CAN CHEAP TALK BURST A BUBBLE?
THE CASE OF THE INSEAD BALL TICKET MARKET

P. Raghavendra Rau

March 2000

Krannert Graduate School of Management
Purdue University
1310 Krannert Building
West Lafayette, IN 47907-1310
U.S.A.
Tel: 1 (765) 494 4488
Fax: 1 (765) 494 9658
E-Mail: rau@mgmt.purdue.edu

I would like to thank Bernard Sinclair-Desgagné, Charles Corbett, John McConnell, and seminar participants in the 1995 INSEAD Business Economics Seminar, and the 1995 International Conference of Game Theory and Applications, Jerusalem, respectively for helpful comments. I would also like to thank MBA student Gurpreet Takhar for his help in obtaining the data.

CAN CHEAP TALK BURST A BUBBLE?
THE CASE OF THE INSEAD BALL TICKET MARKET

ABSTRACT

This paper examines a case at a business school in Europe where one trader in a sophisticated e-mail market announced that he was trading on ethical considerations rather than on profit maximization considerations. This seemingly irrelevant Acheap talk@ announcement caused the price of the traded asset to decline by 30% in one day. The paper hypothesizes that this is because the announcement made it no longer common knowledge that all market participants were using the same price-setting rule, which caused a consequent collapse in market prices. The paper develops a simple model and derives conditions under which cheap talk can burst an asset-price bubble.

Journal of Economic Literature Classification Codes: C79, D84

Introduction

What causes an asset-price bubble to burst? According to the popular press, bubbles burst when investors Acome to their senses@, perhaps after receiving new information on supply or demand or on the underlying value of the asset. If the new information is irrelevant to prices however, it should not be a factor contributing to the bursting of the bubble. In contrast, this paper examines a case at INSEAD, a prominent business school in Europe, where one trader in a sophisticated e-mail market announced that he was trading on ethical considerations rather than on profit maximization considerations. This seemingly irrelevant announcement caused prices in the market to collapse. This paper develops a simple model and derives conditions under which cheap talk can burst an asset price bubble.

Asset price bubbles have been mentioned frequently in the popular press over the last decade. For example, the longest bull market in the history of the United States has created a great deal of controversy in the popular press, with some authors arguing that the stock market is an overvalued bubble[1] and others arguing that there is a Anew paradigm@ of higher productivity in the U.S. and the stock market is actually undervalued (see for example, Glassman and Hassett, 1999 or Kadlec, 1999). Similarly, the phenomenon of Adotcom@ Internet firms earning phenomenally high returns either after going public or even just changing their names to dot com names, has been characterized as an Internet Abubble@. Cooper, Dimitrov and Rau (1999) for example, document that stocks earn cumulative abnormal returns of approximately 125% in the ten days around the announcement of a name change to an Internet related dotcom name. If these are bubbles, they are not new phenomena. Mackay (1841) documents manias across time and in different markets, ranging from the Dutch tulip bulb craze in the 1630s to the South Sea Bubble in 1720. Sobel (1965) reports similar manias in the US in the 1850s with railroad and mining stocks and in the 1960=s with science and technology stocks. The existence of such bubbles has also been postulated in other markets outside the U.S[2]. and in markets outside the stock market.

---

[1] See ATrapped by the Bubble@, the Economist, 25 September 1999.

[2] The Economist (see for example, AMed Sea Bubble@, 23 October 1999) describes a bubble in Cyprus in 1999. According to the article, huge demand for the 50-odd shares listed on the exchange has pushed the index up by more than 500%. The Economist attributes this to herd behaviour on the part of market participants: AAs soon as returns on shares started looking decent, ordinary Cypriots piled in. Some have bet their life savings on the market; others have borrowed to buy shares. Fittingly, in a country where beach restaurants tend to raise prices rather than mark them down in the slow season, the amateur investors - reckoned to be one in four adults - are more enthusiastic than financially savvy.@

The literature on the formation and bursting of bubbles is, however, relatively sparse. Most papers focus on explaining the major stylized fact associated with bursting bubbles: a sudden large decline in price, usually occurring in the absence of any public information. Usually the most common example quoted in these papers is the 1987 crash where, it has been argued, prices fell by 20% in a single day without any news of importance (see for example, Romer, 1993 or Hong and Stein, 1999). In addition, the papers assume either that all participants in the market are rational and there is pent-up hidden information which suddenly arrives in the market, or that some participants are irrational, suffering from overconfidence or other systematic upward biases.

Among papers of the former category, Gennotte and Leland (1990) develop a model where a small unobserved (that is, except for a small proportion of Ainformed@ traders) supply shock leads to lower prices. These lower prices then lead uninformed investors to lower their expectations of supply and create a magnified price response. This drop in prices is then exacerbated by hedging plans, leading to a market crash. Bikhchandani, Hirshleifer, and Welch (1992) develop a model of informational cascades where it is optimal for an investor to follow the behaviour of investors before him, ignoring any private information he might have. These cascades are fragile and small shocks in information can lead to big changes in mass behaviour, leading to fads, fashions, booms and crashes. Romer (1993) develops a model where small changes in price revealed through the trading process, reveals large pent-up private information to the market and causes large swings in price. Bulow and Klemperer (1994) develop a model where there is a difference between a strategic buyer=s valuation of the good and his willingness to pay (WTP) for the good. The WTP curve is below the demand curve and is much flatter at the top, leading to buying frenzies or selling panics, when slight changes in buyers= WTPs can change large numbers of customers from being unwilling to buy to being willing to buy or vice versa.

In contrast, other papers assume explicit irrationality on the part of at least some of the market participants. Hong and Stein (1999) for example, develop a model where investors are overconfident about the precision of their signals. This model is similar to Romer (1993) but makes the assumption of irrationality to account for the stylized fact that large price changes are much more likely to be declines than increases. Herring and Wachter (1999) document bubbles in real estate in America, Sweden, Thailand and Japan and find that they seem to share similar causes. First, they hypothesize that investors overestimated the Afundamental value@ of property, mistakenly leading them to perceive a chance to profit from building new property. Second, participants in the property business faced severe agency issues. Since property was largely financed with debt, borrowers had an incentive to exploit their creditors by increasing the riskiness of their projects. Third, they hypothesize that investors show systematic biases taking decisions, often acting in ways contrary to traditional economic models of rational self-interest. Specifically,

investors exhibited Adisaster myopia@: people calculated the likelihood of something happening on how easily they could imagine it. Since it was a long time since they had seen a previous bursting of a property bubble, they underestimated the probability that the bubble would burst again. As a result, they placed too much weight on recent increases in property prices as an indicator of fundamental value.

All the models assume however, that the new information which arrives is directly relevant to the price formation process. They do not explain for example, the extreme volatility of small Internet stocks, where much of the new information may be false or irrelevant. These stocks are talked up (and down) on Internet bulletin boards and chat rooms and frenzies and crashes in the stocks are reported in the popular press almost every day. For example, the Wall Street Journal suggests[3] that Internet chatter can drive up the shares of tiny companies with no profits or even no continuing operations. According to the newspaper:

> ATake NEI WebWorld Inc., a Dallas printing company in bankruptcy proceedings and whose stock was involved in an alleged Internet stock scam. NEI shares soared nearly 1,170% Thursday, a day after news of the alleged scheme broke ... The reason for the surge? Apparently, simply the fact that the stock's name was in the news - even though the news was none too positive. On Wednesday, the U.S. Attorney for the Central District of California said his office had charged two men with fraudulently pumping up the price of NEI over two days in November by posting false rumors on Internet message boards. The Securities and Exchange Commission also filed civil stock-fraud charges against the two men and an associate ... Authorities said the message-board rumors, about a purported takeover by another company, were completely false and designed simply to drive up the price of NEI=s thinly traded stock so the defendants could profit from it. NEI last year filed to liquidate under Chapter 7 of the federal Bankruptcy Code and no longer has a listed phone number in Dallas.@

Since messages posted in Internet chat rooms and bulletin boards are cheap talk, they should have little impact on the price.

Similarly, these models do not explain what might cause a bubble to burst if all investors believe that they are in a bubble but are afraid to stay out in case they are wrong. The Wall Street Journal describes a market[4] where professional investors think that technology stocks are overvalued but keep buying more. According to the WSJ:

---

[3] See Buckman, R., ASome investors load up on NEI shares before checking what the news was@. December 17, 1999, p. C18.

[4] See Ip, G., AHigh Anxiety: Techs Keep Rising Despite Fears@, December 27, 1999, p. C1.

> AMany investors buying into the stocks have little conviction they are worth their prices, but feel they have to own the winners. The same ambivalence extends to the overall market: A new survey says individual investors= expectations are higher than ever -- even as many think stocks are overvalued.@

This WSJ article suggests that one reason that the bubble might burst is if new information on interest rates, relevant to the price formation process, arrives in the market, causing investors to simultaneously sell and leading to a crash. This paper suggests an alternative mechanism for the bubble to burst. It hypothesizes that in fact, there is no need for the new information to be relevant to the price formation process. Cheap talk can cause bubbles to burst if it is no longer common knowledge that all investors in the market are ignoring the cheap talk.

The experimental economics literature suggests that bubbles are relatively easy to form and burst in experimental asset markets. For example, Smith, Suchanek, and Williams (1988) examine an experimental market where all investors receive the same dividend drawn from a known probability distribution at the end of a known finite number of trading periods. They find price bubble formation in fourteen of twenty-two experiments and conclude that common probabilistic dividend information is not sufficient to induce common expectations. King (1991) modifies these experiments, allowing some participants to obtain private information on the dividend values. However, uninformed traders know that there are insiders in the market. The price paths observed are similar to those observed by Smith, Suchanek and Williams. Camerer and Weigelt (1991) further modify these experiments to allow for the possibility that no one is given any private information i.e. participants are unsure whether there are any insiders. Mirages, where traders overreacted to uninformative trades, causing deviations from fundamental values, were still observed in several cases.

One common feature of all these experiments however, is that they are designed in such a way that either the new information available is always common knowledge or the participants reveal information only through their bids. For example, Smith, Suchanek and Williams use a double-auction mechanism where the traders only have information on the price process; Camerer and Weigelt use a double-oral auction with buyers shouting out bids to buy and sellers shouting out bids to sell. In all these cases, there is no role for cheap talk, nor is there any situation where the common knowledge assumption is violated. Given that traders do transmit other information in real life (with an attendant possibility for cheap talk and disinformation), and the increasing frequency of anonymous on-line trades, it is reasonable to believe that the model described in the paper is taking on increasing relevance. It is moreover, an idea which has not been tested empirically.

The paper is organized as follows. Section 1 describes the e-mail market and the collapse of prices in the market. Section 2 outlines an intuitive explanation and section 3 describes a simple model and develops conditions under which cheap talk can burst a bubble. Section 4 concludes.

1. The Ball Ticket Market

INSEAD (The European Institute of Business Administration) is one of the oldest management institutes in Europe. The institute offers a one-year M.B.A. program with two entering classes (called promotions) every year - one promotion starting every year in January and the other in July. This program is the largest in Europe, with nearly three hundred MBA students entering in each promotion.

At the end of each program just before graduation, the students of that promotion organize a ball - in May, the Summer Ball and in December, the Winter Ball. These balls are usually held in exclusive locations - generally in private châteaus in France. Both in 1993 and 1994, for example, the INSEAD Summer Ball was held in the Orangerie at Versailles near Paris.

To guarantee the exclusivity of the event, only a limited number (around 2,500) of tickets are sold, usually in a multi-stage process. In 1994, for example, these tickets were sold in a three-stage process. In a first stage, usually held about two to three months before the actual event, tickets are sold at a low fixed price and are strictly rationed (generally to two per student or INSEAD staff member). If more tickets are desired or if some students have not bought tickets in that period, a second round opens about a fortnight later. Here prices are raised by a preannounced fixed amount from the first stage. If tickets still remain to be sold, a third and generally final round opens about 6 weeks before the Ball itself, during which all the remaining tickets are sold at a still higher preannounced fixed price. This round stays open for either a fortnight or until all the tickets are sold out. A rationing rule still operates in the latter rounds. For example, someone wishing to buy ten tickets in the third round, would be initially sold only two and be allocated the other eight only if the tickets were not sold out[5].

The Summer Ball, especially, is usually an immense success. With 2,500 paying attendees, it has been consistently Europe=s largest ball. The Summer Ball weekend also coincides with the annual Alumni meeting in INSEAD. Consequently, tickets are usually in great demand both by INSEAD students as well as alumni - who sometimes fly in from around the world to visit INSEAD and attend the Ball. Many of these alumni arrive without tickets to the Ball, giving rise to potential excess demand for the Ball tickets.

[5] The three-round system is probably adopted for two reasons. First, since a considerable amount of money has to paid in advance to hire the château and so on, the system encourages everyone to buy early. Second, since the Ball is organized by the students of the current promotion, the restriction of the first two rounds to the students helps to make sure that all their friends and colleagues in the same promotion are able to buy tickets at a more affordable price than the alumni later on.

Since INSEAD is a business school, the students are familiar with the principles and strategies (such as arbitrage) which rational traders in a financial market might be expected to use. All students have access to electronic mail and this e-mail system provides the basis for a well-developed market for the sale and purchase of cars, household items, renting of houses, and exchanges of other goods and services. It also supports an inevitable secondary market for tickets to the Ball.

In general, the e-mail market works as follows: Sellers choose whether to quote a fixed price or whether to ask for bids for any item they wish to sell. Simultaneously, buyers decide whether to respond to any previous seller e-mail messages or post their own offers or reservation prices for the item. These prices are observable to anyone with access to the e-mail system. Also, the e-mail system is not confidential - the identities of both the would-be sellers and potential buyers are known. However, it is difficult to observe whether a trade does take place. Also, if a trade does occur, the actual prices at which the deal was concluded are unobservable because consummation of the transaction occurs outside the system[6].

The secondary market for INSEAD Ball tickets arises from two sources:

- $ Unexpected demand and supply shocks - people suddenly demanding more tickets or selling tickets they had earlier bought.
- $ Speculation - many INSEAD students specifically buy tickets that they expect not to use, because they hope to resell the tickets just before the Ball at a higher price than they paid for the tickets.

Usually, by design, to guarantee the exclusivity of the event, the supply of tickets is kept lower than the expected demand. Expectations that there will be excess demand encourages students to buy early at the lowest official price, even if they are not sure they will be going to the Ball, because they expect to sell the tickets for a higher price later. Historically, the price of the Ball tickets has risen till the date of the Ball, with final prices on the e-mail market about 50% higher than the final official price for the tickets[7]. The highest prices are paid just before the day of the Ball - usually by INSEAD alumni who have arrived at INSEAD from all over the world without

[6] Since the INSEAD community is quite small, however, it may be possible to infer in some cases whether trade did take place or not. For example, in a well-developed secondary market, if sellers and buyers post their supplies and demands for tickets on the e-mail, then if the same seller has been consistently reposting his messages every day, it is possible both to observe the pattern of prices he quotes and if he suddenly stops quoting, to infer with some degree of success that a trade has taken place.

[7] On the order of FF 1,200

tickets. These alumni now demand tickets and are willing to pay much higher prices than INSEAD students.

In 1994, however, events did not take place quite according to expectations. The Ball was scheduled for 28 May, 1994 and tickets began selling in March 1994 at a price of 670 French Francs each, rationed to two tickets per INSEAD student. These were all sold within a week, after which the second round started with tickets being sold at a price of 770 FF. The final round started in the middle of April with tickets being sold at a price of 850 FF. All these three prices had been announced simultaneously by the Summer Ball Committee prior to the opening of the first round.

The secondary market began around the middle of the second stage with sellers quoting ask prices of 850-900 FF per ticket and being accepted[8]. Both bidding and asking prices showed a steadily increasing price trend - about the beginning of May, asking prices were on an average around 1,100 FF per ticket. So far, events were following their normal course with some would-be sellers who had bought in the first round already thinking about how to spend their expected 2 H 400 FF profit[9].

At this time, however, *one* INSEAD MBA student sent out an e-mail message deploring the tendency of the other MBA students to try to sell their tickets at higher prices than they had paid - criticizing the students for trying to gouge their friends and colleagues in the hope of making a Afast buck@. The sender appealed for moralistic behavior on the part of the INSEAD students and to show that he himself was not immoral, he offered to sell his two Ball tickets at face value. The next day, he put out another message claiming that he had sold his two tickets to an anonymous buyer, thanked everyone for the barrage of messages he had received about the value of arbitrage and other financial concepts but said that none of these arguments had influenced him. He also advised everyone to do the same and Anot have to worry about getting good prices later@. There was no evidence then or later, whether the student had in fact, even held the tickets at all, let alone that he had sold them at face value.

Almost immediately, with no warning, prices of tickets in the market collapsed. Within two days, both bid and ask prices were at the third-stage price of 850 FF, a decline of 30%. The price stayed

[8] This even led to public e-mail announcements by the Ball ticket committee asking people not to buy from such sources as official tickets were still available at a lower price than those being asked for on e-mail. This did not have much effect.

[9] The author can personally vouch for the truth of this assertion.

at this level for about a week. Around a week before the Ball, prices started falling again. They briefly slowed around the second stage price of 770 FF but went on to fall to around 670 FF about three days before the Ball. Some students, unabashedly claiming to be speculators, made a series of public announcements, asking people to hang on to their tickets and not to sell too early as alumni would start to come in on the last few days and be willing to pay large amounts to buy tickets. These announcements did nothing to slow the tide. On the last day before the Ball, though there were unconfirmed rumors of a couple of students selling tickets to alumni at high prices, public e-mail announcements showed that the ask price had declined in some cases, still further. The lowest ask price for a ticket was 650 FF, no less than 600 FF below the previous year=s last-day price.

2. What Happened? An Intuitive Explanation

The experimental economics literature suggests that bubbles are less likely to form with increasing experience on the part of the participants, both with the trading rules and with each other (see for example, Van Boening, Williams and LaMaster, 1993). The Ball ticket market however, is essentially a one-shot game - the participants will not be around for the next ball (unless they come as alumni) and no sellers can impose any punishments on any others - thus, no equilibrium can be enforced. In other words, the folk theorem is not applicable.

One of the two key factors driving prices is expectations. If sellers and buyers both hold expectations that the price will rise, sellers would want to hold out for higher prices later, while buyers would prefer to buy earlier. The market would be a seller=s market, as was the INSEAD Ball ticket market in all previous years. On the other hand, if expectations were that prices would fall, sellers would be increasingly anxious to sell and buyers= bargaining powers would increase. In the INSEAD market, both these two distinct phases of the market were observed: the initial sellers= market with steadily increasing prices and the later buyers= market with a collapse of prices.

However expectations alone do not explain the switch between the two market phases described above, though they would explain why any rise or fall would be accentuated. The reason for the shift in markets in this case, was the arrival of the Aethical@ seller - who wanted to sell at a very low price. This seller claimed to be using a pricing rule different from all the other sellers in the market: while other sellers might base their ask prices on the basis of their estimates of demand and supply, this seller claimed to be selling at his own reservation price. Thus, the fact that this seller wanted to sell at an (absurdly) low price could not convey any information to the other sellers about the parameters in their pricing rules - parameters of potential demand by buyers and

potential supply by sellers. Hence, if the market was efficient, prices should not (theoretically) have changed. However the pricing rules used by the other sellers are optimal only under an assumption that it is common knowledge that all sellers are profit maximizing, an assumption which can be rendered invalid by the intrusion of the Aethical@ seller.

Game theorists usually make the assumption that all players are rational, each player knows that everyone else is rational and knows that everyone else knows that he is rational and so on - *ad infinitum* - in other words that the rationality of the players is common knowledge. In the presence of the ethical seller, this structure breaks down at some level. In this type of situation, the equilibrium prediction for this game with Aalmost common knowledge@ is very different from the game with common knowledge.

Apart from expectations therefore, the other key factor driving sellers= estimates of what the other sellers will quote is common knowledge about sellers= pricing rules. Both these factors combine to give rise to the twin phenomena observed in the Ball ticket market - the switch in market phase from a sellers= to a buyers= market and the consequent collapse of prices.

Consider any seller[10]. He will have a probability distribution over possible reservation values for buyers He updates this distribution in a Bayesian fashion depending on the history of prices and trades observed and will optimize his time of sale and price asked for, depending on his beliefs. The arrival of the Aethical@ seller does not convey any new information about the possible reservation values of the buyers and hence, the Bayesian updating described above should not lead his to change his optimal price and time of sale. Hence it does not explain the switch in market phase observed here.

Consider what has happened from the common knowledge point of view. Sellers may know that they themselves are profit-maximizing and that the seller making the ethical announcement is in fact unique. Also, they know that no other seller should take the ethical seller=s statement seriously, but no longer know whether other sellers think that *they themselves* do not take the ethical seller=s message seriously. Some sellers who place a greater probability on low demand will now prefer to sell at a low price immediately rather than take the risk of being unable to sell their tickets later.

[10] Note that buyers do quote bid prices and make strategic decisions as complex as those faced by the sellers. However, here I concentrate only on the decisions faced by the sellers.

With these sellers revising their optimal prices downwards, other sellers are no longer sure whether this revision of prices is due to a breakdown of the common knowledge of the profit-maximizing pricing rule assumption or whether it is due to the fact that these low sellers had received new information about the potential demand. If entirely due to the former, sellers who did not revise their estimates downward would not have to worry; no new information had reached the market. If the low-sellers had in fact received new information, (that potential demand was lower than expected for example) then optimally all the sellers should lower their prices. Since no seller can distinguish between the two events however, the optimal strategy for each seller would be to revise his own price downwards and this would set off a downward price spiral.

This collapse of prices in the market would happen in the absence of the ethical investor only if some seller suddenly came into possession of some information that caused him to revise downwards his estimates of buyer demand - for example, if he learnt that the Alumni Reunion had been canceled. His optimal response would be to price *below* the prevailing price trend - to make sure that *his* ticket sold before any one else got the information. This would give information to the other participants and might set off a downward price spiral[11]. The ethical seller had exactly the same effect - except that the announcement of the ethical seller, essentially cheap talk, no longer made it common knowledge that all sellers used a profit-maximizing pricing rule. This in turn, caused a collapse of prices in the market in the normal way described above.

The contribution of the model in this paper is to derive conditions under which no efforts by the sellers to restore common knowledge of the profit-maximizing pricing rule would work. These efforts in fact, were made in the INSEAD market. Self-proclaimed Aspeculators@ broadcast e-mail messages appealing to sellers to stop selling at low prices, giving estimates of potential profits to be made if the sellers colluded and so on. These efforts to stop the price decline were fruitless.

3. The Model

The situation is similar to the Aelectronic mail@ problem (see Rubinstein, 1989) and to the Acoordinated attack@ problem (see Halpern, 1986). Rubinstein shows that for a two-player game,

[11] It could be argued that in fact, this was the real reason prices in the market collapsed - new information had arrived that potential demand was going to be low. I do not dispute this. I argue however, that it is not necessary for the new information to have arrived. Moreover, I consider it unlikely that new information had in fact, arrived. As one of the participants in the market, I would have a strong interest in obtaining such information. I did not note any such information or rumor anywhere in INSEAD before the collapse. Also, since demand was in fact not low - on the last day, there were several demands by alumni for tickets - there should have been some recovery in prices in the days immediately preceding the Ball. There was no such recovery.

if player *I* is not sure that (player *J* knows that player *I* knows)^n that the state is *b* for any large (but finite) *n*, the two players will always coordinate on a worse outcome *A*, than if it were common knowledge that the state were *b*, when the two players would coordinate on a better outcome B. In this paper, I show that in the presence of an ethical seller, other (profit-maximizing) sellers with low estimates of buyer demand will shift to a lower price in order to be sure of selling their tickets, irrespective of any attempts at communication with any other sellers. I demonstrate this for a particular two-strategy two-seller case. The proof follows that of Rubinstein (1989).

Assume without loss of generality, that the Ball ticket is a sunk cost. In other words, if the seller cannot sell the ticket, it is valueless to him. The seller can choose to sell at a high price *H*[12] or at the face value of the ticket - a lower price *L*. Sellers are either profit-maximizing, *PM*, or ethical, *E*. Buyer demand for the tickets is either 1 with a probability of a, or more than 1 with a probability of (1-a). If both sellers quote the same price when demand is low, they have an equal probability of selling, otherwise the lower quoting seller gets the sale. If demand is high, whatever price the seller quotes, he will make the sale.

If both players are profit-maximizing they will play

***G*$_{PM}$**

Demand = 1 (Low)(Prob a)

		Seller 2 ***H***	Seller 2 ***L***
Seller 1	***H***	*H/2, H/2*	0,*L*
	L	*L*,0	*L/2, L/2*

Demand > 1 (High) (Prob (1-a))

		Seller 2 ***H***	Seller 2 ***L***
	H	*H,H*	*H,L*
	L	*L,H*	*L,L*

Note that for (*H*, *H*) to be a Nash equilibrium in this game, we must have

$$a\,(H/2) + (1 - a)\,H \exists L \qquad \textbf{(1)}$$

If seller 1 is ethical, then quoting a high price will be anathema to her, whether or not she

[12] This price is the prevailing price generated by the standard price process, depending on buyer and seller expectations of supply and demand.

consummates the deal. Therefore the two will play:

G_E

Demand = 1 (Low)(Prob a)

		Seller 2	
		H	***L***
Seller 1	***H***	-4, *H*	-4, *L*
	L	*L*,0	*L*, *L*

Demand > 1 (High) (Prob (1-a))

		Seller 2	
		H	***L***
	H	-4, *H*	-4, *L*
	L	*L*,*H*	*L*,*L*

This game has only one Nash equilibrium (*L*, *L*).

The model starts after the ethical seller has declared herself and sold her ticket. Two profit-maximizing sellers remain. What is their optimal strategy allowing unlimited communication between them?

First, assume that the probability that either seller is ethical, is exogenously determined as *p*. I postulate that if seller 1 of these two is in fact profit-maximizing, (with an attendant probability of (1-*p*)), he would like to coordinate on the equilibrium (*H*, *H*). He will send a message saying that he is profit-maximizing and he believes that demand will be high[13]. Player 2 knows this. The electronic mail system is imperfect however and if the message is sent, it does not reach the recipient with a probability e. If it does reach the recipient, the recipient=s computer sends back an automatic confirmation of the receipt. At any moment in time, the two players= computers display a number showing the number of messages sent
by their own computer, *t*. These parameters *p*, a and e are common knowledge to both players. I show here that the collapse of the market to the (*L*, *L*) equilibrium occurs if the sellers both place high probabilities on the demand actually being low. Such a collapse would not occur if they were confident that demand were going to be high.

Let (S_1, S_2) be a Nash equilibrium (where $S_i(t)$ is player *I*=s action if his computer sends *t* messages) such that $S_1(0) = L$ ie. if player 1=s computer sends no message, he is ethical and will quote *L*. I

[13] Note that seller 1 always has an incentive to say that he believes that demand will be high and this assertion will therefore be ignored by the other seller. What matters therefore is the message that the seller is profit-maximizing.

prove by induction that $S_1(t) = S_2(t) = L \quad t$, in other words, for a given set of parameters p, a and e, the players will always quote L regardless of the number of messages they exchange.

Suppose player 2=s computer gets no message from player 1. This could be because either

X player 1 is ethical and hence did not send a message (an event that occurs with prior probability p (in terms of the model, player 1 has quoted L ($S_1(0) = L$)) or

X player 1 sent a message with probability (1-p) but this message did not arrive with probability e (for a total probability of (1-p) e)

Irrespective of what $S_1(1)$ is, if player 2 quotes L; his expected payoff is at least

$$\frac{p(aL/2 + (1-a)L) + (1-p)e(aL/2 + (1-a)L)}{p + (1-p)e}$$

If he quotes H on the other hand, he gets at most

$$\frac{p(L/2 + (1-a)L) + (1-p)e(aL/2 + (1-a)L)}{p + (1-p)e}$$

and he will always quote L if

$$a > \frac{(H-L)(e-1)}{L/2 + e/2(H-L) - H} = \Gamma \quad \textbf{(21)}$$

and

$$p \geq \frac{(1-a/2)(H-L)e}{(1-a/2)L + (1-a/2)(H-L)e - (1-a)H} = \Delta \quad \textbf{(3)}$$

It is easy to see from **(2)** that for any set of (L, γ), as H increases, ɜ increases. In other words, as the prevailing price increases, the player 2 has to be more and more pessimistic about buyer demand in order to quote L. Again, for any given set of (L,H), as γ increases, ɜ decreases. As the inaccuracy of the e-mail system increases, even if player 2 is less pessimistic, he will still quote L. Similarly it is easy to see from **(3)** that for any set of (L, ∀, γ), as H increases,) increases. In other words, as the prevailing price increases, the prior probability that player 1 is in fact ethical has to increase more and more in order to convince player 2 to play L. Next assume that the prior probability of a player being ethical, p satisfies **(3)** at the current prevailing price H and the probability of demand being low, ∀ satisfies **(2)**. Then $S_2(0) = L$.

Assume now that we have shown that $T_i < t$, players 1 and 2 quote L in equilibrium. Player 1 is now uncertain whether $T_2 = t$-1 (ie. player 2 never got player 1's message) or whether $T_2 = t$ (ie.

he got player 1's message but his own was lost on the way back to player 1). Player 1 assigns conditional probability z to $T_2 = t - 1$ given by

$$z = \frac{e}{e + (1-e)e} > \frac{1}{2}$$

By the inductive assumption, player 1 estimates that if $T_2 = t - 1$, player 2 will quote L. So if player 1 chooses H, he gets at most

$$z(\theta 0 + (1-\theta)H) + (1-z)(\theta H/2 + (1-\theta)H)$$

whereas if he quotes L, he gets at least

$$z(\theta L/2 + (1-\theta)L) + (1-z)(\theta L/2 + (1-\theta)L)$$

and he will therefore choose L if

$$z \geq \frac{(H-L)(1-\alpha/2)}{H\alpha/2}$$

This is equivalent to

$$H \leq \frac{(-4+2\alpha+2e-e\alpha)L}{3\alpha-4+2e-e\alpha} \quad \textbf{(4)}$$

This upper bound on H increases with both γ and $\forall$. As the system becomes more inaccurate, the less confident player 1 is that his message has got through and he will therefore be more likely to choose to play L. Similarly, as seller 1 becomes more pessimistic about demand, he will be more likely to quote L for a larger H.

Similarly, we can show that for $S_2(t) = L$, it must be that the same upper bound on H holds. Therefore, when all four sufficient conditions **(1)**, **(2)**, **(3)** and **(4)** are satisfied for a set of parameters, H, L, p, $\forall$ and γ, the two players will play (L, L) regardless of the number of messages exchanged.

The sufficient conditions derived here include upper and lower boundaries on H in relation to L and lower boundaries on $\forall$ and p. Intuitively, it shows that breakdown is inevitable even when (H, H) is an equilibrium as long as first, both sellers are sufficiently pessimistic about buyer demand and second, the prevailing price when the "ethical" seller reveals herself, is not too high compared to the face value of the ticket. The intuition behind this last statement is straightforward. If the "ethical" seller makes her announcement when the prevailing market price is very high, then it is extremely unlikely that sellers will believe that there are other such sellers

given that the price is already so high. Hence the ethical seller's announcement will be disregarded. If, on the other hand, the price has not risen too high, the announcement will cause the low-demand-estimate sellers to try to sell at a low price and this will inevitably set off a downward spiral in the market.

4. Conclusion

This paper describes the collapse of asset prices in an e-mail market due to an irrelevant announcement by an "ethical" seller. To characterize the results in a simple manner, the arrival of the ethical seller in the market is new information. It is not common knowledge that this information should be disregarded as it is cheap talk. The model describes a model and develops conditions under which it is not possible for the remaining sellers to restore the common knowledge of the pricing rule, causing prices in the market to collapse.

The model shows that the collapse of prices occurs if the sellers are sufficiently pessimistic about buyer demand and when the prevailing market price is not too high compared to the "true value" of the asset. The model can be used to explain the frenzies and crashes in the price of small Internet stocks that are talked up or down in Internet bulletin boards or chat rooms[14]. Extending the results to these markets therefore, cheap talk can cause prices to collapse as long as all participants feel that the stock is overvalued enough so that buyer demand is likely to be low. However, somewhat paradoxically, the participants should not feel that the asset is extremely overvalued, relative to the "fundamental" value, otherwise the cheap talk will be disregarded.

The model can be extended in several ways. It can be extended for example, to modeling situations where coordination is more or less possible under different economic environments (high or low demand). Similarly, it can be related to the idea of the sustainability of cartels with unobservable demand shocks, where coordination in high price policies is more feasible under positive demand shocks.

[14]It can be argued that the INSEAD ball ticket market, unlike the situation with Internet bulletin boards or chat rooms, was not a bubble. Since expectations are that prices will be much higher on the ball date, due to demand from INSEAD alumni, market participants may have been justified in driving up prices. However, this makes the price drop even more puzzling - markets would have been irrational to drive the price down, if the price was justified by demand. This does not affect the validity of the model - it should be more difficult for market prices to collapse due to cheap talk if there is no bubble (there is a lower probability that demand will in fact be low).

References

Bikhchandani, S., Hirshleifer, D., and Welch, I., 1992, A theory of fads, fashion, custom, and cultural change as informational cascades, *Journal of Political Economy* 100, 992-1026.

Bulow, J., and Klemperer, P., 1994, Rational frenzies and crashes, *Journal of Political Economy* 102, 1-23.

Camerer, C. and Weigelt, K., 1991, Information mirages in experimental asset markets, *Journal of Business* 64, 463-493.

Cooper, M., Dimitrov, O., and Rau, P. R., 1999, A rose.com by any other name, Working paper, Purdue University.

Gennotte, G., and Leland, H., 1990, Market liquidity, hedging, and crashes, *American Economic Review* 80, 999-1021.

Glassman, J.K, and Hassett, K. A., 1999, *Dow 36,000: The new strategy for profiting from the coming rise in the stock market* (Random House, New York).

Halpern, J.Y,. 1986, Reasoning about knowledge: An overview, in J.Y.Halpern, ed.: *Reasoning about Knowledge*, (Morgan Kaufmann).

Herring, R. J., and Wachter, S. M., 1999, Real estate cycles and banking busts: An international perspective, Working paper 99-27, Samuel Zell and Robert Lurie Real Estate Center, Wharton School, University of Pennsylvania.

Hong, H., and Stein, J. C., 1999, Differences of opinion, rational arbitrage and market crashes, Working paper, Stanford Business School.

Kadlec, C.W., 1999, *Dow 100,000: Fact or fiction* (Prentice-Hall Press, New York).

King, R. R., 1991, Private information acquisition in experimental markets prone to bubble and crash, *Journal of Financial Research* 14, 197-206.

Mackay, C., 1841, *Extraordinary popular delusions and the madness of crowds*, (Barnes & Nobles Books, New York).

Rubinstein, A., 1989, The electronic mail game: Strategic behavior under “almost common knowledge”, *American Economic Review* 79, 385-391.

Romer, D., 1993, Rational asset price movements without news, *American Economic Review* 83, 1122-1130.

Smith, V. L., Suchanek, G. L. and Williams, A. W., 1988, Bubbles, crashes, and endogeneous expectations in experimental spot asset markets, *Econometrica* 56, 1119-1151.

Sobel, R., 1965, *The Big Board: A history of the New York stock market* (Free Press, New York).

Van Boening, M. V., Williams, A. W. and LaMaster, S., 1993, Price bubbles and crashes in experimental call markets, *Economics Letters* 41, 179_185.