation. In Canada, the securities industry is regulated at the provincial level. Although each jurisdiction has its own specific concerns, there are three goals which appear prevalent among all: "ensuring an efficient and competitive financial system; protecting depositors; and encouraging the development of financial institutions under their own particular jurisdictions."<sup>7</sup> Thus, it appears that the regulator has a complicated task of setting policy which leads to the realization of all of these goals.

In the area of securities fraud and manipulation, the regulator is concerned with the loss of confidence in the marketplace which these activities may cause. The loss of confidence results in less participation, and inefficiencies can occur if investors pass up valuable projects because of the possibility of being deceived by a manipulator. The regulator's role in this case is to limit the manipulator's effect on the market in the instances where his presence could potentially lead to market failure.

Given that manipulation impinges on the regulator's objective of allocative efficiency, a regulator will want to find a way of reducing the negative effects of

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<sup>7</sup> Coleman, William D., (1992), pg. 146.

manipulation. At the same time, the regulator must be conscious that too much intervention can stifle legitimate trading that enhances allocative efficiency. The optimal regulation will be such that the marginal social cost of intervening to prevent manipulation is equal to the marginal social benefits of preventing manipulation. Regulators have many ways of mitigating the practice of trade-based manipulation. The B.C. Securities Act strictly prohibits manipulation in section 41.1:

41.1 No person, directly or indirectly, shall engage in or participate in a transaction or scheme relating to a trade or acquisition of a security if the person knows or ought reasonably to know that the transaction or scheme  
*(a) creates or results in a misleading appearance of trading activity in, or an artificial price for, any security listed on a stock exchange in the Province,*  
(b) perpetrates a fraud on any person in the Province, or  
(c) perpetrates a fraud on any person anywhere in connection with the securities of a reporting issuer.<sup>8</sup>

However, it is difficult to detect trade-based manipulative activity because it rests with the intent of the trader.<sup>9</sup> Edwards and Edwards (1984) discuss 3 conditions which appear to be necessary in successfully prosecuting manipulative activity. First, there must be proof that the activity resulted in artificial prices. Unfortunately, there does not appear to be a good, workable definition of what constitutes artificial prices. Second, the alleged manipulator's actions must be shown to have caused the artificial price. In another words, the manipulator's position must be large enough to affect the market price. And third, the alleged manipulator must have intended to create the artificial price. It is not easy to determine if a trader is manipulating an asset price or if he is speculating on special

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<sup>8</sup> B.C. Securities Commission, consolidated Nov. 8, 1991, Section 41.1. Emphasis added.

<sup>9</sup> See Fischel and Ross (1991).



information or subjective views which he might have on the supply and demand of the asset. Furthermore, it could be that a trader has not intended to manipulate the market but his actions are mistakenly interpreted by others as manipulative. Since the actions of a trader accused of being a manipulator can be interpreted in many ways, this final condition can be the most difficult to prove. Thus, given the difficulty of prosecuting trade-based manipulation, other means of regulation, such as preventive measures, are needed.

Disclosure requirements are used to attempt to ensure that material facts are publicized in a timely fashion. In addition, insiders must report their trades on a regular basis. This leaves less room for the manipulator to deceive the market. In the futures market they rely on position and daily price change limits. These reduce any effects that the manipulator might have on prices, and decrease the potential profit of short-term manipulation by limiting the size of the trades. However, these limits can be ineffective, especially, if they are not coordinated across the various markets on which a security is listed.<sup>10</sup>

Exchanges also monitor price and volume changes, halting trade in the event of unusual behaviour. If the trading of a share is halted the exchange will require the company to explain the unusual behaviour. The company might then respond with previously-unreleased information or with a statement that it knows of no information that would cause

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<sup>10</sup> See Kyle, Albert S., (1988).

such movement. Halts give the market time to digest any information and allow participants to return to trading that is more orderly and informed.

Although trading halts might mitigate manipulation, they also create costs for the market. Gerety and Mulherin (1992) empirically studied trading activity around the daily opening and closing of markets. They found that there was a symmetry between the trading volume at the close of day 1 and the opening of day 2. This implies that some traders do not prefer the risk of holding a position overnight when the market is closed. The result suggests that trading halts might impose costs on these investors as the closure of the market creates too much uncertainty for them. It may force some investors to hold positions longer than desired. Furthermore, if the decision rule regarding trading halts is predictable by investors then it may lead to overreaction by market participants. A halting rule might trigger 'panic' selling as investors try to trade before the halt. This may lead to a less stable trading environment. Optimal regulation has to consider the possible costs of using trading halts.

#### **IV. Models of Manipulation Profitability**

Recently, there have been several studies on the profitability of trade-based manipulation. These studies approach the problem from different angles, consider different markets, and reach differing conclusions. Some argue against the profitability of manipulation, while others use models to derive conditions under which a manipulator's actions can be profitable. In most of the models, the manipulator tries to take advantage of

the presence of asymmetric information where one agent is unsure about another agent's identity or level of information. It is usually assumed that the manipulator disguises himself as an informed trader in order to deceive the market.

Fischel and Ross (1991) argue that successful trade-based manipulation is difficult, if not impossible, to achieve. First, they suggest that manipulation is self-defeating because just the possibility of manipulation can lead to thinner markets and increased costs associated with decreased liquidity. The cost of liquidity is the premium one pays in order to trade immediately. It is usually charged by the market maker who takes on a position without immediate prospects of closing it out. For the risk she takes, she requires a reward. The bid-ask spread reflects this cost. Because of liquidity costs, a manipulator must pay a relatively higher price to buy and a relatively lower price to sell which cuts into his profits. In order for manipulation to be profitable, the price movement caused by the manipulator must be large enough to compensate for this cost. Thinly traded shares are more easily manipulated because relatively small changes in supply or demand can cause price movement. Yet, the more thinly traded a security the higher its cost of liquidity and the larger its bid-ask spread.<sup>11</sup> Therefore, one will offset the other and profits may be negligible. Second, Fischel and Ross argue that the manipulator's trading strategy cannot be profitable in the long run. In other words, the long run equilibrium does not include profitable manipulative activity. A manipulator must appear to have information when buying in order that others take his lead and bid the share price up further after he has

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<sup>11</sup> See Fischel and Ross (1991).

bought. When he wants to collect his profits he must then convince the market that he is not informed to prevent others from selling with him and driving the price down before he gets a chance to close his position. He must disguise himself as an informed trader when creating his position and then convince the market that he is uninformed when he unwinds his position. The authors suggest that in an anonymous market it is unlikely that a manipulator can achieve this goal without expending a large amount of capital. Unfortunately, these arguments are not modelled rigorously and thus their plausibility is hard to evaluate.

As if responding to the second argument of Fischel and Ross, Gastineau and Jarrow (1991) suggest that the manipulator can make profits by taking advantage of "differences in intertemporal price sensitivity attributable to noise traders following positive-feedback (trend-following) investment strategies."<sup>12</sup>

Jarrow (1992) extends this result. He defines a large trader as one whose trades affect prices, either because he has market power or because others believe that he might be informed. The large trader is considered a manipulator if his trades are not based on any information.<sup>13</sup> Thus, the model relies on a level of asymmetric information which allows the manipulator to hide his identity from the market. Jarrow focuses on market manipulation trading strategies in a market which is frictionless and where the price process is stochastic but functionally related to the trades of the large trader. In this setting, there are trading

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<sup>12</sup> Gastineau and Jarrow (1991), pg. 40.

<sup>13</sup> Jarrow (1992) ignores the possibility of the large trader (e.g. a pension fund) trading for liquidity reasons.

strategies where profits are earned at no risk. In other words, the market manipulation trading strategies are arbitrage opportunities. One such strategy involves the manipulator creating a trend. He buys more and more of the security, increasing its price and creating a bubble. He then closes out his position before the trend collapses (i.e. he sells out at the top). This strategy requires that the way prices change is affected by the speculator's actions. Jarrow concludes that profitable manipulation is possible if the price process depends on the past sequence of the large trader's holdings and not on his aggregate holdings.

In another study of trade-based manipulation, Kumar and Seppi (1992) use a two-market model consisting of a spot market and a futures market. They show that manipulation is profitable if the futures account can be closed out by cash settlement and the spot price can be manipulated. Cash settlement in this model is important because it makes the futures market infinitely liquid so that corners and squeezes are highly unlikely. In comparison, the spot market is less liquid and therefore spot prices will be affected by trade. By manipulating the spot price once a futures position is taken it is believed that one can improve the settlement price. As long as the futures position is larger than the spot position, a net profit can result.

The model of Kumar and Seppi consists of the manipulator, noise traders who trade in both markets independently, an informed trader who trades in the spot market, and a market maker who sets prices in order to break even. At time 1, the manipulator and noise

traders trade in the futures market. At time 2, the manipulator, noise traders and informed trader trade in the spot market. At time 3, the futures contract is deliverable. At time 4, the liquidating dividend is announced and paid out. The manipulator can pool with the noise traders in the futures market and with the informed trader in the spot market. Thus, the market maker cannot be sure of the extent to which the manipulator is in the market. The manipulator can then manipulate the price in the spot market as the other participants will not know whether or not he has information. The artificial price in the spot market will allow for a more favourable settlement price in the futures market. Given that his futures position is larger than his spot position the manipulator will earn profits.<sup>14</sup> This model also hinges on the fact that the manipulator can disguise himself in both markets, thereby taking advantage of asymmetric information.

Allen and Gale (1992) show that a manipulator can make a profit in an asset market as long as the other investors believe that there is a possibility that he may be informed. The model is three periods long with one consumption date at the end. It involves the possibility of a large trader buying a portion of the asset at time 1 and selling it at time 2. This large trader may be either an informed trader or a manipulator. Given that he is informed it is assumed that news will be released at a later date. A critical assumption of the model is that bad news will be announced earlier than good news. This is modelled by assuming that if the news is bad it is announced at time 2, otherwise good news is announced at time 3.

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<sup>14</sup> Kumar and Seppi (1992) suggest that the manipulator's profits can be restricted by price discreteness, position limits, and margin requirements. Furthermore, the manipulator's profits or utility are negatively related to the number of manipulators in the market and the degree of risk aversion by the manipulator.

There are two levels of payoff possible at time 3, low ( $L$ ) and high ( $H$ ). If the large trader is the manipulator then no news will be revealed and the payoff will be  $L$ . If the large trader is the informed trader and bad news is announced at time 2 then the final payoff will also be  $L$ . Given the informed trader has entered, if no news is announced at time 2 then good news will be announced at time 3 and the payoff will be  $H$ . Finally, if no large trader enters the final payoff is assumed to be  $L$ . The pooling equilibrium occurs when a large trader enters the market, and continues at time 2 if no announcement is made. Under this circumstance, the small investors are faced with asymmetric information as they do not know if the large trader is informed or is a manipulator. The price increases between time 1 and 2 because there is some resolution of uncertainty. If no news is announced at time 2 then the small investors know that if it is the informed trader, only good news will be forthcoming - bad news would have been revealed at time 2. Unfortunately, there is still some uncertainty because the small investors might be dealing with the manipulator in which case no news will be forthcoming at time 3.

The small investors are willing to sell the asset even though it may be below the value expected by the large trader for several reasons. First, they are uncertain as to whether the large trader is informed or manipulating the market. Second, if the large trader is informed there is still the possibility that his information may be wrong and that bad news will be revealed. And third, the small investors are more risk averse than the large trader. The manipulator is able to make a profit when the small investors are sufficiently risk averse and the probability of manipulation is sufficiently small.

The majority of these studies demonstrate the importance of the manipulator masquerading as an informed trader. Asymmetric information is therefore a necessary condition for profitable manipulation. Asymmetric information occurs when one agent does not know the quality of another agent's information or does not know the true identity of the other agent. For example, asymmetric information exists when an uninformed agent, trading with an informed agent, does not know the quality of the informed agent's information about a security's payoffs. Or it may be the case that the uninformed agent does not know who he is trading with; it may be an informed agent or another uninformed agent. Traders with different information sets may value an asset differently and therefore may be willing to take different sides of the market. The noise created by the difference in knowledge allows prices to slowly reveal an informed trader's information; thus, he is able to profit from his information. Grossman and Stiglitz (1980) argue that if prices did reflect all costly information then informed traders would not be compensated for acquiring the information and would therefore prefer to be uninformed. Without informed traders prices would be very slow in moving toward their true values and markets would be less efficient in allocating resources. However, in addition to encouraging manipulation, asymmetric information can impose costs on other market participants.

Even without manipulators, small investors may be harmed by asymmetric information. They are at a disadvantage against the informed trader and will tend to lose more often if they trade with the informed trader. The 'adverse selection' cost, identified by Kyle and others, will drive some of the uninformed out of the market making it less



liquid and more costly for the traders who must trade for liquidity reasons. Thus, the regulator is faced with a trade off. On one hand, keeping markets open facilitates the incorporation of information into prices. On the other hand, the asymmetric information gives the informed trader an unfair advantage which makes trading or investing by the uninformed and liquidity traders more costly. Any resulting transfers of wealth from one market participant to another create distributive concerns. However, the existence of asymmetric information may cause allocative losses as well.

Several papers have looked at the trade off between insiders or informed traders and outsiders. Ausubel (1990) argues against insider (informed) trading stating that insider activity causes loss of confidence by outsiders who will reduce their investment. This lost investment more than offsets the insider's profits. He concludes that both parties are made better off if the insiders can credibly promise not to trade on their information. In contrast, Leland (1992) argues that the impact of insider trading is uncertain. He shows that allowing insider (or informed) trading leads to higher, more informative stock prices and a higher level of real investment. However, the presence of insiders reduces liquidity and causes welfare losses for outside investors and liquidity traders. The effect on total welfare will depend on various factors present in the economy. For example, total welfare will likely increase if the information held by the informed trader affects production decisions as well as the stock price. Bernhardt, Hollifield and Hughson (1992) also show that the net welfare effect depends on the type of information held by the insider. Outsiders will tend to stay away from securities that appear to be heavily traded by insiders causing portfolio distortion;

however, the insiders' information could be useful in making future real investment decisions and should be reflected in the security price. The authors conclude that losses from portfolio distortion may be offset by improved efficiency of real investment due to more informative prices. Furthermore, the authors show that when insider trading has little impact on long-term real investment decisions it is far less beneficial to society.

Of course, the net effect on welfare created by asymmetric information is only further complicated when the market must also contend with a manipulator. The regulator is now faced with a three-way trade-off. In one corner, the informed trader may add value to society by enhancing allocative efficiency. In another corner, the manipulator reaps profits from the presence of asymmetric information, while reducing market efficiency. Finally, in the third corner, the small, uninformed investors and the liquidity traders are harmed by the possible presence of both.

## **V. Conclusion**

To date there have been studies of the profitability of manipulation in the financial literature and discussions on the difficulties of defining and regulating manipulation in the legal literature. However, there does not appear to be any attempt to model the trade-offs faced by a regulator who must contend with manipulation. In the following chapter, we consider a model where the existence of trade-based manipulation can lead to a less efficient use of resources. Due to the noise he creates, the manipulator can discourage capital formation. Our model demonstrates how a regulator can reduce this noise through trading

halts which allow the revelation of the asset's true value before the manipulator is allowed to close his position. However, trading halts do create illiquidity costs and these must be weighed against the benefits derived from halts when a regulator sets policy.

## Chapter 2

### Model of Trade-Based Manipulation and Trading Halts

#### I. The Model<sup>15</sup>

In this chapter, we model a market where there is a possibility of trade-based manipulation. The framework we use is similar to that of Allen and Gale (1992). There are 3 categories of market participants: the small investors who are risk averse and uninformed, the large trader who is risk neutral and either informed or uninformed (i.e. the manipulator), and the regulator.

There is a riskfree project with a rate of return normalized to zero, and a risky project. Both projects require the same investment of capital at the beginning. While the riskfree project has a certain payoff at the end, the risky project pays out an uncertain liquidating dividend,  $V_q$ , where  $q \in \{H, L\}$ ,  $V_H > V_L$ .

The model has 3 trading periods and one consumption date at the end. At time 0, the small investors decide whether to invest their endowed capital in a risky project or a riskfree project. If the small investors decide to invest in the risky project then Nature chooses the type of large trader they will face. At time 1, given the small investors do invest in the risky project, the large trader (either informed or uninformed) decides whether or not to buy shares of the project from the small investors. At time 2, the regulator, observing a purchase of shares at time 1, decides whether or not to halt trading in order to

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<sup>15</sup> The variables defined below are also listed in Appendix A.

reveal information and perhaps to unmask the manipulator. If the regulator does not halt trading then the large trader is free to sell his shares back to the small investors at time 2. Otherwise, he must wait until time 3 to close his position. The effect of a halt is to eliminate the potential gain from a trade by the uninformed trader or manipulator.

If the informed trader is chosen and the project's payoff is  $L$  then this is announced at time 2. On the other hand, if the project's payoff is  $H$  it will not be announced until time 3. When the uninformed trader is chosen the project's type is not revealed until time 3. At time 3, the project pays a liquidating dividend. See Appendix B for a tree diagram of the game.

Given the small investors choose the risky project, the motivation for trade is as follows. At time 1, there is risk with regards to the type of large trader that is chosen by Nature and the uncertainty of the final payoffs. The small investors are willing to sell to the large trader in order to unload some of this risk, and the large trader is willing to buy to collect a risk premium. At time 2, the informed trader wants to sell because he is faced with an illiquidity cost if he waits until time 3.<sup>16</sup> The large uninformed trader is able to hide his identity by mimicking the informed trader; therefore, he wants to sell at time 2 while his identity is still unknown. The small investor is willing to buy back at time 2 because some of the uncertainty will have been resolved. So at time 1, a risk premium drives the exchange in one direction while at time 2, a liquidity premium drives a reversal of trade.

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<sup>16</sup> This illiquidity cost will be discussed in greater detail later.

## II. The Small Investors

The small investors are risk averse. Because they are homogeneous we can treat them as one investor. The representative small investor is endowed with capital at the beginning of the game. At time 0, he must decide whether to invest this capital in a risky project or a riskfree project. The small investor makes his decision by comparing his expected utility from investing in the risky project with that of the riskfree project.

## III. The Large Trader

At time 0, Nature chooses the type of large trader that the small investor will face if he decides to invest in the risky project. The large trader is risk neutral and his type is denoted by  $t \in T = \{I, U\}$ , where  $I$  indicates the informed trader and  $U$  indicates the uninformed trader or the manipulator. The type,  $t$ , is chosen according to an exogenous probability distribution on  $T$ . Let  $\Theta$  denote the probability that the informed trader is chosen, and  $(1-\Theta)$  denote the probability that the uninformed trader is chosen, where  $\Theta \in (0, 1)$ . This distribution is common knowledge.

The large trader maximizes his expected utility by selecting a strategy  $b(t)$ , the probability of issuing a buy order for a proportion  $B$  of the project at time 1. We assume that  $b(t) \in [0, 1]$  so that both mixed and pure strategies are allowed. The proportion,  $B$ , is exogenously chosen and lies between 0 and 1.<sup>17</sup>

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<sup>17</sup> This implies that short-selling is not allowed.

It is assumed that the informed trader is informed about good news regarding the risky project. Let  $\tau^I$  denote the conditional probability of a high state occurring given a large trader of type  $t$ , or  $\tau^I = \text{prob}(H \mid t)$ . Thus,  $\tau^I$  and  $\Theta$  are related. In this model we assume:

$$\tau^I = \begin{cases} \tau^I = 0.9 & \text{with probability } \Theta \\ \tau^U = 0.5 & \text{with probability } 1-\Theta. \end{cases}$$

Given that investment in the risky project occurs, the small investor does not observe which large trader enters and therefore does not observe  $t$  directly. Therefore, at time 0, before the purchase decision of the large trader is made, he only knows that the probability of a high state occurring is equal to:

$$\Theta \tau^I + (1-\Theta) \tau^U.$$

On the other hand, when the uninformed trader enters the market he *does know* that there is no informed trader and that  $\tau^I = \tau^U = 0.5$ . He is therefore more informed than the small investor. However, the uninformed trader has less precision than the informed agent. For example, if  $H = 20$  and  $L = 10$  then the conditional variance of the risky project's final payoffs for the informed trader would be:

$$\begin{aligned} \text{Var}[\text{Payoff} \mid \text{Informed Trader}] &= \\ 0.9 (20 - 19)^2 + 0.1 (10 - 19)^2 &= 9.0. \end{aligned}$$

On the other hand, the conditional variance of the risky project's final payoffs for the uninformed trader would be:

$$\text{Var}[\text{Payoff} \mid \text{Uninformed Trader}] =$$

$$0.5 (20 - 15)^2 + 0.5 (10 - 15)^2 = 25.0.$$

The variance of the final payoffs is lower for the informed trader than for the uninformed trader; therefore, the informed trader has more precision.

We assume that the informed trader faces illiquidity costs. If he buys at time 1 then he will want to sell at time 2 for reasons that are exogeneous to the model. If he cannot sell at time 2, then he must bear a cost,  $w$ , for having to wait until time 3 to sell. We discuss the implications of this cost in chapter 4.

As was discussed previously, *given that an informed trader is chosen by Nature*, if the project is of type  $L$  then bad news will be announced at time 2, instead of time 3. If the project is of type  $H$  it will not be announced until time 3. Therefore, the actions of the informed trader force some information to be revealed early. If we were to assume that the uninformed trader never buys at time 1 (i.e.  $b(U) = 0$ ), and we witness a purchase by the large trader at time 1, then we will know that it is the informed trader, and therefore at time 2 we will know the final payoff of the project. If no news is announced at time 2 it will automatically be known that good news will be announced at time 3.

However, if the uninformed trader does buy with probability  $b(U) > 0$  then there will be extra noise in the market. If no news is announced at time 2, there are now 2 possibilities: either the large trader is informed and good news will be announced at time 3



or the large trader is uninformed and the outcome of the project is still uncertain and will only be resolved at time 3.

#### **IV. The Regulator**

Like the small investor, the regulator does not know the identity of the large trader. If the large trader buys at time 1, then the regulator decides to halt trading at time 2 with probability  $\pi$ , where  $\pi \in [0,1]$ . The regulator chooses  $\pi$  with her specific objectives in mind. In this model, we assume that her objective is to promote economic efficiency. We might conceptualize this by examining the maximization of the sum of the expected utilities. Although a trading halt results in the uninformed trader or manipulator being revealed, it also imposes a cost on the informed trader who is impatient to close his position. The informed trader does not like the illiquidity created by the halt. Thus, the regulator faces a trade-off between the benefits derived from revealing the manipulator and the costs imposed on the informed trader.<sup>18</sup>

#### **V. The Equilibrium Prices and the Final Payoffs**

If, at time 1, the small investor decides to invest in the risky project, then the large trader must decide whether or not to buy a proportion,  $B$ , of the project. We assume that the price at which the large trader buys the share,  $P_1$ , is determined from the first order condition of the maximization of the small investor's expected utility (i.e. an equilibrium price is chosen). In other words:

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<sup>18</sup> In chapter 4, we discuss the impact of imposing illiquidity costs on the small investor.

$$P_1 = \frac{E[U'(W_s | \text{Risky Project, Buy}) V_s]}{E[U'(W_s | \text{Risky Project, Buy})]} \quad (2)$$

where,  $W_s$  is the final payoff of small investor in state  $s$ ,  $V_s$  is the liquidating dividend in state  $s$ , and

$s \in [\text{states given the small investor invests in the } \textit{risky} \text{ project, and the large trader } \textit{buys} \text{ at } t=1]$

or from Appendix B,  $s \in [U3...U6, I1...I4]$ .

For the informed trader,  $P_1$  is less than his expected value of the risky project. He knows that  $\tau^t = \tau^1 = 0.9$ ; however, the small investor does not know if the large trader is informed or uninformed, given that it is optimal for both large traders to trade at least some of the time. Therefore, his belief about the probability of the high state occurring is lower. For the small investor,

$$\begin{aligned} \text{Prob}(H | \text{Trade}) &= 0.9 \text{Prob}(\text{Informed} | \text{Trade}) + 0.5 \text{Prob}(\text{Uninformed} | \text{Trade}) \\ &= 0.9 \frac{\Theta b(I)}{(1-\Theta)b(U) + \Theta b(I)} + 0.5 \frac{(1-\Theta)b(U)}{(1-\Theta)b(U) + \Theta b(I)} \end{aligned}$$

which is less than 0.9 given:  $0 < \text{Prob}(\text{Informed} | \text{Trade}) < 1$ . Furthermore, because the small investor is risk averse, he is willing to sell for less at time 1 in order to pass on some of the risk from the project to the large trader.

If the large trader buys at time 1 then he will want to sell at time 2. The uninformed trader wants to sell at time 2, since the only way he can earn a profit is if the small investor still thinks that he might be informed, while the informed agent wants to sell at time 2 in order to avoid an illiquidity cost of  $w$ . We assume that  $w$  is large enough to persuade the informed trader to always want to sell at time 2. In chapter 4, we discuss what occurs if this is not the case.

At time 2, the regulator must decide whether or not to halt trading in order to reveal the project type. If she halts trading then there is no market activity at time 2 and everyone must wait until time 3 in order to liquidate their positions. Thus, there is no price at time 2 if the regulator halts trading.

If the regulator does not halt trading, then the large trader can close his position at time 2. If the large trader is informed and the project turns out to be of type  $L$  then it will be revealed at time 2 and the informed trader will have to sell his shares at  $L$ . However, if no news is announced at time 2 then the small investor will still not know who he is trading with. It may be the informed trader, in which case, the payoff will be  $H$ , or it may be the uninformed trader, in which case, the payoff will be either  $H$  or  $L$ . Thus, if no announcement is made at time 2, then the price that the large trader will sell at,  $P_2$ , will again be determined from the first order condition of the maximization of the small investors' expected utility. Thus,

$$P_2 = \frac{E[U'(W_s | \text{Risky Project, Buy, No Halt, No Announcement}) V_s]}{E[U'(W_s | \text{Risky Project, Buy, No Halt, No Announcement})]} \quad (4)$$

where  $W_s$  and  $V_s$  are defined as before, and

$s \in [\text{states given the small investor invests in the } \textit{risky project}, \text{ the large trader buys at } t=1, \text{ the regulator does } \textit{not} \text{ halt trading, and there is } \textit{no announcement} \text{ at } t=2];$

or from Appendix B,  $s \in [U5, U6, I1]$ .

If the uninformed trader never buys at time 1 (i.e.  $b(U)=0$ ), then at time 2,  $P_2$  will equal  $H$ . In our model,  $P_2$  will be greater than  $P_1$  because, for all strategies followed by the informed and uninformed traders, the lack of announced ‘bad news’ at time 2 provides favourable information.

In the event that the regulator does not halt trading, the large trader, given he buys at time 1, will liquidate at time 2, and only the small investor will liquidate at time 3. However, if the regulator halts trading at time 2 then the small investor and the large trader will have to liquidate at the project’s true value at time 3.

The final payoffs at time 3 for the uninformed trader, the informed trader and the small investor are as follows in Table 1. The states correspond exactly to those in the tree diagram in Appendix B.

**Table 1 - The Final Payoffs from the Risky Project**

State	t=0 Probability	Uninformed	Informed	Small Investor
U1	$(1-\Theta)(1-b(U))\tau^U$	0	0	H
U2	$(1-\Theta)(1-b(U))(1-\tau^U)$	0	0	L
U3	$(1-\Theta)b(U)\pi\tau^U$	$(H-P_1)B$	0	$H + (P_1-H)B$
U4	$(1-\Theta)b(U)\pi(1-\tau^U)$	$(L-P_1)B$	0	$L + (P_1-L)B$
U5	$(1-\Theta)b(U)(1-\pi)\tau^U$	$(P_2-P_1)B$	0	$H + (P_1-P_2)B$
U6	$(1-\Theta)b(U)(1-\pi)(1-\tau^U)$	$(P_2-P_1)B$	0	$L + (P_1-P_2)B$
I1	$\Theta b(I)(1-\pi)\tau^I$	0	$(P_2-P_1)B$	$H + (P_1-P_2)B$
I2	$\Theta b(I)(1-\pi)(1-\tau^I)$	0	$(L-P_1)B$	$L + (P_1-L)B$
I3	$\Theta b(I)\pi\tau^I$	0	$(H-P_1)B - w$	$H + (P_1-H)B$
I4	$\Theta b(I)\pi(1-\tau^I)$	0	$(L-P_1)B - w$	$L + (P_1-L)B$
I5	$\Theta(1-b(I))\tau^I$	0	0	H
I6	$\Theta(1-b(I))(1-\tau^I)$	0	0	L

## VI. The Strategies and the Objective Functions

*The Small Investor:*

The small investor chooses between the two projects by comparing his expected utility from both. His expected utility from investing in the risky project is:

$$E_{SI}[Utility \mid Risky \ Project] = \sum_s \rho_s E[U(W_s)] \quad (5)$$

where  $\rho_s$  is the probability of state  $s$  occurring (as listed in Table 1),  $W_s$  is the final payoff of the small investor in state  $s$ , and  $s \in [U1...U6, I1...I6]$ . His expected utility from investing in the riskfree project is just the utility from the certain payoff. Therefore, if the payoff from the riskfree project at time 3 is  $Y$  then the small investor's expected utility from investing in the riskfree project is:

$$E_{st}[Utility | Riskfree Project] = U_{st}[Y]$$

Thus, the small investor will invest in the risky project if:

$$E_{st}[Utility | Risky Project] \geq U_{st}[Y]$$

*The Large Trader:*

The large trader maximizes his expected utility by choosing a strategy,  $b(t)$ , the probability that he issues a buy order at time 1. Since he is risk neutral his utility function translates into his profit function. Thus, we get for the informed trader:

$$\begin{aligned} E_I[Profit] = & b(I) \left\{ (1-\pi) \left[ \tau^I (P_2 - P_1) B + (1-\tau^I) (L - P_1) B \right] \right. \\ & \left. + \pi \left[ \tau^I ((H - P_1) B - w) + (1-\tau^I) ((L - P_1) B - w) \right] \right\} \end{aligned} \quad (8)$$

And for the uninformed trader:

$$E_U[Profit] = b(U) \left\{ \pi \left[ \tau^U (H - P_1) B + (1 - \tau^U) (L - P_1) B \right] + (1 - \pi) (P_2 - P_1) B \right\} \quad (9)$$

*The Regulator:*

We assume the regulator's objective is to promote allocative efficiency by encouraging investment in the optimal project. However, at the same time, she must minimize the cost of intervening, which in this model is represented by the illiquidity cost,  $w$ .

In the next chapter, we demonstrate an instance where if the uninformed trader never enters, the small investor will want to invest in the risky project. However, if it is optimal for the uninformed trader to enter then the small investor will not want to invest in the risky project. Thus, the uninformed trader's actions affect the small investor's investment decision. The regulator wants to intervene if she can, by her actions, encourage the small investor to invest in the risky project once again. However, since the trading halts impose a cost on the informed trader the regulator must only intervene to the point where the small investor is indifferent between the 2 projects. In this way, the regulator minimizes the cost of trading halts,  $w$ , subject to the constraint of achieving investment in the optimal project.

The regulator's objective function might be viewed as the sum of the expected utilities of the 3 market participants. The regulator would then maximize this sum with respect to  $\pi$ . We might state this optimization problem as follows:

$$\text{Max}_{\pi} \Theta E_l[\text{Profit}] + (1 - \Theta) E_v[\text{Profit}] + E_{st}[\text{Utility}]$$

It is important to note that summing ordinal utilities may be inappropriate and therefore caution must be taken when interpreting the results. However, conceptualizing the problem in this way does reveal that the function is not continuous at the point where the small investor is indifferent between the 2 projects. If the small investor chooses the riskfree project then the large traders will have expected utilities equal to 0; however, when the small investor chooses the risky project then the large traders will have expected utilities greater than 0.

## **VII. Conclusion**

In this chapter, we have described a model which can be used to show the effect of manipulation on market participants. We have expanded on previous models by including a regulator whose objective is to mitigate any negative effects that a manipulator might have on a market. In the next chapter, we will use the model to demonstrate the trade-offs faced by a regulator who is faced with the possibility of trade-based manipulation, and we will solve for equilibria using a numerical example. In chapter 4, we will discuss further our assumptions, commenting on their importance to our results.



## Chapter 3

### Demonstration and Discussion of Model

#### I. An Example

In order to illustrate different equilibria for the model we present a numerical example. To begin let us assume that the exogenous variables are set such that:

$$H = 50 \qquad L = 10$$

$$B = 0.3 \qquad \Theta = 0.9$$

$$\tau^I = 0.9 \qquad \tau^U = 0.5$$

$$w = 3.0134$$

$$\text{Payoff at time 3 of Riskfree Project} = Y = 40.5$$

Expected Payoff of Risky Project at time 0:

$$\begin{aligned} &= \Theta[\tau^I H + (1-\tau^I)L] + (1-\Theta)[\tau^U H + (1-\tau^U)L] \\ &= 44.4 \end{aligned}$$

Furthermore, we assume that:

$$U[W] = \text{utility function of small investors} = \ln(W)$$

$$U'[W] = \text{marginal utility} = 1/W$$

(1)

In order to provide a benchmark, consider first the possibility that the regulator never halts trading, i.e.  $\pi = 0$ . We will also assume that the uninformed trader never buys at time

1 or that  $b(U) = 0$ <sup>19</sup>, and that these constraints are common knowledge. Given the small investor decides to invest in the risky project, the final payoffs at time 3 for the informed trader and the small investor are presented in Table 2.

**Table 2 - Final Payoffs to the Informed Trader and the Small Investor**

State	t=0 Probability	Informed	Small Investor
U1	0.05	0	50
U2	0.05	0	10
I1	$0.81b(I)$	$0.3(P_2 - P_1)$	$50 + 0.3(P_1 - P_2)$
I2	$0.09b(I)$	$0.3(10 - P_1)$	$10 + 0.3(P_1 - 10)$
I5	$0.81(1 - b(I))$	0	50
I6	$0.09(1 - b(I))$	0	10

(i) In this example, it is easy to solve for  $P_2$ . If the large trader buys at time 1, then he must be the informed trader (since we have set  $b(U) = 0$ ). Given he buys at time 1, if no announcement is made at time 2 then the small investor will know for sure that good news will be announced at time 3 and will therefore set  $P_2 = H = 50$ . If bad news is announced at time 2 then the large trader will have to sell at  $L = 10$ .

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<sup>19</sup> This corresponds to a world in which there are no manipulators. However, Nature still decides  $\tau^l$ . The informed trader only participates if  $\tau^l = \tau^l$ .

(ii) To solve for  $P_1$  we use the first order condition of the maximization of the small investor's expected utility in order to find the equilibrium price. In this example,

$$P_1 = \frac{0.9 U' [50 + (P_1 - 50)0.3]50 + 0.1 U' [10 + (P_1 - 10)0.3]10}{0.9 U' [50 + (P_1 - 50)0.3] + 0.1 U' [10 + (P_1 - 10)0.3]} \quad (11)$$

$$= 41.4677.$$

(iii) Next, the informed trader, if he is chosen by Nature, will maximize his expected profit with respect to  $b(I)$ :

$$\begin{aligned} \text{Max}_{b(I)} E_I[\text{Profit}] &= b(I) \left[ \tau^I (P_2 - P_1)B + (1 - \tau^I) (L - P_1)B \right] \\ &= b(I) [0.9(50 - 41.4677)0.3 + 0.1(10 - 41.4677)0.3] \quad (12) \\ &= 1.3597b(I) \end{aligned}$$

Therefore,  $b^*(I) = 1$ . Every time the informed trader is chosen by Nature, he will buy proportion  $B$  of the asset at time 1. The expected profit of the informed trader is:

$$E_I[\text{Profit} \mid b^*(I) = 1] = 1.3597.$$

(iv) If the small investor invests in the risky project then his expected utility will be:

$$\begin{aligned}
E_{st}[Utility | Risky Project] &= 0.05 U[50] + 0.05 U[10] \\
&+ 0.81 U[50 + 0.3(41.4677 - 50)] \\
&+ 0.09 U[10 + 0.3(41.4677 - 10)] \quad (13) \\
&= 3.7040
\end{aligned}$$

The expected payoff of the small investor given he invests in the risky project is 43.1763, while the variance of his payoff is 122.7945.

If the riskfree project pays out 40.5, the small investor's expected utility from investing in the riskfree project would be 3.701302. Thus, in this instance, the small investor obtains a higher expected utility if he invests in the risky project, and therefore, he will choose the risky project. Also, the informed trader's expected utility or profit goes from zero if no investment in the risky project is made, to 1.3597 if the risky project is undertaken. Hence, in the absence of a manipulator wealth-increasing trade takes place.

(2)

We will now consider the existence of the uninformed trader or manipulator; however, we will still assume that the regulator never halts trading (or  $\pi=0$ ). The final payoffs become more complicated when we include the uninformed trader. They are presented in Table 3.

**Table 3 - Final Payoffs Given Presence of Uninformed Trader**

State	t=0 Probability	Uninformed	Informed	Small Investor
U1	0.05(1-b(U))	0	0	50
U2	0.05(1-b(U))	0	0	10
U5	0.05b(U)	0.3(P <sub>2</sub> -P <sub>1</sub> )	0	50+0.3(P <sub>1</sub> -P <sub>2</sub> )
U6	0.05b(U)	0.3(P <sub>2</sub> -P <sub>1</sub> )	0	10+0.3(P <sub>1</sub> -P <sub>2</sub> )
I1	0.81b(I)	0	0.3(P <sub>2</sub> -P <sub>1</sub> )	50+0.3(P <sub>1</sub> -P <sub>2</sub> )
I2	0.09b(I)	0	0.3(10-P <sub>1</sub> )	10+0.3(P <sub>1</sub> -10)
I5	0.81(1-b(I))	0	0	50
I6	0.09(1-b(I))	0	0	10

(i) If the small investor decides to invest in the risky project, then the large trader will again maximize his expected profit. In this case, the informed trader will maximize with respect to  $b(I)$ , and the uninformed trader will maximize with respect to  $b(U)$ .

$$\begin{aligned}
 \text{Max}_{b(I)} E_I[\text{Profit}] &= b(I) \left[ \tau'(P_2 - P_1)B + (1 - \tau')(L - P_1)B \right] \\
 &= b(I) [0.9(P_2 - P_1)0.3 + 0.1(10 - P_1)0.3]
 \end{aligned}$$

$$\begin{aligned}
 \text{Max}_{b(U)} E_U[\text{Profit}] &= b(U)(P_2 - P_1)B \\
 &= b(U)(P_2 - P_1)0.3
 \end{aligned}$$

where:

$$P_2 = \frac{\Gamma_{us} U' [W_{us}] 50 + \Gamma_{u6} U' [W_{u6}] 10 + \Gamma_{II} U' [W_{II}] 50}{\Gamma_{us} U' [W_{us}] + \Gamma_{u6} U' [W_{u6}] + \Gamma_{II} U' [W_{II}]}$$

$$\Gamma_{us} = \frac{(1 - \Theta) b(U) \tau^u}{(1 - \Theta) b(U) + \Theta b(I) \tau^I} = \frac{0.05 b(U)}{0.1 b(U) + 0.81 b(I)}$$

$$\Gamma_{u6} = \frac{(1 - \Theta) b(U) (1 - \tau^u)}{(1 - \Theta) b(U) + \Theta b(I) \tau^I} = \frac{0.05 b(U)}{0.1 b(U) + 0.81 b(I)}$$

$$\Gamma_{II} = \frac{\Theta b(I) \tau^I}{(1 - \Theta) b(U) + \Theta b(I) \tau^I} = \frac{0.81 b(I)}{0.1 b(U) + 0.81 b(I)}$$

$$P_1 = \frac{\Delta_u \{ \tau^u U' [W_{us}] 50 + (1 - \tau^u) U' [W_{u6}] 10 \} + \Delta_I \{ \tau^I U' [W_{II}] 50 + (1 - \tau^I) U' [W_{I2}] 10 \}}{\Delta_u \{ \tau^u U' [W_{us}] + (1 - \tau^u) U' [W_{u6}] \} + \Delta_I \{ \tau^I U' [W_{II}] + (1 - \tau^I) U' [W_{I2}] \}}$$

$$\Delta_u = \frac{(1 - \Theta) b(U)}{(1 - \Theta) b(U) + \Theta b(I)} = \frac{0.1 b(U)}{0.1 b(U) + 0.9 b(I)}$$

$$\Delta_I = \frac{\Theta b(I)}{(1 - \Theta) b(U) + \Theta b(I)} = \frac{0.9 b(I)}{0.1 b(U) + 0.9 b(I)}$$

and  $W_s$  is the final payoff of the small investor in state  $s$ .  $\Gamma_s$  is the conditional probability that state  $s$  occurs given the large trader buys at time 1, the regulator does not halt trading at time 2, and no announcement is made at time 2.  $\Delta_t$  is the conditional probability that the large trader  $t$  buys at time 1, given a large trader buys at time 1.

In this example we must solve for  $b(U)$ ,  $b(I)$ ,  $P_1$  and  $P_2$  simultaneously. We get:

$$b^*(U) = 1,$$

$$b^*(I) = 1,$$

$$P_1 = 34.5889,$$

$$P_2 = 39.9553.$$

Both the uninformed and the informed trader will always want to buy at time 1 when they are chosen by Nature. The prices are lower than if the uninformed trader never entered because the small investor cannot distinguish between the two large traders. In part (1) above, if the large trader bought at time 1 then the small investor knew immediately that the informed trader was chosen and that  $\tau^I = \tau^I = 0.9$ . Furthermore, if the large trader did not buy at time 1, then the small investor knew that  $\tau^I = \tau^U = 0.5$ . Thus, in part (1), the small investor could update his belief about  $\tau^I$  at  $t=1$ . However, with the possible existence of the uninformed trader the small investor is now unsure of who he is dealing with. He cannot update his beliefs about  $\tau^I$  as accurately at time 1. If no announcement is made at time 2, then the small investor will still be uncertain (although he will be able to eliminate some of the possible states). The uncertainty that exists with the possibility of the uninformed trader entering the market causes both prices to be lower. Since the uninformed trader tries to manipulate the market, the informed trader's actions are 'muddied'. The pooling which occurs slows down the price discovery process.

(ii) Given the above values, the expected profits of the large traders are:

$$E_I[\text{Profit}] = 0.7113,$$

$$E_U[\text{Profit}] = 1.6099.$$

Thus, the informed trader's expected profit decreases with the possible entrance of the uninformed trader (from 1.3597 to 0.7113). The expected final payoff of 44.4, now must be shared among three participants instead of two. Therefore, with the possible entrance of the uninformed trader, the expected profit is redistributed in favour of the uninformed trader.

(iii) The expected utility of the small investor given he invests in the risky project is now:

$$E_{si}[\text{Utility} \mid \text{Risky Project}] = 3.6995.$$

His expected payoff and variance of payoff are:

$$E_{si}[\text{Payoff} \mid \text{Risky Project}] = 43.5989$$

$$\text{Var}[\text{Payoff}_{si} \mid \text{Risky Project}] = 143.6092.$$

Comparing these results to those in part (1), we see that the expected payoff of the small investor increases, as does the variance of payoff. *The overall effect is that the expected utility of the small investor decreases.* Since the small investor is risk averse he is concerned about not only his expected return from the project but also about the higher moments associated with the expected return. The presence of the uninformed trader changes the distribution of the payoffs, adversely affecting the small investor's expected utility.

(iv) Before investing in the risky project the small investor will compare his expected utility from the risky project with that of the riskfree project. The small investor's utility from investing in the riskfree project is still 3.701302. *Therefore, the small investor will*



want to invest in the riskfree project if the uninformed trader sets  $b(U) = 1$  (i.e. if the uninformed trader always buys at time 1 when chosen by Nature). The uninformed trader's actions discourage the small investor from investing in the risky project. This results in a loss to the economy. Since the small investor does not invest in the risky project the expected profits of the large traders fall to zero. And for the small investor:

$$E_{SI}[\text{Utility} \mid \text{Riskfree Project}] = 3.701302$$

$$E_{SI}[\text{Payoff} \mid \text{Riskfree Project}] = 40.5$$

$$\text{Var}[\text{Payoff}_{SI} \mid \text{Riskfree Project}] = 0$$

The small investor is willing to decrease his expected payoff (from 43.5989 to 40.5) in return for a large decrease in variance (from 143.609 to 0). Looking at the market as a whole, the total expected payoff falls from:

$$0.9(0.7113) + 0.1(1.6099) + 43.5989 = 44.4$$

to 40.5. The total expected utility for this economy falls from:

$$0.9(0.7113) + 0.1(1.6099) + 3.6995 = 4.5007$$

to 3.7013. Thus, the equilibrium, resulting from the presence of the manipulator, involves investing in the sub-optimal project.

(3)

One way to convince the small investor to invest in the risky project is for the uninformed trader to reduce  $b(U)$ , the probability of buying at time 1, to the point where the small investor will once again be willing to invest in the risky project.<sup>20</sup> In this example,

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<sup>20</sup> However, we will show later that this strategy does not result in an equilibrium.

if the uninformed trader reduces  $b(U)$  to 0.51 then the small investor's expected utility from the risky project will increase to 3.701344, and he will want to invest in the risky project once again. The graph in Appendix C shows the relationship between  $b(U)$  and the small investor's expected utility.

- (i) The prices are calculated in the same way as in part (2) except that  $b(U)$  is fixed at 0.51.  $b(I) = 1$  still maximizes the informed agent's expected profits. And,

$$P_1 = 37.2640,$$

$$P_2 = 43.8259.$$

These prices are greater than those in part (2) because there is less chance that the uninformed trader will try to manipulate the market and therefore there is a higher probability that given the large trader buys at time 1 it is the informed trader.

- (ii) Under this scenario, the expected profits of the large traders are:

$$E_I[\text{Profit}] = 0.9538,$$

$$E_U[\text{Profit}] = 1.0040.$$

Since there is less chance that the uninformed trader will disguise himself as the informed trader, the informed trader's actions are more quickly reflected in the prices. Furthermore, the redistribution of payoff is not as large. The informed trader's expected profit is greater, while the uninformed trader's expected profit is less.

(iii) As stated above the small investor's expected utility from investing in the risky project increases to 3.701344. *However, we can show that this solution is not an equilibrium.* Once the small investor decides to invest in the risky project, the uninformed trader will want to defect from  $b(U) = 0.51$  to  $b(U) = 1$ . In this way, the uninformed trader can increase his expected profit from 1.0040 to 1.6099. However, the small investor will know before hand that the uninformed trader will want to defect and will therefore not invest in the risky project. The uninformed trader has no way of legitimately signalling that he will not defect. Thus, this solution is not an equilibrium and a regulator will be needed to ensure that the risky project is chosen.

#### (4)

In order to reach an equilibrium in which the risky project is chosen, we will need the intervention of the regulator. The regulator's objective is to maximize the total expected utility of the market participants. As we will see, in this example, the regulator can induce the small investor to invest in the risky project by setting the probability of trading halts,  $\pi > 0$ . The final payoffs to the market participants are presented in Table 4.

**Table 4 - Final Payoffs Given the Regulator May Halt Trading**

State	t=0 Probability	Uninformed	Informed	Small Investor
U1	$0.05(1-b(U))$	0	0	50
U2	$0.05(1-b(U))$	0	0	10
U3	$0.05b(U)\pi$	$0.3(50-P_1)$	0	$50+0.3(P_1-50)$
U4	$0.05b(U)\pi$	$0.3(10-P_1)$	0	$10+0.3(P_1-10)$
U5	$0.05b(U)(1-\pi)$	$0.3(P_2-P_1)$	0	$50+0.3(P_1-P_2)$
U6	$0.05b(U)(1-\pi)$	$0.3(P_2-P_1)$	0	$10+0.3(P_1-P_2)$
I1	$0.81b(I)(1-\pi)$	0	$0.3(P_2-P_1)$	$50+0.3(P_1-P_2)$
I2	$0.09b(I)(1-\pi)$	0	$0.3(10-P_1)$	$10+0.3(P_1-10)$
I3	$0.81b(I)\pi$	0	$0.3(50-P_1)-w$	$50+0.3(P_1-50)$
I4	$0.09b(I)\pi$	0	$0.3(10-P_1)-w$	$10+0.3(P_1-10)$
I5	$0.81(1-b(I))$	0	0	50
I6	$0.09(1-b(I))$	0	0	10

(i) Again, if the small investor decides to invest in the risky project then the large trader  $t$  will maximize his expected profit with respect to  $b(t)$ , given the optimal  $\pi$ . The objective functions of the large traders are as follows:

$$\begin{aligned}
 \text{Max}_{b(I)} E_I[\text{Profit}] &= b(I) \left\{ (1-\pi) \left[ \tau^I (P_2 - P_1) B + (1-\tau^I) (L - P_1) B \right] \right. \\
 &\quad \left. + \pi \left[ \tau^I ((H - P_1) B - w) + (1-\tau^I) ((L - P_1) B - w) \right] \right\} \\
 &= b(I) \left\{ (1-\pi) \left[ 0.9 (P_2 - P_1) 0.3 + 0.1 (10 - P_1) 0.3 \right] \right. \\
 &\quad \left. + \pi \left[ 0.9 (50 - P_1) 0.3 + 0.1 (10 - P_1) 0.3 - 3.0134 \right] \right\}
 \end{aligned}$$

$$\begin{aligned}
 \text{Max}_{b(U)} E_U[\text{Profit}] &= b(U) \left\{ \pi \left[ \tau^U (H - P_1) B + (1-\tau^U) (L - P_1) B \right] \right. \\
 &\quad \left. + (1-\pi) (P_2 - P_1) B \right\} \\
 &= b(U) \left\{ \pi \left[ 0.5 (50 - P_1) 0.3 + 0.5 (10 - P_1) 0.3 \right] \right. \\
 &\quad \left. + (1-\pi) (P_2 - P_1) 0.3 \right\}
 \end{aligned}$$

where:

$$P_2 = \frac{\Gamma_{U5} U' [W_{U5}] 50 + \Gamma_{U6} U' [W_{U6}] 10 + \Gamma_{I1} U' [W_{I1}] 50}{\Gamma_{U5} U' [W_{U5}] + \Gamma_{U6} U' [W_{U6}] + \Gamma_{I1} U' [W_{I1}]}$$

$$\Gamma_{U5} = \frac{(1 - \Theta) b(U) \tau^U}{(1 - \Theta) b(U) + \Theta b(I) \tau^I} = \frac{0.05 b(U)}{0.1 b(U) + 0.81 b(I)}$$

$$\Gamma_{U6} = \frac{(1 - \Theta) b(U) (1 - \tau^U)}{(1 - \Theta) b(U) + \Theta b(I) \tau^I} = \frac{0.05 b(U)}{0.1 b(U) + 0.81 b(I)}$$

$$\Gamma_{I1} = \frac{\Theta b(I) \tau^I}{(1 - \Theta) b(U) + \Theta b(I) \tau^I} = \frac{0.81 b(I)}{0.1 b(U) + 0.81 b(I)}$$

$$P_1 = \frac{\Delta_U [\pi (G_{U3} 50 + B_{U4} 10) + (1 - \pi) (G_{U5} 50 + B_{U6} 10)] + \Delta_I [\pi (G_{I3} 50 + B_{I4} 10) + (1 - \pi) (G_{I1} 50 + B_{I2} 10)]}{\Delta_U [\pi (G_{U3} + B_{U4}) + (1 - \pi) (G_{U5} + B_{U6})] + \Delta_I [\pi (G_{I3} + B_{I4}) + (1 - \pi) (G_{I1} + B_{I2})]}$$

$$G_m = \tau^I U' [W_m]$$

$$B_m = (1 - \tau^I) U' [W_m]$$

$$\Delta_U = \frac{(1 - \Theta) b(U)}{(1 - \Theta) b(U) + \Theta b(I)} = \frac{0.1 b(U)}{0.1 b(U) + 0.9 b(I)}$$

$$\Delta_I = \frac{\Theta b(I)}{(1 - \Theta) b(U) + \Theta b(I)} = \frac{0.9 b(I)}{0.1 b(U) + 0.9 b(I)}$$

and  $W_s$  is the final payoff of the small investor in state  $s$ .

The regulator will set  $\pi$  to maximize the total expected utility of the economy. The graphs in Appendix D show the relationships between  $\pi$  and the small investor's expected utility,  $\pi$  and the large traders' expected utilities or profits, and  $\pi$  and the sum of expected utilities. In this problem, we have to solve simultaneously for  $b(U)$ ,  $b(I)$ ,  $P_1$ ,  $P_2$ , and  $\pi$ . The maximization of the large traders' expected profits depend on  $\pi^*$ ; however,  $\pi^*$  also depends on the maximization of the large trader's expected profits, or  $b^*(I)$  and  $b^*(U)$ . In this example, we obtain the following solution:

$$\begin{aligned}\pi^* &= 0.18, \\ b^*(U) &= 1, \quad b^*(I) = 1, \\ P_1 &= 35.2944, \quad P_2 = 40.0820.\end{aligned}$$

(ii) The expected profits of the large traders are:

$$\begin{aligned}E_I[\text{Profit}] &= 0.4734, \\ E_U[\text{Profit}] &= 0.8918.\end{aligned}$$

The expected profit of the informed trader decreases as  $\pi$  increases because of the illiquidity cost,  $w$ , imposed on him by the halts. The uninformed trader's expected profit is lower because, given he buys at time 1, 18% of the time he will be revealed before he can close his position.

(iii) For the small investor:

$$\begin{aligned}E_{SI}[\text{Utility} \mid \text{Risky Project}] &= 3.701392 \geq U_{SI}[Y=40.5] \\ E_{SI}[\text{Payoff} \mid \text{Risky Project}] &= 43.3966\end{aligned}$$

$$\text{Var}[\text{Payoff}_{\text{st}} \mid \text{Risky Project}] = 135.2591.$$

(iv) This is an equilibrium as no one is tempted to defect. Given  $\pi=0.18$ , the large traders maximize their profits by setting  $b^*(U) = 1$ , and  $b^*(I) = 1$ , and the small investor receives a slightly higher expected utility by investing in the risky project. Although the increase in  $\pi$  causes the expected payoff of the small investor to decrease, it also causes the variance of payoff to decrease. Again, the risk aversion of the small investor means that the effect on the higher moments associated with the expected return are important to the small investor.

From this example, we have shown that the regulator can encourage capital formation through the use of trading halts when there is the possibility of trade-based manipulation in the market. The total expected utility increases from 3.7013 (when the riskfree project was chosen) to:

$$0.9(0.4734) + 0.1(0.8918) + 3.7014 = 4.2166.$$

However, there is a deadweight loss with the use of trading halts. Under this last scenario, the total expected payoff is now:

$$0.9(0.4734) + 0.1(0.8918) + 43.3966 = 43.9118.$$

Although, this is greater than the payoff from the riskfree project, 40.5, it is less than the original expected payoff of the risky project or 44.4. The loss comes from the cost,  $w$ , imposed on the informed trader for having to wait until time 3 to sell, and equals  $\Theta\pi w =$



0.4882. Thus, if the small investor is willing to invest in the risky project even with the possible presence of the uninformed trader then the regulator should not intervene in the market with trading halts, given her objectives are those stated above. If the regulator does set some level of trading halts in this instance, she is only imposing an unnecessary cost on the informed trader. Furthermore, because of the illiquidity cost that trading halts impose, the regulator will only want to intervene to the point where the small investor is indifferent between the 2 projects. The regulator's objective in this example does not coincide with driving the manipulator out of the market.

(5)

The preceding example, allows us to comment on another result from our model. If we were to assume that neither of the large traders ever bought at time 1 or that  $b(U) = b(I) = 0$ , then the small investor if choosing the risky project would not be able to share any of the risk. In this particular example, this would lead to the small investor investing in the riskfree project since investing in the risky project would result in an expected utility of 3.686702 which is less than that from the riskfree project. Although, the small investor would have an expected payoff of 44.4 from investing in the risky project, the variance of the payoff, 192.64, would be too high for the risk averse investor to bear. Thus, the existence of the informed trader helps lower the variance of the small investor's payoff. When the risk neutral informed trader trades with the small investor, he takes on some of the risk from the project which makes the small investor more willing to invest in the risky project.

## II. Discussion

A regulator who must contend with trade-based manipulation in the market must try to ensure that the manipulative activity does not discourage capital formation which is allocatively efficient. Thus, if an investor would invest in a project in the absence of manipulation but not in the presence of manipulation, then the manipulator's actions contribute to an inefficient allocation of resources. The regulator would then want to intervene in some way in order to discourage manipulation and encourage investment.

In our model, the presence of the manipulator (or  $b(U) > 0$ ) causes the expected utility of the small investor to be lower than in the absence of the manipulator. Since the small investor is risk averse, the noise created by the possible presence of the manipulator negatively affects the small investor's expected utility from investing in the risky project. In some cases the effect may be large enough to discourage the small investor from the risky project. Since there is no way for the manipulator to legitimately signal that he will limit his presence in the market in order to reduce the noise somewhat, the regulator will want to introduce the possibility of trading halts in order to discourage manipulation through decreased profits, and encourage investment through decreased noise. However, trading halts can impose illiquidity costs on some. In our model, the informed trader is harmed by trading halts. The regulator has to ensure that the informed trader does not want to leave the market because of the trading halts. If he does then the small investor might once again choose the riskfree asset since he cannot share the risk of the risky project with anyone else. Thus, the trade-off that the regulator faces is between the benefits derived from encouraging

efficient capital formation by the small investor and the costs imposed on the informed trader because of the possible reduction in liquidity. In the next chapter, we discuss some of the model's assumptions and their importance to the results.

## **Chapter 4**

### **Sensitivity of the Assumptions**

Our model contains several assumptions which are quite restrictive. Although some are required in order to achieve our results, in some instances they can be relaxed to a certain extent and still produce the same conclusions. In this chapter, we discuss the sensitivity of the more important assumptions on our results.

#### **I. The Regulator**

In our model, we assume that there is only one regulator; however, in reality there are normally 2 levels of regulation in the securities market. On one level, the stock exchange is a self-regulatory body in that it is made up of member brokerage houses and sets regulations which it imposes on itself. On the second level, the government monitors the exchanges and sets further regulations to ensure their policy objectives are met. For example, in British Columbia, the Vancouver Stock Exchange is monitored by the B.C. Securities Commission.

It has been argued by Easterbrook (1986) and Edwards and Edwards (1984) that in the presence of manipulative activity, exchanges are capable of optimally restricting manipulation without further help from government. The social costs of manipulation are internalized by an exchange, either directly or indirectly. To the extent that manipulation forces investors out of the market, either because they perceive it to be unfair or because the

extra noise makes it less useful, an exchange is affected directly through lower trading volumes, and therefore, less revenues. To the extent that manipulation decreases allocative efficiency, an exchange is affected indirectly. The government which acts in the public interest will put pressure on an exchange when it feels that the exchange is compromising allocative efficiency. This pressure forces an exchange to internalize the costs which do not affect them directly. Thus, an exchange will optimally set regulation in order to limit manipulation. Since the government and the exchange's goals are basically aligned with regards to manipulation, we have assumed in our model that there is only one regulator.

## II. The Illiquidity Cost Imposed on the Large, Informed Trader

If  $w$ , the illiquidity cost imposed on the informed trader, were not large enough to persuade the informed trader to sell at time 2 then the uninformed trader would not earn any profits. If it were optimal for the informed trader to wait until time 3 to sell but the uninformed trader still sold at time 2 then the small investor would know for certain that they were trading with the uninformed trader at time 2 and that  $\tau^I = \tau^U = 0.5$ .  $P_2$  would then be less than  $P_1$  because  $P_1$  would be partially a function of  $\tau^I$  which is greater than  $\tau^U$ . Therefore, the uninformed trader would face a loss. Furthermore, if the uninformed trader were to also wait until time 3 to liquidate his position, then he would again face a loss since  $P_1$  would be greater than  $\tau^U H + (1 - \tau^U)L$ , the expected liquidating dividend at time 3 for the uninformed trader. This again follows because  $P_1$  is partially a function of  $\tau^I$ , where  $\tau^I > \tau^U$ . Therefore, in order to expect positive earnings, the uninformed trader requires the

illiquidity cost imposed on the informed trader to be large enough to make him want to sell at time 2.

In order to find the break even point for  $w$ , where the informed trader is indifferent between selling at time 2 and time 3 we must look at his payoffs from doing both. Given that bad news is not announced at time 2, if the informed trader were to sell at time 2, his earnings would be  $(P_2 - P_1)B$ , and if he were to sell at time 3, his earnings would be  $(H - P_1)B - w$ . Therefore, it must be the case that  $w \geq (H - P_2)B$  in order for it to be optimal for the informed trader to always sell at time 2.<sup>21</sup>

### III. An Illiquidity Cost Imposed on the Small Investor

In our model, we assumed that the small investor does not face an illiquidity cost when the regulator imposes random trading halts. As in Allen and Gale (1992), we could assume that the small investor plans to invest in a project for the long term and that he is a passive player in the market. However, if the opposite were true and the small investor were to face an illiquidity cost in the presence of possible trading halts, then his expected utility would be negatively affected.<sup>22</sup> If the cost were large enough then it could offset the benefits from trading halts, namely, the reduction in noise created by the possible presence of the manipulator, and cause the expected utility to decrease as  $\pi$  increased. In this case, the regulator's actions would not be of benefit to the market and the optimal solution would

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<sup>21</sup> If bad news is announced at time 2, then the informed trader will always want to sell at time 2 as long as  $w$  is non-negative. This is because the payoff from selling at time 2 --  $(L - P_1)B$  -- will be higher than that from selling at time 3 --  $(L - P_1)B - w$ .

<sup>22</sup> A table of the small investor's final payoff in each state given the existence of the illiquidity cost is presented in Appendix E.

be to keep  $\pi = 0$  even if this meant that the riskfree project would be chosen. Using the exogenous variables from the example in Chapter 3, the graph in Appendix E shows the relationship between the small investor's expected utility and  $\pi$ , as the illiquidity cost to the small investor,  $c$ , is increased. For some values of  $c$ , the small investor's expected utility still increases with  $\pi$ , however, at a slower rate. In these instances, the regulator would have to set  $\pi$  at a higher value (than if there were no illiquidity cost,  $c$ ) in order to convince the small investor to invest in the risky project. As long as the informed trader is still willing to participate at the higher level of  $\pi$ , this would be an optimal strategy. Thus, the presence of an illiquidity cost imposed on the small investor can mitigate the benefits of trading halts and might even make them useless in the face of manipulation.

#### **IV. Information Structure**

Our information structure is very similar to that of Allen and Gale (1992). In their paper, they provide as an example in support of their choice of structure, a company in its developmental stage. Developing a product or a manufacturing technique requires many test before it can be determined if it is a viable product or process. An early test which fails is bad news and can be announced; however, it is not until after many tests that success can be announced. As another example, suppose that a company is facing a possible lawsuit and the informed trader finds out that it is unlikely that the lawsuit will be filed. The longer the period that a lawsuit is not announced, the greater the chance that no lawsuit will be filed. Thus, bad news (i.e. the announcement of the lawsuit) will occur earlier than good news (i.e.

the realization of no lawsuit). We can, therefore, think of situations where this type of structure exists.

In our model, we only examine the profitability of 'long' manipulation, where the uninformed trader buys first and then sells. It seems reasonable to assume that 'short' manipulation is also possible if the structure were changed to good news before bad news. However, this is not the case. As Allen and Gale (1992) argue, under the current framework, a bear raid would not be successful since "the sale of stock at date 1 w[ould] lower the price below the expected value at date 2."<sup>23</sup> The reason for this is that the risk would be loaded on the risk averse small investor instead of the risk neutral large trader. The small investor would only purchase at time 1 and take on the risk at a relatively low price. In practice, evidence shows that 'short' manipulation (bear raids) are less frequent than 'long' manipulation, possibly because of the additional cost associated with margin accounts when shorting a security.<sup>24</sup>

Our information structure is restrictive, and our results must be considered with this in mind. We have only looked at one specific scenario where manipulation is profitable and can cause economic inefficiency. It is unclear how disruptive manipulation might be under other circumstances and how effective trading halts might be in these cases.

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<sup>23</sup> Allen and Gale (1992), pg. 518.

<sup>24</sup> See Edwards and Edwards (1984).



## **V. Risk Aversion of Small Investor**

In this model, as in Allen and Gale's (1992) model, the small investor must be more risk averse than the large trader in order for manipulation to be profitable. If this were not the case, then the informed trader would never enter because he would always trade at a loss in the possible presence of the manipulator. Consequently, the manipulator would not be able to pool with the informed trader and deceive the small investors. In Appendix F, we prove that when the small investor is risk neutral, the informed trader's expected profit is non-positive. Thus, the difference in risk aversion among the market participants, by motivating trade in the first place, is important to our results.

## **VI. Correlation Between Large Trader Type and $\tau^i$**

In order to distinguish between the informed and uninformed large trader, we attached a different probability of good news to each. By setting the probability of good news given the uninformed trader,  $\tau^U = 0.5$ , the uninformed trader has the least possible precision in his information (i.e. when there are 2 possible payoffs, the greatest variance of payoffs occurs when probabilities are set at 0.5 and 0.5). Thus, the informed trader has greater precision as long as his probability of good news is not 0.5. Unfortunately, in a binomial distribution this difference in precision creates a difference in mean payoff. If Nature chooses the informed trader, then the project's expected payoff is higher. Is this correlation plausible in practice? As one example, consider the existence of short-selling constraints. In this case, an informed trader will only be interested in seeking out good news about a project. Thus, if an informed trader is chosen, it does seem plausible that the expected

payoff will be higher than if the uninformed trader were chosen. As another example, suppose the project involves a resource company which has staked a piece of land. With probability  $\Theta$  this land is rich in minerals. If it is, then a truly informed miner will know that it is and will be willing to buy. However, if it is not rich in minerals then the uninformed manipulator may want to deceive the market into believing that it is a valuable resource site. As long as the small investor is unable to distinguish between the informed miner and the uninformed manipulator then the pooling equilibrium described in our model will hold. Again, it seems reasonable that in the presence of the informed trader the expected payoff could be higher.

## **VII. Conclusion**

Our model contains some restrictive assumptions so care should be taken in applying our results. They cannot be easily generalized to other situations. Since such restrictive assumptions appear necessary for profitable manipulation, it suggests that, in practice, trade-based manipulation may not be profitable under a lot of circumstances.

## **Chapter 5**

### **Policy Implications and Conclusion**

#### **I. Policy Implications**

Our model and the numerical example in Chapter 3 show how the use of random trading halts can be used to encourage allocative efficiency by mitigating the negative effects of trade-based manipulation. The optimal strategy does not necessarily result in the complete elimination of manipulative activity. Allocative efficiency can exist in a market that is not completely devoid of trade-based manipulation. Thus, the regulators' objectives of creating a fair 'playing field' and of promoting economic efficiency do not necessarily require the same response. Creating a fair 'playing field' might require the complete elimination of trade-based manipulation, while promoting allocative efficiency might only require preventive measures which mitigate the effects of manipulation. In this case, regulators must weigh their objectives before the optimal policy can be designed.

Our model also demonstrates the competing interests that a regulator of a securities market must contend with. The possible presence of manipulative activity can force some investors out of the market leaving the market more illiquid and also threatening allocative efficiency. The regulator's response in this instance might be to use random trading halts to reduce the noise created by the manipulator and convince those marginal investors to remain in the market. However, this will come at a cost to other participants who are affected by the illiquidity that the trading halts create. There is a conflict of interest between

those who are most affected by the manipulative activity and those who are most affected by the trading halts. The regulator must consider how best to balance these conflicting concerns. The optimal strategy is one where the marginal social benefit of restricting manipulation equals the marginal social cost resulting from the policy created to mitigate manipulation or its effects. In our model, the regulator's response became one of interfering as little as possible in order to achieve her objective.

The regulator's strategy in our model appears quite simple. She only needs to set random trading halts in order to reduce the effect of manipulation in the market. However, determining when and with what probability is a complicated issue and requires knowledge of the probability of manipulation in the market at any particular time. This appears to be a difficult, if not an impossible obstacle to overcome. In practice, regulators monitor market activity: both volume and price changes. From this data, they make inferences about the possible presence of a manipulator and halt trading when suspicious trading activity occurs. Our model demonstrates that if done correctly, trading halts may be an effective weapon against trade-based manipulation.

## **II. Future Research**

Although we have only concentrated on the simplest form of trading halts, other types of halts, such as position limits or price limits, may also be effective in reducing the noise created by manipulative activity. A model similar to ours could be developed in order to analyze their impact on the problem of trade-based manipulation. Empirically, these

different types of halts can be studied to try to ascertain which is the most effective at the least cost.

Trading halts initiated by exchanges could also be analyzed to determine if there are any common denominators with regards to the type of information revealed, the presence of block trades, or the price movement around the halts. The more that is learned about the tools available to regulators, the more effective the regulators can be at designing policy.

Finally, as mentioned in the previous chapter, we have only looked at one specific instance where profitable manipulation can curtail investment. Our results cannot be generalized to other circumstances. It is, therefore, unclear how disruptive trade-based manipulation is over all and how effective the use of trading halts would be in mitigating any resulting effects.

### **III. Concluding Remarks**

Because trade-based manipulation is difficult to verify the threat of prosecution may not be an effective tool in preventing it. Trading halts, on the other hand, interfere directly with the manipulator's activity and therefore the possibility of random trading halts may be enough to limit the entrance of manipulators, or at least reduce the negative effects of manipulation. In this paper, we only consider the simplest form of trading halts. However, to the extent that price and position limits are forms of trading halts, they too may be effective.

Trade-based manipulation creates noise or misinformation in the market because it interferes with the actions of the truly informed trader. The price discovery process is hampered and the true value of a security is not revealed as quickly. Our model describes a situation where trade-based manipulation can cause inefficiencies through the curtailment of investment. It also demonstrates how the introduction of random trading halts can mitigate the negative effects of manipulation. In some instances, there appears to be an equilibrium which fosters economic efficiency even with the continuing existence of manipulative activity. However, trading halts also increase the cost of trading for some participants because they introduce additional illiquidity to the market. Regulators must be conscious of the trade-off between these two competing interests when setting policy to deal with manipulation.

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## Appendix A

$H$  = high payoff of project,

$L$  = low payoff of project,

$V_s$  = liquidating dividend in state  $s$ ,  $V_s \in [L \text{ or } H]$ ,

$W_s$  = final payoff of small investor in state  $s$ ,

$\Theta$  = probability that the agent is informed,

$\tau^t$  = probability that the project will payoff  $H$  given the large trader  $t$  is chosen, where  $t \in T = \{I, U\}$ ,

$b(t)$  = probability that large trader  $t$  issues a buy order at time 1,

$\pi$  = probability that the regulator will halt trading at time 2, given the risk neutral trader buys at time 1,

$w$  = the cost imposed on the informed agent of waiting until time 3 to sell.

$\Gamma_s$  = conditional probability of state  $s$  occurring given the large trader buys at time 1 and no announcement is made at time 2,  $s \in [U5, U6, I1]$ ,

$$\Gamma_{U5} = \frac{(1-\Theta)b(U)\tau^U}{(1-\Theta)b(U)+\Theta b(I)\tau^I}$$

$$\Gamma_{U6} = \frac{(1-\Theta)b(U)(1-\tau^U)}{(1-\Theta)b(U)+\Theta b(I)\tau^I}$$

$$\Gamma_{I1} = \frac{\Theta b(I)\tau^I}{(1-\Theta)b(U)+\Theta b(I)\tau^I}$$

$\Delta_t$  = conditional probability of large trader  $t$  buying at time 1 given that a large trader buys at time 1.

$$\Delta_U = \frac{(1-\Theta)b(U)}{(1-\Theta)b(U)+\Theta b(I)}$$

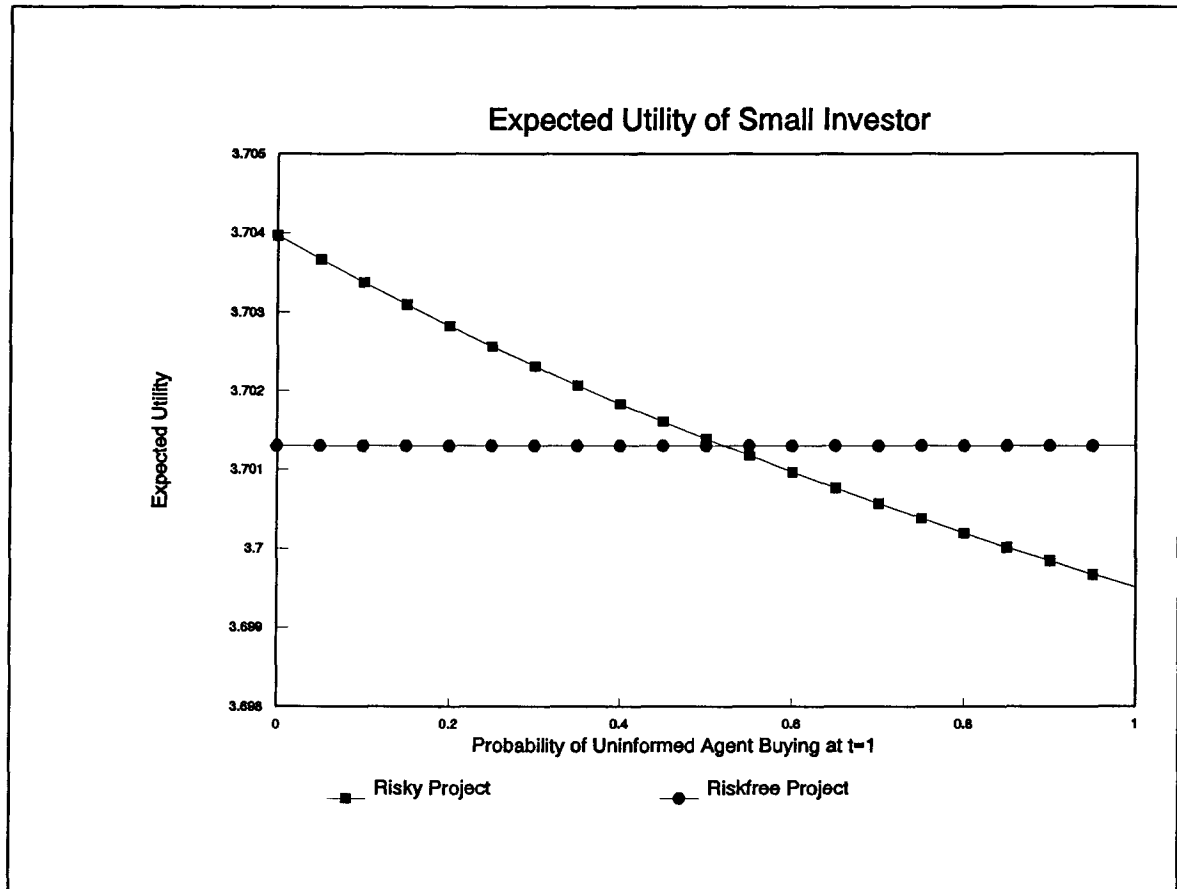
$$\Delta_I = \frac{\Theta b(I)}{(1-\Theta)b(U)+\Theta b(I)}$$

**t=3**



## Appendix C

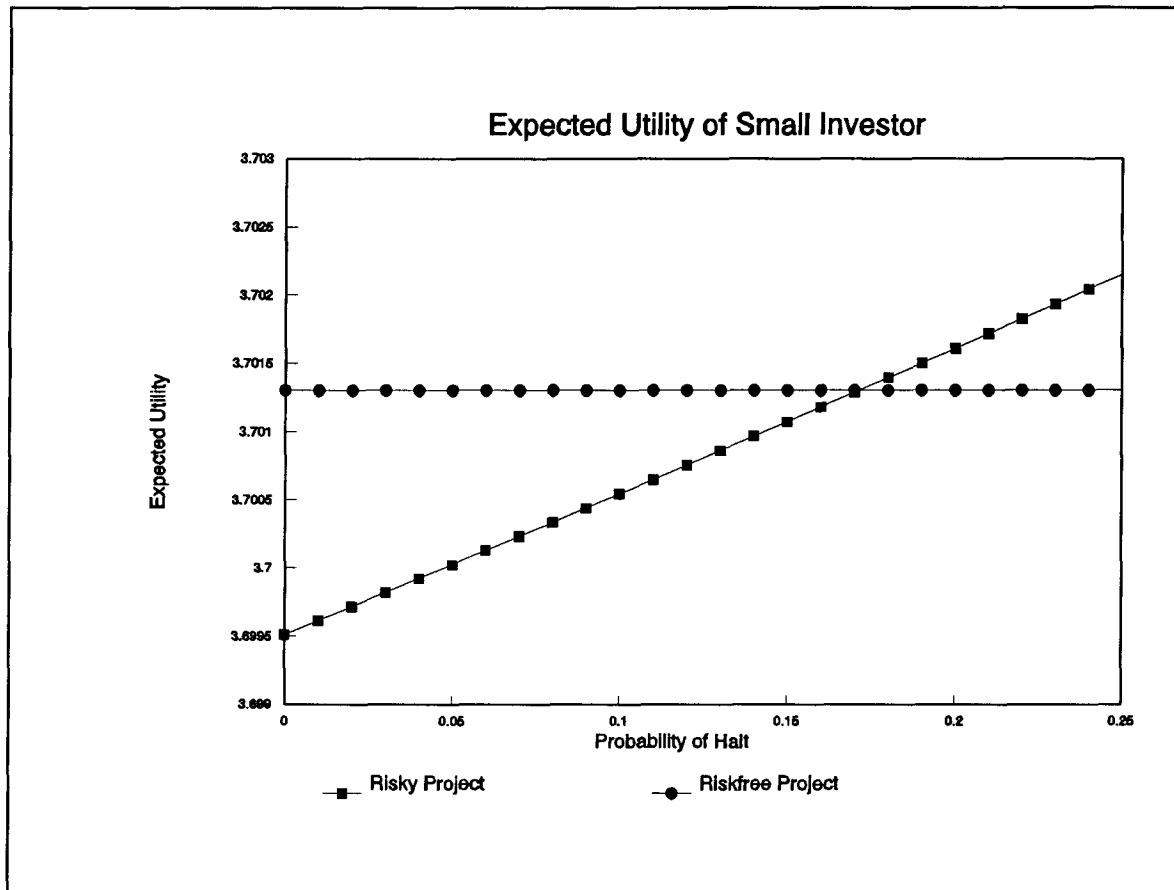
Figure C.1 - Small Investor's Expected Utility vs.  $b(U)$



As  $b(U)$  increases, the small investor's expected utility decreases. At approximately  $b(U) = 0.51$  the small investor becomes indifferent between the two projects.

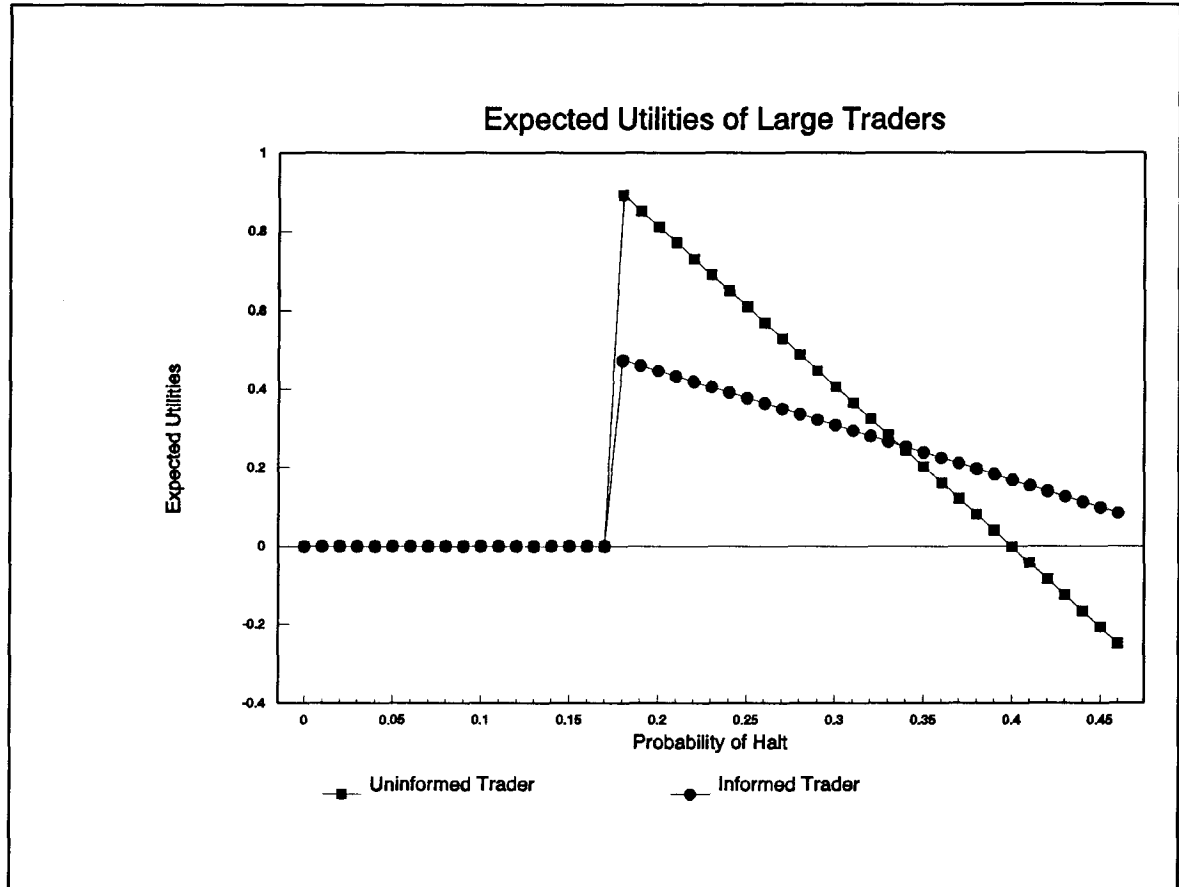
## Appendix D

Figure D.1 - Small Investor's Expected Utility vs.  $\pi$



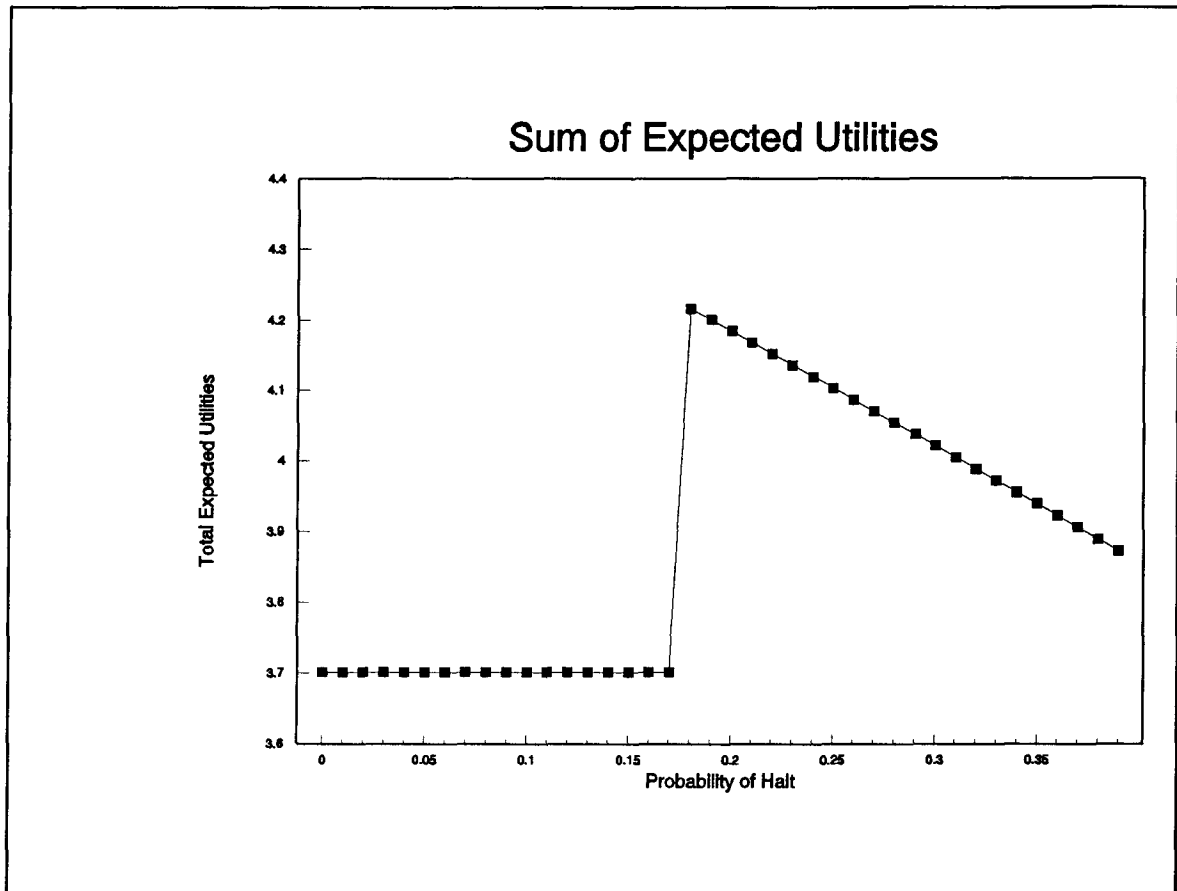
As the probability of halts,  $\pi$ , increases, the small investor's expected utility also increases. At approximately  $\pi = 0.18$  the small investor becomes indifferent between the two projects.

**Figure D.2 - Large Traders' Expected Utilities vs.  $\pi$**



The large traders' utility function is discontinuous where the small investor is indifferent between the 2 projects.

Figure D.3 - Sum of Expected Utilities vs.  $\pi$



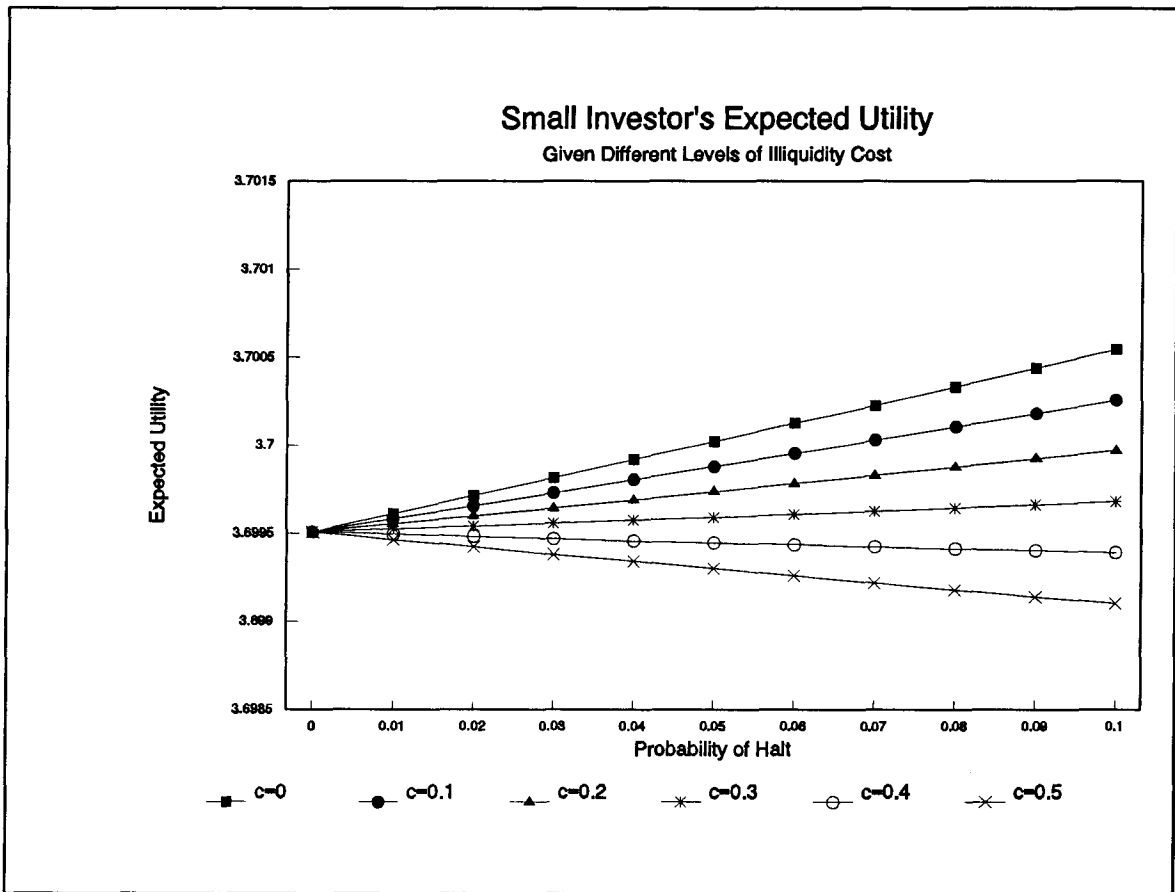
The function is equal to:

$$\Theta E_l[\text{Profit}] + (1-\Theta) E_u[\text{Profit}] + E_{sl}[\text{Utility}]$$

The optimal level of  $\pi$  occurs where the small investor is indifferent between the 2 projects.

## Appendix E

Figure E.1 - An Illiquidity Cost Imposed on the Small Investor



An illiquidity cost imposed on the small investor reduces the benefits from trading halts. At a certain level, the cost completely offsets the benefits and the expected utility decreases with an increase in  $\pi$ .



**Table E.1 - The Small Investor's Final Payoffs Given an Illiquidity Cost**

State	Final Payoff
U1	H
U2	L
U3	$H + (P_1 - H)B - c$
U4	$L + (P_1 - L)B - c$
U5	$H + (P_1 - P_2)B$
U6	$L + (P_1 - P_2)B$
I1	$H + (P_1 - P_2)B$
I2	$L + (P_1 - L)B$
I3	$H + (P_1 - H)B - c$
I4	$L + (P_1 - L)B - c$
I5	H
I6	L

## Appendix F

If the small investor were risk neutral then the informed trader would never be able to trade at a profit in the possible presence of the manipulator. To begin, the equilibrium prices would be as follows:

$$P_1 = (1-x)[\tau^U H + (1-\tau^U)L] + x[\tau^I H + (1-\tau^I)L]$$

$$x = \frac{\Theta b(I)}{(1-\Theta)b(U) + \Theta b(I)}$$

$$P_2 = (1-y)[\tau^U H + (1-\tau^U)L] + yH$$

$$y = \frac{\Theta b(I)\tau^I}{(1-\Theta)b(U) + \Theta b(I)\tau^I}$$

where  $y < x$ .

To prove this, we can show that:

$$\frac{\Theta b(I)\tau^I}{(1-\Theta)b(U) + \Theta b(I)\tau^I} < \frac{\Theta b(I)}{(1-\Theta)b(U) + \Theta b(I)}$$

$$\tau^I[(1-\Theta)b(U) + \Theta b(I)] < (1-\Theta)b(U) + \Theta b(I)\tau^I$$

$$\tau^I(1-\Theta)b(U) < (1-\Theta)b(U)$$

The last line is true as long as  $\tau^I < 1$ .

Now, in order to prove that the informed trader cannot expect to profit when the small investor is risk neutral, we show that his expected value of the asset at time 2,  $E_t[V_2]$ ,

is less than the price at time 1. We will only prove this in the instance where  $\pi = 0$ . In other words, we will show that:

$$E_1[V_2] = \tau^I P_2 + (1-\tau^I) L < P_1.$$

Proof:

$$\begin{aligned} E_1[V_2] &= \tau^I [(1-y)(\tau^U H + (1-\tau^U)L) + yH] + (1-\tau^I)L \\ &= [\tau^I \tau^U (1-y) + \tau^I y]H + [\tau^I (1-y)(1-\tau^U) + (1-\tau^I)]L \end{aligned}$$

$$P_1 = [(1-x)\tau^U + x\tau^I]H + [(1-x)(1-\tau^U) + x(1-\tau^I)]L$$

In order to show that  $E_1[V_2] < P_1$ , we only need to show that:

$$(1-y)\tau^I \tau^U + y\tau^I < (1-x)\tau^U + x\tau^I.$$

Since  $y < x$ , then  $y\tau^I < x\tau^I$ , and it is sufficient to prove that:

$$(1-y)\tau^I \tau^U < (1-x)\tau^U.$$

Or:

$$\frac{(1-\Theta)b(U)\tau^I \tau^U}{(1-\Theta)b(U) + \Theta b(I)\tau^I} < \frac{(1-\Theta)b(U)\tau^U}{(1-\Theta)b(U) + \Theta b(I)}$$

$$\tau^I [(1-\Theta)b(U) + \Theta b(I)] < (1-\Theta)b(U) + \Theta b(I)\tau^I$$

$$\tau^I (1-\Theta)b(U) < (1-\Theta)b(U)$$

Again the last line is true as long as  $\tau^I < 1$ . Thus, we have shown that the informed trader's expected value of the asset at time 2 is less than the price of the asset at time 1, when the small investor is risk neutral. Therefore, he can not expect to profit by trading with the risk neutral small investor. Since the presence of the regulator imposes an

illiquidity cost on the informed trader, his losses only get worse when the regulator intervenes with random trading halts (given the illiquidity cost is sufficiently large).