Master Thesis in International Economics and Finance
Stockholm School of Economics

Bonuses and Bubbles:

An Experimental Study

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Abstract:

We report from 15 laboratory asset markets where we examine the effect of a bonus incentive on asset bubble formation. In contrast to previous studies with similar settings, only three of our 15 markets bubble. Our results demonstrate that a bonus incentive does not induce subjects to trade above fundamental value and the outcome suggests that the use of highly sophisticated subjects significantly reduces decision error and speculation within markets. Moreover, the experimental results show that a bonus incentive does increase market activity, and contrary to other studies increased turnover is not a result of decision error or speculation but rather due to increased competitive behavior of the subjects.

Key Words: Asset Market Bubbles, Experimental Asset Markets, Bonus, Subprime Crisis

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INTRODUCTION

INTRODUCTION TO ASSET BUBBLES

Bubbles form when asset prices increase to unreasonably high levels that deviate from fundamental value. According to standard financial theory, market prices should only change with new information that changes investors' dividend expectations and therefore the fundamental value of the asset (Smith, *et al* 1988). A bubble could already be observed in 16th century Holland, when the price of certain tulips reached values several times a normal person's yearly income. However, in 1639, tulips suddenly lost all their excess value. Over the past century we have witnessed several bubbles such as the New York Stock Market crashes in 1929 and 1987, the Asian crisis in the late 1990s, the IT-bubble in 2000 and the 2007-09 subprime crisis.

The subject of asset bubbles is very relevant today (2009) as the world is in a recession fuelled by the subprime crisis. With the help of new technology, the financial industry invented instruments such as credit default swaps (CDS) and collateralized debt obligations (CDO) that enabled investors to only face the "pipeline risk". Loans were held for a short time before they were sold on; they were "originated and distributed" (Brunnermeier, 2008).These instruments were mostly backed by collateral of subprime mortgages with the belief that the value of real estate was constantly to increase, as the U.S. had never experienced a downturn in the housing market. When prices began to decrease and mortgage companies faced difficulties a domino effect across the whole U.S. financial industry occurred and institutions that had been solid in the past started to face liquidity problems. As market liquidity dried up, banks, which financed their obligations with instruments of shorter and shorter maturity, approached financial distress. Funding liquidity also dried up and no one was able to borrow money.

The crisis has spread outside of the U.S. as international investors had invested in the subprime market. There has been a wave of bankruptcies of financial institutions across the world and the shock-waves of the crisis have reached companies outside of the financial industry; a world recession has become reality.

Discussions of what actually caused and fuelled the crisis are still ongoing. A low interest rate environment that created cheap capital, the miscalculation of mortgage default risk and the transformation of the banking environment from traditional issuance of loans to "originate and distribute" have all been mentioned as possible causes. The mortgage crisis was further amplified by the short term funding of financial institutions, the network effects that resulted in greater counterparty risk and a bonus environment that induced high risk taking. This notion that the bonus system has amplified the financial crisis is especially pronounced in the world media where articles are published

on this topic every day. The argument that bonuses "reward talent" is debatable (Taleb, 2009-02-25), and the economic and moral implications of bonus incentives are being widely discussed.

As shareholders want to profit maximize, a bonus system should be used to create a stimulus for employees to generate high and well-directed effort. However, if the stimulation is too high, there is a danger that the agent will pursue his or her own interests. It has been argued that today's bonus environment has "encouraged a certain class of risk-hiding and deferred blow-up" (Taleb, 2009). The unreasonably high bonuses induce excessive risk taking, short term thinking and unsustainable behaviour in the financial industry (*Dagens Nyheter*, 2009-02-12).

Taleb (2009) argues that there is a mismatch between when the bonus payments occur and when the effects of the risks taken are materialized. Due to this, banks have lost their past profits periodically "while bankers strike it rich." An investor might even start taking risks again when the economy picks up, blaming the bubble burst on a "systemic crisis". This "free option" of getting the profits but not the losses is a vicious asymmetry driving the investment banking industry. In the US, the investment banking sector distributed 39 billion dollars to 185.687 employees in 2007 (*Affärsvärlden*, 2008-01-17) and one can wonder whether all of this money was well spent. On the February 9th 2009 *The Scotsman* reported that John Thain, the chief executive of Merrill Lynch, spent 1.22 million dollars to decorate his office of which 1,400 dollars were spent on a waste paper basket.

The traditional role of a bank, intermediation, has become secondary and large banks today have nearly become gigantic hedge funds (Warde, 2008). When intermediation and the national payment system gets into trouble it imposes huge costs on society where companies operating in other industries face severe liquidity problems and people's personal savings are threatened. As a financial crisis becomes reality, it is the "tax payers in our respective countries that keep funding these global monsters and keep coughing up money for mistakes made by bankers" as banks themselves are "too big to fail" (Taleb, 2009).

Bonuses are therefore considered to have fuelled the high risk environment and thereby the subprime crisis. Today the debate has gone far beyond the investment banking industry and on January 23rd 2009, Pontus Schultz, editor in chief of *Veckans Affärer*, stated that no matter sector,"[s]mart senior management will refrain from bonuses this year".

Due to the financial crisis and today's moral debate about bonus compensation, we find it interesting and highly relevant to examine whether bonuses have an effect on asset bubbles. We aim to do this from an economic theoretical perspective and we use experimental asset markets with sophisticated subjects to study the behaviour resulting from a bonus incentive. The level of bonus used in the experiment is intended to create a competitive market environment where the best performing subject in each round will be rewarded with a bonus according to relative performance. Hence, the aim of this

thesis is to test the behaviour of sophisticated subjects in experimental asset markets in order to examine if bubbles are amplified when the environment is manipulated by a bonus.

Our results demonstrate that a bonus incentive does not induce subjects to trade above fundamental value. However, the experimental results confirm that a bonus incentive increases market activity by encouraging competitive behavior of the subjects within each market.

DISPOSITION

The thesis will be divided into four main parts; introduction, method, experimental results and conclusion. The introduction guides us through experimental asset markets, previous findings in the area and the theoretical framework used in our analysis. We also motivate our contribution to asset market experiments and define our hypotheses. This is followed by an explanation of experimental design and a careful justification for the method used. The presentation of our experimental results is followed by an analysis linked to our theoretical framework. In the concluding part we discuss the implications of our findings, topics for further research and provide a short summary of the thesis.

INTRODUCTION TO THE EXPERIMENTAL ASSET MARKET

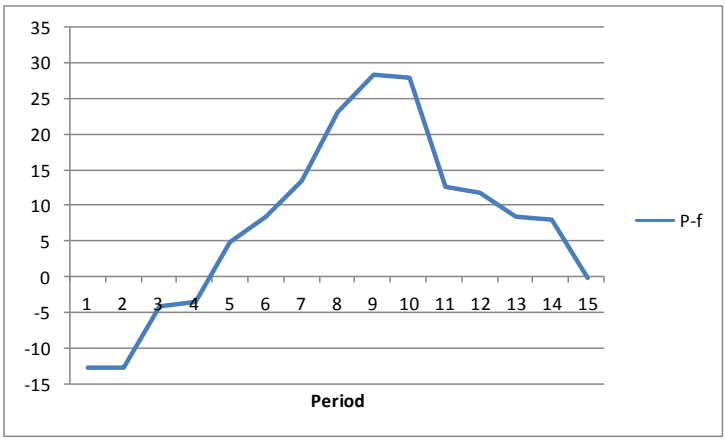
Economists have studied the formation of and reasons for asset bubbles in many different ways. However, real asset bubbles are complicated to analyze because of the complexity and the unpredictability of human behaviour. Instead economists create experimental asset markets in controlled environments.

A common form of experimental asset market is a *double auction* where a number of traders can buy and sell an imaginary asset. The market is called a *double auction* because buyers and sellers simultaneously submit their bid and ask prices. An auctioneer then chooses a price p that clears the market. The asset has a finite stream of dividends and in each trading period the dividend can take on any number of values with equal probability. The fundamental value of the asset is then calculated as the number of trading periods left times the expected dividend. There are two main differences between this experimental asset market and the real asset markets; in the experimental market there are no transaction costs and the fundamental value is common knowledge to all subjects participating. However, in real markets, asset prices are affected by many different factors and therefore the fundamental value can be difficult or even impossible to calculate.

PREVIOUS FINDINGS

The occurrence of bubbles in a highly controlled setting of laboratory asset markets has been widely discussed and examined since the ground-breaking findings of Smith, Suchanek and Williams (henceforth called SSW) in 1988. In these markets;"risk neutral traders with rational beliefs, and common knowledge of rational beliefs . . . have no reason to trade" (Sunder, 1995). Yet, SSW found that trading *does* occur; and at such high volumes and in such a pattern that could only be described as a bubble. *Figure 1* shows a typical asset price bubble in experimental asset markets.

Figure 1 A Typical Bubble in Experimental Asset Markets. The graph shows price minus fundamental value over 15 periods of trading



Note: the figure shows an asset market bubble from one of our experimental markets. The experiment is explained in more detail in the "Experimental Design" section

SSW conducted many experiments to test the robustness of bubble occurrence. When testing the effect of experience, the same traders met again in an identical market (once-experienced) and then yet again (twice experienced). The duration and amplitude of the bubble subsided with experienced traders and when the same traders met a third time, the market hardly bubbled. These findings have been replicated in many experiments since (Dufwenberg *el al.* 2005, Van Boeing *el al.* 1993).

As the subjects usually used for experiments are undergraduate university students, the question was raised whether their naïve perception of the market was the cause for bubble formation. It was objected that in real markets most traders have a lot of experience. In order to differentiate between experience of trading in the "real world" and in an asset market, let us call experience in the real world "sophistication". SSW conducted an experiment with sophisticated subjects, namely professional and business people residing in Tucson, Arizona and concluded that sophistication (by their definition) does not eliminate irrational behaviour, nor do professionals "converge" to rational behaviour faster. In fact, this was the only experiment "that closed on a mean price higher than in all previous trading periods".

Since 1988, many changes in the institutional settings of the SSW experimental asset market have been introduced. Van Boeing *et al.* (1993) created a call market and found that even though a call market has less price deviations than the double auction markets, the price deviations have higher amplitude. Lei *et al.* (2001) eliminated the possibility to speculate by letting subjects be either buyers or sellers, not both. They found that speculation was not the sole cause of bubbles. They then tested what would happen if subjects were given an alternative market to trade in. Even though the trading volume subsides when an alternative trading market is presented, bubbles still form.

In 2005 Dufwenberg, Lindqvist and Moore (henceforth called DLM) examined what happens when you mix experienced and inexperienced traders. Here it is important to state that experience only reduces bubbles if all experimental settings (institutions, traders) are unchanged from market to market. DLM find that in mixed experience markets less bubbles form.

Haruvy and Noussair (2006) tested the effect of short selling and find that short selling lowers asset prices, however, the prices are not low enough to track fundamentals and bubble formation can still be observed. Noussair and Tucker (2006) find that in the presence of a futures market and a spot market, the asset bubbles that form in the spot market are smaller. A futures market would thus "impede the formation of bubbles in the spot market". However, the futures markets itself exhibits a bubble crash pattern.

In 2008, Hussam, Porter and Smith (henceforth called HPS) examined whether bubbles can be "rekindled" with experienced subjects. By first letting the subjects trade twice in an environment similar to that of SSW (in order to get the subjects once-experienced) and then shocking the environment, they tested whether this could make bubbles rekindle. The shock was meant to mirror today's environment more closely compared to other experimental asset markets and consisted of adding more market liquidity by lowering the initial number of shares, increasing the dividend variance and increasing the amount of cash for each subject. The subjects were also mixed, after being twice experienced, into different groups. In these conditions, a bubble is indeed rekindled and even experience is not enough to eliminate bubbles.

THEORETICAL APPROACH

There are two angles from which we can examine bubbles in experimental asset markets: we can ask ourselves *when* bubbles do/do not occur and *why* they do occur. These questions are connected. In order to answer when bubbles occur, economists have changed the institutional settings of the experimental asset market, such as creating call markets, futures markets, etc. Even though this thesis takes a deductive approach, and we aim to ask ourselves *if* bubbles are amplified and reform when we introduce a bonus incentive, we need to form an understanding of the current theories about why bubbles occur. Therefore we will discuss the concept of rationality.

The rational expectations hypothesis (REM[1]) is based on the definition of rationality made by Muth in 1961 and states that "expectations, since they are informed predictions future events, are essentially the same as predictions of the relevant economic theory." Or, even simpler; agent's predictions are right *on average*. Because bubbles have been shown to subside with experience, one can draw the conclusion that the subjects' behaviour converges towards REM *with experience*. In the article from 1988, SSW conclude that: "Even these experiments are not an exception to the general conclusion that the REM model of asset pricing is supported only as an *equilibrium concept* underlying an adaptive capital gains price adjustment process." Hence; even though equilibrium might be obtained in the long run (with thrice experienced subjects), it does not give an explanation to why bubbles occur in the first place.

If the value of an asset is common knowledge, it would seem irrational to trade at any price higher than the fundamental. The subjects in the asset market all have the same information about the dividend stream and should be able to price the assets through backward induction. Still, bubbles occur in these settings. What is not common knowledge, however, is the rationality of the other subjects. Trading at prices that deviate from fundamental might still be rational, because what we mean by rational behaviour depends on the beliefs of the traders in the market. If one trader believes that other traders will act irrationally and takes advantage of this, we would refer to his actions as rational. Since we can only observe the activities of the subjects, not the thought process that leads up to these activities, HPS (2008) state: ". . . findings inform us of what traders *do not do.* In particular they do not think about the problem the way we economists do, namely, to induct backward from future anticipated prices" (p. 927)

SSW hypothesized about price deviations being due to lack of *common* expectations, not due to *irrational* expectations. They state that "common dividend, and common knowledge thereof, is insufficient to induce initial common expectations. As we interpret it this is due to agent uncertainty about the behaviour of others." (p. 1120) The lack of common expectations is referred to as heterogeneous beliefs, whereas common initial expectations are called homogeneous beliefs. As we only observe subject behaviour, we cannot distinguish between bubbles caused by not being able to price assets correctly through backward induction and bubbles caused by heterogeneous beliefs. This is also true for the traders in the asset market. Bubbles may therefore be a result of bounded rationality (Levine and Zajac, 2006); perfectly rational decisions are often not feasible in practice due to the finite computational resources available for making them. In this case, it would mean that subjects are not certain that all other subjects behave rationally, and therefore they appear to take "irrational" decisions.

[1] We follow the notation of SSW 1988 and call this "the Rational Expectations Hypothesis according to Muth". Hence, REM and not REH.

We can therefore distinguish two concepts; rationality dependent on beliefs about the behaviour of others' and true irrationality; not being able to price assets correctly through backward induction, which we also refer to as decision error. These two concepts are the most plausible explanations of bubble occurrence.

An aspect of heterogeneous beliefs is speculation, which has been put forward as a possible cause of bubble formation. Speculation for capital gains occurs when subjects believe they can "outsmart" other traders in the market, and sell on an overpriced asset to a "less informed" trader. In 1995, Sunder wrote: "bubbles . . . arise when some traders believe that other traders, for whatever reasons, would be willing to pay more than the asset was worth and decided to pay a higher price themselves in order to extract capital gains." Lei *et al.* in 2001 examined this when they eliminated the ability of traders to speculate and found that bubbles still occurred. Even though they found that speculation does not seem to be the main reason, it can still contribute to asset bubble formation.

Overconfidence can also explain why subjects believe that they can "outsmart" other traders. This self-serving bias is a phenomenon that has frequently been studied by economists and psychologists. In 1981 a Swedish researcher, Ola Svensson, studied people's predictions of their own driving ability and found that most people consider themselves to be above average drivers. This kind of behaviour is known as the Lake Wobegon effect, but in academic sources it is most commonly described as the above average or better-than-average effect. If a subject is overconfident in an experimental asset market, she believes that in contrast to her peers, she will be able to predict the span of the bubble and withdraw just in time before the bubble bursts. Levine and Zajac (2006) describe this phenomenon as the "greater fool" where each participant "holds the unrealistic believe [*sic*] that her financial acumen is better than everybody else's" (p. 2). Therefore, subjects knowingly purchase overpriced assets in the hope of selling them on to naïve investors.

According to Haruvy *et al.* (2007) the subjects constantly overestimate the time left before the "*peak price period*", even when they are in their fourth consecutive market. Peak price period is defined as the period in which the highest price occurs. Overconfidence might make traders take uncalled for risks, and this could be an explanation for bubble formation. Odean (1998) finds that overconfidence affects the trading volume in markets and the asset turnover increases when traders are overconfident. Since the experimental market we are interested in often shows trades at excessive volume, there has been speculation whether the excessive volume can be linked to bubbles. Haruvy *et al*. 2007 imply that a large turnover "suggest[s] speculation on future price changes or errors in decision making". Lei *et al.* (2001) even include trading at high volume in their definition of an asset bubble. Further, SSW found that the trading volume just prior and following the collapse of the asset bubble is smaller than the average volume during bubble formation.

The second reason for bubble creation might be decision error, a true irrationality, because subjects are unable to correctly calculate the assets' fundamental value by linking the expected future dividend stream to rational prices (Noussair and Tucker, 2006). "Because the data is difficult to reconcile with theory it is natural to conjecture that aspects of the methodology of this particular type of asset market experiment are the sources of errors in decision making" (Lei *et al*, 2001, p. 846). If a subject does not understand the mechanics of the market they are trading in, it will be very difficult for that subject to make "rational" decisions. This sort of bias should be diminished and eventually eliminated with experience as subjects learn the "rules of the game".

Another aspect of decision error is a possible bias towards active participation. Lei *et al.* (2001) examine the change in trading volume (and thus indirectly the bubble) to find out if bubble formation partly arises from the lack of other activities in the asset market. The experimental market is designed for trading and offers no alternative pastimes for subjects that do not want to trade. Therefore, they test what they call "the active participation hypothesis". Indeed, when subjects are given an alternative to trading the volume decreases, however, bubbles can still be observed.

Noussair and Tucker (2006) believe that "none of the institutional and environmental manipulations [examined before 2006] . . . would prevent bubbles because they do not assist agents to backward induction or to form common expectations about future prices nor do they provide alternative activities to trading in the asset market" (p.169) Instead, in order to reduce decision error, participation bias and create homogeneous expectations, they tried to form a futures market, examining whether this would prevent bubble formation. Noussair and Tucker argue that a futures market can address these problems at once as it fixes spot market prices at observable levels and the associated futures prices may help in the solution of the backwards induction problem. They find that futures markets do indeed reduce the occurrence of bubbles. The effect of having futures markets is interesting to study as it brings the underlying expectations of the traders into the open, if so only for a short time. Hence, depending on the structure of the futures market mechanisms, trader's expectations about the direction of the market are revealed.

Even though futures markets diminish the bubble phenomenon, no fully satisfying theoretical explanation of bubble phenomenon formation has yet been presented. Hence, we cannot fully explain the subjects' behaviour. As HPS (2008) write: "Bubbles are the funny and unpredictable phenomena that happen on the way to the 'rational' predicted equilibrium...*if the environment is held constant long enough*" (p. 927)

OUR CONTRIBUTION

When HPS conducted their research in 2008 they examined the robustness of market experience and aimed to make institutional manipulations in their experimental asset market to reflect some of the alleged causes of the subprime crises. They wanted to show that bubbles are aggravated by new sources of yield (dividend) uncertainty and more available liquidity.

The debate about the financial crisis is ongoing and we find it important to keep investigating causes of the crisis in order to increase the understanding of the asset bubble phenomenon. Experimental asset markets provide us with a good, but not perfect tool, by which one can examine human response to institutional manipulations. Although this kind of research has been in progress since 1988 we still find areas where more research would be helpful.

We would like to contribute to the experimental asset market studies of bubble formation by examining the behaviour of subjects when the environment is manipulated by a bonus. To the best of our knowledge, no research has been made to test the effect of a bonus incentive in an experimental asset market and due to the discussions in the introduction of the thesis we find it relevant to investigate if a bonus incentive can amplify asset price bubbles.

HYPOTHESES

In order to narrow the purpose of our thesis, we have chosen three different treatments by which we examine reactions in a bonus induced environment. First, we want to find out if a bubble can reform by giving a bonus incentive to experienced subjects. Secondly, we want to examine if the incentive of a bonus can amplify bubbles compared to no bonus incentive. Finally, we want to investigate if a bonus reduces the effect of the asset price converging towards its fundamental value as subjects become more experienced. These treatments are explained in *table 1*.

Table 1 Our Three Treatments

Treatment	Description
1	Adding a bonus as an incentive to experienced subjects to examine whether the bubble can be reformed
2	Control group with no bonus
3	Control group with bonus through all three rounds.

We have defined three different hypotheses about what might happen when we manipulate the environment with a bonus. As previous experiments have consequently shown, bubbles seem to persist no matter institutional change. Further, due to the ongoing economic and moral debate about bonus systems amplifying the financial crisis we find it reasonable to believe that a bonus will re-amplify bubbles, even when subjects are twice-experienced. In a similar fashion to HPS (2008), we aim to test if bubbles can be reformed, as described in *hypothesis 1*.

Hypothesis 1: Introducing a bonus treatment to an experimental asset market will cause bubbles to reform when traders are twice-experienced

We also believe that the bonus treatment will amplify bubbles in all markets, no matter the experience level of the subjects. It is our belief that the bonus incentive will keep the markets from reaching the REM equilibrium even when the subjects become experienced. Therefore, we have chosen the following hypotheses:

Hypothesis 2: A bonus treatment with inexperienced traders will amplify bubble formation compared to a control group of inexperienced traders

Hypothesis 3: The experienced control group with a bonus treatment will have more severe bubbles compared to the control group without a bonus treatment

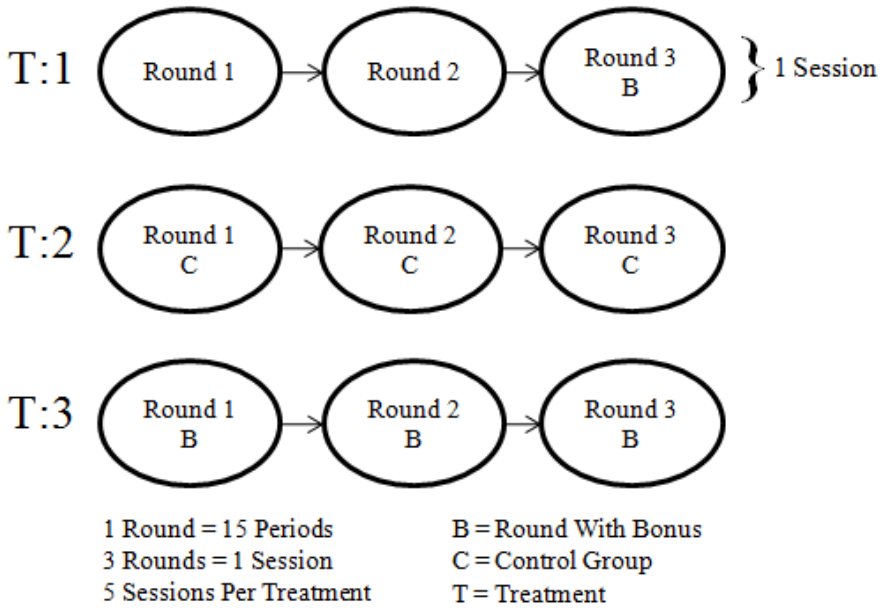
METHOD

EXPERIMENTAL DESIGN[2]

We aim to follow the method used by SSW, DLM and HPS as closely as possible so that comparisons can be made between the studies. The experimental design is illustrated in *figure 2*.

A total of 90 subjects, students studying at the Stockholm School of Economics (henceforth called SSE), were used in our experiment. Everyone was invited to the experiment and the first students to confirm participation were able to partake. As the students arrived to the experiment they were randomly assigned different treatments and markets.

Figure 2 The Experimental Design



To test our three hypotheses we use three different treatments: treatment one, where we add a bonus incentive in the last round (T1), a control treatment in line with the experimental design used by SSW (T2) and a second control treatment where all three rounds have a bonus incentive (T3). In the bonus treatment, we inform the subjects that the best trader will get an additional monetary reward (bonus).

Each trading round consists of 15 periods. During each period the subjects are able to trade for 2 minutes and there are no transaction or brokerage fees on trading within this market. The monetary values are given in tens of *ören*, hence 10 units of experimental currency is equal to 1 SEK. The total expected payoff per session, that a participant can expect to receive, is 201 SEK.

[2] See the Appendix for a detailed instruction given to the participating students in the experiment

At the end of each trading period, every unit of asset in the trader's inventory pays a dividend that is uniformly distributed over the range {0, 3, 9, 16}. Hence, there is a 0.25 probability to receive each dividend and the average dividend is equal to 7. Because the asset has no terminal value after the final dividend in period 15, the fundamental value starts at 105 and diminishes by 7 each period. The value of the asset is calculated as the average dividend of 7, times the amount of periods remaining, which is given by the formula:

$$V = E(d)(16 - t) \text{ where } d = \text{dividend and } t = \text{period.}$$

Every session consists of three rounds and is replicated 5 times, resulting in 5 different sessions for every treatment. The trading was conducted in a computerized continuous double auction. The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007), which has previously been used in experimental asset markets to study the formation of bubbles (DLM 2005; Haruvy and Noussair 2006; Levine and Zajac, 2006; Haruvy *et al.* 2007).

Each experiment had three types of traders and subjects were randomly distributed across the trader types (see *table 2*). The trader types received different amount of initial cash and shares. The subjects were able to trade as many assets as they wanted but needed to hold sufficient amount of cash to purchase an asset or sufficient units of assets to make a sale.

Table 2 Initial Trader Portfolios and Expected Values. This is the composition of the subject's portfolios at the beginning of each round.

Trader Type	Initial cash	Initial shares	Expected value
High cash/low shares	355	3	670
Medium cash/medium shares	250	4	670
Low cash/high shares	145	5	670

Note: all values are given in experimental currency.

The subjects were given both written and oral instructions before trading and had to answer three questions about gender, major and their expected outcome compared to the other five subjects in that market. Hence, they had to rank themselves between 1 and 6 and predicted their own performance within the group.

JUSTIFICATIONS FOR METHOD

As we aim to follow the method by SSW, DLM and HPS as closely as possible, we want to motivate the deviations from previous studies and the new elements found in our experimental design.

The subjects used are students from the SSE ranging from the Bachelor to the Master of Science Programme in Economics and Business. We classify these subjects as sophisticated as they have, during their time at SSE, studied economics, game theory and finance. This is in line with the

definition of sophistication used by McCabe and Smith in 2000. We believe the use of sophisticated subjects will help us to reduce the effect of decision error.

We have chosen to use six subjects per session which is in the lower range of subjects previously used in experimental asset markets. However, as we aim to compare the difference in bubble magnitude between treatments with and without a bonus, rather than examining if bubbles occur at all, the choice between six and twelve subjects will not matter.

Every trading period is 2 minutes long compared to the 4 minute periods used by both SSW and HPS. We hope that trading during 2 minutes will help to reduce the effect of the active participation bias where subjects that only have one market to trade in tend to trade because they lack other activities. In contrast to SSW and HPS, 2 minutes of trading was used in the experiment by DLM.

Three sessions are conducted in the same room at the same time. Hence, every subject can see 17 other participants but he or she does not know which participant belongs to which market. Therefore we limit opportunities for collusion within each market.

The bonus incentive used in our experimental asset market could make the subjects act on their overconfidence. To find out if the Lake Wobegon effect holds (if subjects feel overconfident before the experiment starts and consider themselves to be above average) we will ask the subjects to rank their expected outcome compared to their peers within the group. When the subjects predict the outcome of the test, they will also be requested to state gender and major at the SSE. These factors can be interesting to investigate in order to find out if males are more overconfident than females and to examine the mix between bachelor and master students in our experiment.

Further, the bonus is an environmental manipulation that is not supposed to make it rational for the subjects to trade at prices above fundamental value. Therefore, it is important to keep the bonus low enough in order not to change the rational behaviour of trading at fundamental value. However, the bonus needs to be high enough to be coveted by the subjects. Looking at the real life structure of the bonus system at investment banks before the financial crisis, a bonus for a typical first year analyst could exceed 100 percent of his or her yearly fixed salary. An average banker working on company mergers and acquisitions could have expected to receive a bonus four to five times their annual salary of GBP 120,000 (*The Scotsman,* 2009-02-09) When it comes to top executives, about 75 percent of their total pay consisted of a variable bonus.

If we are therefore to draw analogies with real life, this would imply that we treat one session (three rounds) as the equivalent of one "year" in a trader's life and our chosen bonus of 600 SEK per session (200 SEK per round), is about three times the yearly "salary" of a trader in our experiment. However, as the winner in each round will receive 200 SEK as a bonus, the 600 SEK might not be given to the same subject in each session. Therefore, if a subject receives the expected value of 201 SEK in the

market and wins one round, and therefore a bonus of 200 SEK, this bonus will reflect about one year's salary. Further, we have chosen to use a bonus incentive dependent on relative rather than absolute performance as we want to keep it rational to trade at fundamental value.

We have chosen not to use an absolute bonus structure as it might make it rational to trade above fundamental value, hence make it rational to speculate. Traders could thus initiate a bubble by buying assets at high prices in the hope of selling them on at even higher prices as the bubble becomes more severe. Another reason for using a relative bonus structure is that we do not know the behaviour of the subjects in advance, hence if the asset prices in the experimental market will track fundamental value or not. Therefore, it will be difficult for us to choose an absolute level. This bonus structure is in contrast to the real world where bonuses are given on the basis of both.

If we assume that traders are risk-neutral we can show that the fundamental price still constitutes equilibrium, even when we introduce a bonus. Imagine a bonus incentive market with only one period of trading and three traders, who are spread over the different trader types described in *table 2*. If no one trades, the two traders with high cash/low assets and high assets/low cash each have a 50 percent chance of winning the bonus, whereas the trader with the medium portfolio has no chance at all. Hence, if a high dividend occurs, the trader with the high asset portfolio will win the bonus, but if a low dividend occurs, the trader with the high cash portfolio will win. The medium trader will not be able to win the bonus as the structure of the initial cash and initial number of assets differs among the trader types. Hence, the total expected value of their payoff will be different when a bonus incentive is induced.

By the same argument it is rational for any trader to have a portfolio that is composed of only assets or only cash, and therefore traders will have an incentive to trade. However, since the fundamental value of each share is 7, and the increase in expected portfolio value from buying an asset is also equal to 7, it will never be rational for any trader to buy an asset at a price different from the fundamental. This example shows that a bonus incentive makes it rational to trade, but that the equilibrium price is still equal to the fundamental value. The fact that it is rational to trade in our manipulated asset markets differentiates us from previous laboratory experiments.

STATISTICAL METHOD

MEASURES OF BUBBLE CHARACTERISTICS

There are several measures that can be used to examine the severity of a bubble (see HPS 2008, Haruvy *et al.*, 2007, Van Boeing 1993, DLM 2005). We use the three measures that we find most helpful to our study. The first is the amplitude of a bubble:

Amplitude: Measures the through-to-peak change in market asset value relative to fundamental value and is given by the formula:

$$A = Max\{P_t - f_t\}E : t = 1,...,15\} - Min\{P_t - f_t\}E : t = 1,...,15\}$$

Where P_t is the average trading price in period *t*, f_t is the fundamental value in period *t*, and *E* is the initial fundamental value. In effect, the amplitude measures the "height" of asset bubbles, and a larger amplitude indicates a more severe bubble.

Turnover: Measures the normalized trading activity in the market.

$$T = \sum V_t / S$$

Where Vt is the volume traded in period t and S is the total outstanding stock in the experiment. If it was common knowledge that markets were to track fundamental value there would be little reason to trade. Therefore, high turnover suggests the presence of an asset market bubble (Haruvy et al., 2007)

Normalized Average Price Deviation: Measures the average absolute deviations from fundamental value.

$$NPD = \sum \frac{|P_t - f_t|}{S}$$

Where Pt is the average trading price, ft is the fundamental value, and S is the stock outstanding. The normalized average price deviation is a measure of the absolute deviations from fundamental value, be they positive or negative. A high normalized average price deviation shows that the price deviates substantially from fundamental value, and therefore indicates bubble formation.

The three measures are calculated for each market and give us five observed measurements per treatment. In some markets, there might be periods where no stocks are traded. If this occurs, these periods will be removed from the data before calculating the amplitude and normalized average price deviation. If we included a non-trading period, it would increase the amplitude and normalized price deviation and make it seem as though markets with few trades formed asset bubbles, even if this was not the case.

We test our results pair-wise and use two statistical tests in order to do so: the Mann-Whitney U statistic and the Wilcoxon signed rank test. We also test overconfidence with the Bowman-Shelton test for normality.

THE MANN WHITNEY U STATISTIC

The Mann Whitney U Test is a test where independent random samples are taken from two different populations (Newbold et al. 2003). When we want to examine differences between treatments we use the Mann-Whitney U statistic, which is given by:

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

Where n1 is the number of observations from the first population, n2 is the number of observations from the second population, and R1 = the sum of ranks of the observations from the first population. Our sample sizes are small (five observations) and we therefore need to use a statistical table for small samples. One can object that five observations are low when it comes to getting statistically significant results, but it is in line with the number of observations used in previous experiments (SSW, DLM, HPS).

WILCOXON SIGNED RANK TEST FOR PAIRED SAMPLES

We also want to compare differences between rounds within the same population. Wilcoxon and Mann Whitney U is essentially the same test, with the difference that Mann Whitney is used for testing between populations and Wilcoxon is used for testing within a population.

The Wilcoxon test statistic, W, is given by the sum of the ranks of the observations from the first population, after the observations have been ranked in ascending order.

THE BOWMAN-SHELTON TEST FOR NORMALITY

The test statistic we use when testing for overconfidence is the Bowman-Shelton test for normality. The test statistic is given by:

$$B = n\left[\frac{\text{Skewness}^2}{6} + \frac{\text{Kurtosis}^2}{24}\right]$$

where n is the number of observations.

Skewness measures if the sample is symmetrically distributed around the mean, and is calculated as:

$$Skewness = \frac{\sum_{n}(x_i - \bar{x})^3}{ns^3}$$

Kurtosis measures the weight of the tails of the distribution and is calculated as:

$$Kurtosis = \frac{\sum_{n}(x_i - \bar{x})^4}{ns^4} - 3$$

A normally distributed population would have skewness 0 and kurtosis 3, and the null hypothesis of a normal distribution is rejected for large values of the test statistic.

If we had markets with perfect information; knowledge of ones own abilities as well as knowledge of the abilities of others relative to oneself, the expected results would be evenly distributed over the interval 1-6. However, in a market where information is incomplete, it is reasonable to assume a normal distribution of rankings. If we look at Svensson's (1981) example of car drivers, it is reasonable to assume that most people are average drivers but tend to overestimate their abilities relative to others. In the presence of overconfidence, the distribution of subjects' rankings will be skewed, and we have therefore decided to use the Bowman-Shelton to test for overconfidence among subjects.

EXPERIMENTAL RESULTS

RESULTS

We report on a set of fifteen experimental sessions conducted at the SSE in February 2009.

Table 3 shows the distribution of subjects over gender, the stage of study and major. The majority of our subjects were male and finance was the dominant major, and in total we had more bachelor than master students.

Table 3 Percentage Distribution of Participating Students

Gender	Male	76.7 %
	Female	23.3 %
Stage of Study	Bachelor Students	60 %
	Master Students	40 %
Major	Finance	28.9 %
	Accounting and Finance	12.2 %
	Economics	5.6 %
	Marketing	7.8 %
	Management	5.6 %

In contrast to previous findings, we observe very little asset bubble activity in our markets. Only three of fifteen markets formed extensive bubbles and only one of these three markets came from treatment three, T3, where the bonus incentive was induced from the start. The other two sessions of asset bubble markets were found in treatment one (T1). Even though the bonus incentive was not given until in the third (and final) round, asset bubbles formed through all three rounds.

Table 4 shows the percentage of bachelor students, amplitude, turnover and normalized average price deviation for the three markets that bubbled. As a comparison, the average amplitude for the markets that did not form asset bubbles was 0.12, the average turnover 2.29 and the average normalized average price deviation 1.48. Although we cannot prove convergence towards trading at fundamental value statistically, as we only have three observations of bubbles, we can see in *table 3* that the amplitude and the normalized average price deviation were reduced as traders gained more experience. This is in line with previous results, showing that asset bubbles diminish with experience. Further, we found that at least 50 percent of the subjects were bachelor students in the markets that formed asset price bubbles, even though the subjects were randomly distributed between treatments.

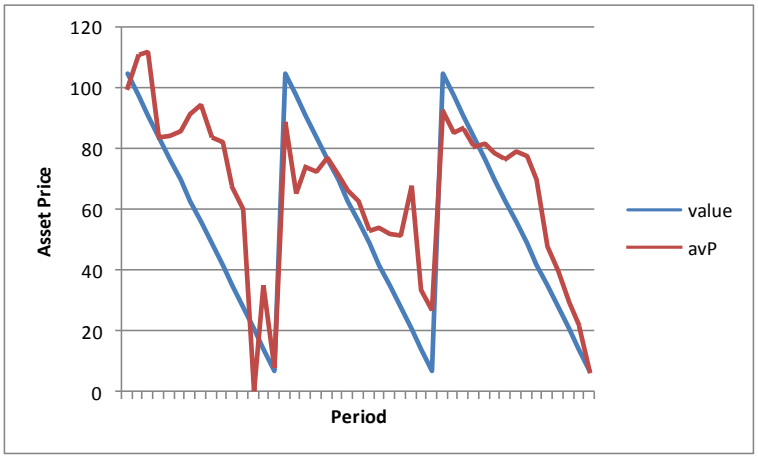
Table 4 Characteristics of The Bubbling Markets

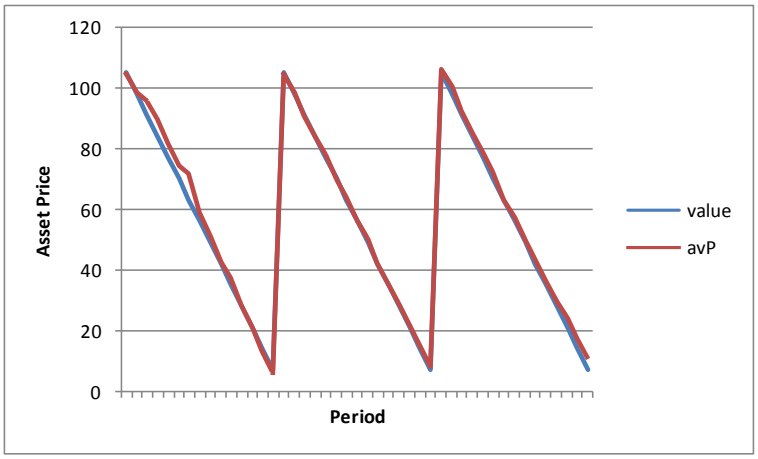
	Percentage of Bachelor Students	Round	Amplitude	Turnover	Norm. Average. Price Deviation
Bubble Market 1	66%	1	0.62	3.17	13.87
		2	0.55	4.29	10.64
		3	0.52	4.46	14.65
Bubble Market 2	83%	1	0.43	4.63	12.04
		2	0.76	3.83	9.62
		3	0.39	3.79	7.51
Bubble Market 3	50%	1	0.76	4.25	12.65
		2	0.49	3.54	10.83
		3	0.34	1.96	5.89

Note: bubble market 1 comes from T1, bubble market 2 comes from T1, bubble market 3 comes from T3. In table 8 in the "Appendix" we present a summary of the measurements of bubble characteristics for all three treatments.

Figure 3 compares bubble market from with a non-bubble market both from treatment one (T1). The graphs demonstrate a whole session consisting of three consecutive rounds, the average trading price and the diminishing fundamental value. As shown in the top graph, the asset price of the market increases to high levels above fundamental value and creates an asset bubble, while the non-bubble market, at the bottom, tracks fundamental value almost exactly. In our twelve markets that did not bubble, we cannot observe asset bubble formations in ether one of the three consecutive rounds.

Figure 3 A Comparison Between a Bubble and a Non-Bubble Market (three consecutive rounds shown).





Note: the top figure shows an asset price bubble and the bottom figure shows a market that tracks the fundamental value of the asset.

In *table 4* we show comparable values from previous studies that imitated the experimental design made by SSW in 1988. All of our markets have lower turnover and amplitude relative to previous experiments. Even in markets where bubbles did form, the turnover and amplitude are lower in our study than in the comparable studies showed in *table 5*.

Table 5 Values of Bubble Measures in Comparable Studies

	Amplitude	Turnover	Norm. Avg. P. Dev.
Porter & Smith (1995)	1.53	5.49	N/A
Van Boeing et al. (1993)	4.19	5.05	5.21
King et al. (1993)	1.61	4.55	11.88
SSW (1988)	1.24	5.68	4.55
Our average	0.21	2.74	3.45

Note: the table reports average values over all the session, but for SSW, only the average of the inexperienced sessions is reported

Table 6 summarizes the statistical findings of our experiment. The notation is the following: the rounds of treatment one (T1) are referred to as InExp, OnceExp, Bonus. The rounds of treatment two (T2) are referred to as Contr1, Contr2, Contr3 and the rounds of treatment three (T3) are referred to as BContr1, BContr2, BContr3. For instance, BContr2 refers to the second round of treatment three (T3).

Table 6 Summary Statistics

	Amplitude	Turnover	Norm.Avg.P.Dev.
Bonus vs. Contr3	U = 33 p-value = 0.1548	U = 40 p-value = 0.0040	U = 34 p-value = 0.1111
BContr1 vs. Contr1	U = 25 p-value = 0.7262	U = 32 p-value = 0.2103	U = 25 p-value = 0.7262
BContr2 vs. Contr2	U = 26 p-value = 0.6548	U = 30 p-value = 0.3452	U = 26 p-value = 0.6548
BCont3 vs. Contr3	U = 28 p-value = 0.5000	U = 40 p-value = 0.0040	U = 32 p-value = 0.2103
Bonus vs. OnceExp	W = 25 p-value = 0.7262	W = 26 p-value = 0.6548	W = 27 p-value = 0.5794

Result 1: A bonus treatment does not cause bubbles to form

To examine whether *hypothesis 1* holds, we tested the null hypotheses that the amplitude and normalized average price deviations are equal in Bonus (T1) and Contr3 (T2). The associated Mann-Whitney statistic is U = 33 for n = m = 5 and the *p*-value for the amplitude is 0.1548. The equivalent results for the normalized average price deviation are U = 34 with *p*-value = 0.1111. A *p*-value of 0.1111 is close to 10 percent significance, however the markets form bubbles already in the first out of three consequent rounds and introducing a bonus to experienced subjects did not amplify the bubble effect. Therefore, as the *p*-value was of 0.7262 when we compared Bonus (T1) versus OnceExp (T1) we can safely discard *hypothesis 1***.**

To investigate whether *hypothesis 2* holds, we examine the difference in amplitude and normalized average price deviation of the first round in our bonus market (T3) and the first round in our control market with no bonus (T2). The null hypothesis is that the first rounds (BContr1 and Contr1) have equal amplitudes and price deviations. The associated Mann-Whitney statistic for the amplitude is 25 for n = = m = 5, and the *p*-value is 0.7262. For the normalized average price deviation, the equivalent values are 25 and 0.7262. As we cannot reject the null hypothesis, we are not able to state that *hypothesis 2* is true.

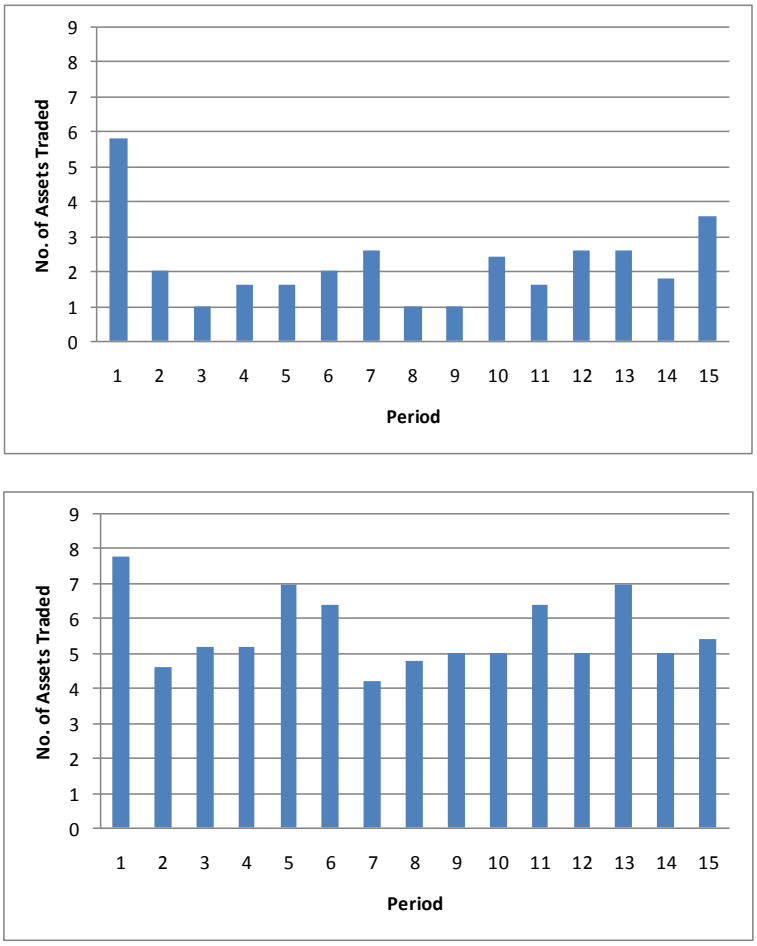
To examine whether *hypothesis 3* holds, we test the null hypothesis that the amplitude of BCont3 (T3) and Contr3 (T3) is the same. The associated Mann-Whitney statistic is U = 28 for n = m = 5 and the *p*-value is 0.5000. Hence, we cannot reject the null hypotheses and as we did not find any significant results, *hypothesis 3* is not found to be true.

In our results we can not find statistical significance that a bonus incentive induces bubble formation. Looking back at our three hypotheses, bubbles have not reformed with twice experienced subjects, nor were they amplified by bonuses, and bonus incentives did not result in larger bubbles when experience increased over time.

Result 2: A bonus incentive increases the trading volume in the last round

Even though the bonus incentive failed to induce bubbles, we noticed an increase in trading volume (see *figure 4*). Both the last round of the bonus group, Bonus (T1), and the twice experienced control group with bonus, BContr3 (T3), show a significantly higher turnover when tested against Contr3 (T2). These results are valid at a 1 percent significance level. The Mann-Whitney test statistic is 40 and the *p*-value is 0.0040 for Bonus (T1) versus Contr3 (T2), and U= 40 with $p = 0.0040$ for BContr3 (T3) versus Contr3 (T2). Thus, the results show that bonuses induce excessive trading in the last round, but only at levels close to fundamental value.

Figure 4 A Comparison Between the Average Numbers of Trades of Twice Experienced Subjects.

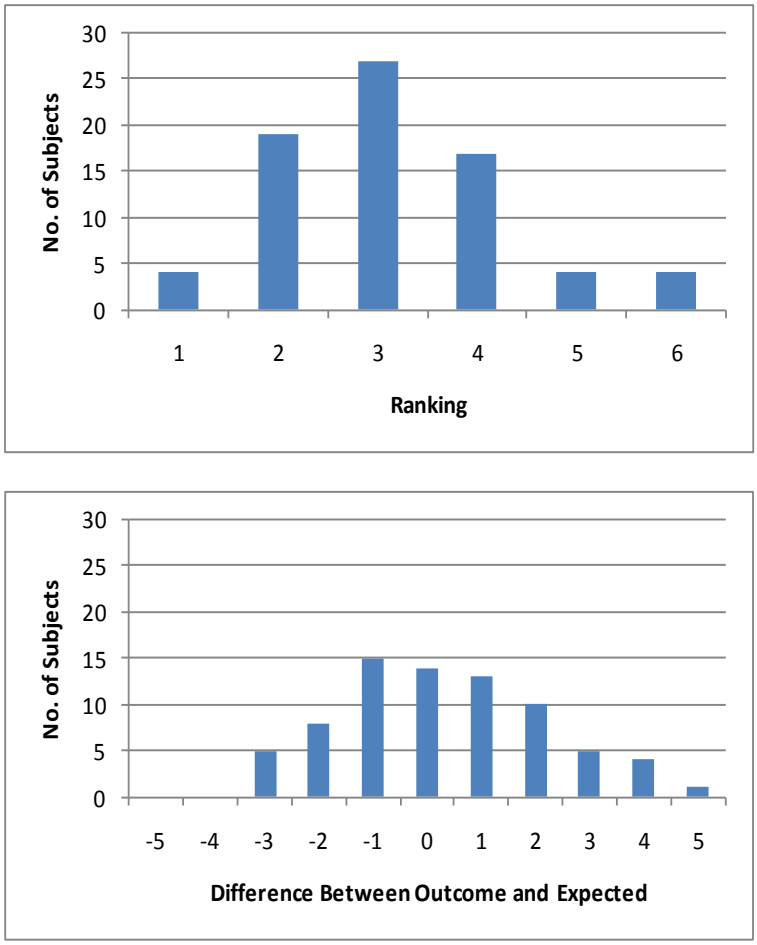


Note: the first figure shows the third round in treatment 2, with no bonus incentive and the second figure shows the third round in treatment 1, when a bonus incentive is used

Result 3: We find an indication of overconfidence among the subjects

Figure 5 demonstrates histograms over subject rankings and the difference between expected and actual outcome. In our data, we find that the histogram over subjects' rankings shows similarities to the normal distribution. As discussed, this is a consequence of imperfect information, since the subjects do not know who they are trading against. If students believed they are *above-average,* and thus overconfident, we would expect a left-side skew in the histogram. We therefore test the null hypothesis that the subjects' ranking of themselves is normally distributed against the hypothesis that it is skewed.

Figure 5 Histograms Over the Subjects' Ranking of Expected Outcome and the Difference Between Expected and Actual Outcome



Note: the top figure shows the subjects' ranking of expected outcome and the bottom figure shows the difference between expected and actual outcome

The associated Bowman-Shelton test statistic for our subjects is B = 3.8958 and we can significantly reject the null hypothesis of a normal distribution on a 10 percent level. When we split the subjects according to gender the test statistics are B = 2.3514 for men and B = 0.7705 for women. Therefore, we cannot reject the null hypothesis according to gender. *Table 7* shows a descriptive summary of the measures necessary to calculate the overconfidence of our subjects.

Table 7 Descriptive Summary by Gender

	n	Mean	Std. Deviation	Kurtosis	Std. Error of Kurtosis	Skewness	Std. Error of Skewness
Women	17	4,0	1,1726	-0,285	1,063	0,527	0,550
Men	60	2,9	1,0488	0,401	0,608	0,468	0,309
Total	77	3,1	1,1637	0,294	0,541	0,531	0,274

Ultimately, we can reject the three hypotheses made in the beginning of the thesis. Our results do not show that introducing a bonus reforms bubbles with twice experienced subjects, a bonus does not amplify bubble formation and experience does not result in larger asset market bubbles over time. However, we find that subjects are slightly overconfident and that a bonus incentive significantly increases market activity in the last round.

ANALYSIS

HPS suggested that bubbles form because people do not think like economists. In our study, we used subjects who study economics and financial theory and to a certain extent, this appears to prevent bubble formation. In order to think like an economist, it seems you actually have to be one.

Our experimental results suggest that bubbles do not form in markets with highly sophisticated subjects, but only if you define sophistication as theoretical, economic knowledge. When SSW conducted their original test of sophistication, they used businessmen who trade in real markets. However, it might have been quite some time since they went to university and learned that the price of an asset is equal to the discounted value of its future dividends. University students should have this knowledge fresh in their memory.

Each participant seemed to have the necessary understanding needed to recognize the concept of fundamental value in a controlled asset market environment. In our experiment the model of fundamental value seemed to hold, on average, throughout all markets. This is in contrast to SSW where they stated that common knowledge is insufficient to induce initial common expectations. In our market the participants appear to have initial homogenous expectations and therefore subjects make rational decisions and carefully trade close to fundamental value.

We also observed that students during the sessions strictly followed the expected value table of the asset and frequently made notes in order to discover if there was any pattern in dividend payments. Consequently, as the subjects appear to fully understand the concept of backward induction; the findings show little sign of decision error.

On average, we have discovered no sign of speculation in the asset markets. SSE students make rational decisions and seem to believe that other participants have rational pricing expectations.

Therefore we find that SSE students understand the sophistication of other participants within the market and somehow believe that they cannot "outsmart" the other traders by selling overpriced assets. However, the subjects do show signs of overconfidence. Therefore, due to the 10 percent significance, we cannot reject the "greater fool" theory or the Lake Wobegon effect.

When it comes to turnover, we find a significant increase in the volume of traded assets in the markets with a bonus incentive. If we assume that the subjects are risk neutral this can be explained by the fact that a bonus incentive makes it rational for subjects to trade, even though the equilibrium price is still equal to the fundamental. Previous studies (Noussair and Plott, 2001, SSW, 1988) have linked excessive volume to bubble formation however, as most of our markets did not form asset bubbles, we cannot confirm this connection. Neither have we found that high turnover is affected by decision error nor speculation.

Rather, the increased market activity can be explained by a competitive behaviour where the subjects aim to receive the highest payoff by taking on a trading strategy to make a few extra SEK. These observations are in line with the discussion in the "Justifications for Method", where we predicted an increased asset turnover in these markets. Competitive behaviour could also be observed after the game when several subjects requested feedback on their strategies and eagerly compared themselves to their competitors in the market.

Nevertheless, in our control markets where we did not give a bonus incentive one can question why the subjects trade at all. This can possibly be explained by participation bias. Our market mechanism gave no alternative activities for the subjects and although we have tried to minimize the trading time to decrease the effect of participation bias, one can wonder whether they traded to amuse themselves. As the ask and bid spreads were closely linked to fundamental value traders seemed to believe they could make a few extra SEK by trading even though it would not affect their profit significantly. As the dividend function is random, in the very long run, one cannot receive more than fundamental value. However, in the short run, subjects in a laboratory market might be lucky in and receive a high dividend payment.

Further, the relatively high monetary bonus incentive did not disrupt market equilibrium (bonuses do not cause bubbles to reform) and the REM holds throughout our markets. Even the three experimental asset markets that did bubble move towards REM in the long run, as the amplitude and price deviation decrease with experience, even though three observations are too few to draw any statistical conclusions. If the observed bubbles are a result of heterogeneous expectations, the uncertainty in the market seems to decrease with time.

Finally, looking at our results we reject *hypotheses 1*, *2* and *3* and we cannot establish a connection between bonus incentives and asset bubble formation. However, as the control markets also lack asset

bubbles there must be something about our study that differentiates it from previous experiments of bubble formation. Perhaps we have succeeded in finding truly sophisticated subjects that really understand the model of asset pricing.

CONCLUSION

DISCUSSION

In the discussion of our results we aim to draw parallels between the experimental asset market and the real world. However, one must be aware of the contrast between the experimental asset markets with its' controlled environment, and the continuously changing and imperfect markets of the real world.

There is an ongoing debate about whether the bonus structure of the investment banking industry is to blame for fuelling the financial crisis of 2007-09. Our results do not confirm the ongoing bonus debate in the media; if bonuses really were to induce higher risk taking we should have been able to observe this in the markets manipulated with a bonus. Instead, we find that the participants are well acquainted with the concept of fundamental value of an asset and unwilling to take uncalled for risks.

In November 2008, a Swedish debate program *Kvällsöppet* on channel four discussed the financial crisis and the executives' greed for bonuses. Lennart Ekdahl, a Swedish journalist and host of the programme, stated that students from the SSE are the future of the Swedish financial industry and pointed out their moral responsibility towards society. We have used these very same students in our experiment, and have not found any evidence of systematic speculation.

Moreover, turnover did increase as bonuses were introduced and we can see a tendency towards competitive behaviour amongst the subjects. According to economic theory, higher liquidity in competitive markets induces a better price mechanism and the price therefore reaches closer to an efficient long-run equilibrium. Therefore, the level of bonus chosen in our laboratory experiment can be interpreted to increase market efficiency without causing asset bubble formation.

However, we can also be critical to the level of bonus chosen in our study. The bonus incentive used in our experiment was three times what a subject would expect to receive in one round while in the real world traders do occasionally receive bonuses that are multiple times their yearly fixed salary. Our bonus incentive was also based on relative rather than absolute performance. It is likely that a larger bonus incentive, that included both a relative and an absolute reward structure, would have made subjects more risk seeking and we might have been able to observe trades above fundamental value.

There is a risk that we have chosen a subject pool that is too sophisticated for bubbles to form in this sort of experiment, and therefore our results can be biased. The SSE students do seem to expect homogenous beliefs among other SSE students and one can question if they would act in the same way if they were mixed with students from other universities. This would be an interesting topic for further research.

The fact that real life asset markets are a mix of naïve and sophisticated traders may have an effect on the occurrence of bubbles. DLM (2005) found that it only requires one third of experienced traders to reduce bubble formation. In our experiment, the three markets that did bubble consisted of between 50 and 83 percent bachelor students. Perhaps if a new study was made with only bachelor SSE students, who are not as highly sophisticated, one might observe different results. The subject pool could also be a mixture of bachelor SSE students and other unsophisticated students.

In the real world with imperfect markets containing information asymmetries, the competitive behaviour might increase the SSE students' overconfidence against subjects with other backgrounds. In this kind of market, the SSE student might believe she can outsmart other actors and a bonus might result in higher risk taking, speculation and hence, bubble formation.

Further, although double auction markets have been widely used and found to consistently produce bubbles, there are certain innate weaknesses in this market setting. In order for the experiment to work, the subjects have to trade with their initial endowment. This means that they in effect "gamble" with their own money and that any risks taken are borne by the subjects themselves. One of the main critiques of the bonus system has been that the risks taken are not borne by the traders, and sometimes not even by the financial institutions that employ them, but by the society and tax-payers.

Another interesting issue to examine is the individual behaviour of subjects in the experimental asset market. One can for instance look at individual trading strategies to investigate if traders with different portfolio types, as described in *table 2*, behave differently. For instance, if traders with a large amount of cash sell their assets and hope for low dividends, and on the contrary, if traders with a large amount of assets keep buying assets and hope for high dividends. Further, just as people in real world overpay for lottery tickets, even though the probability of winning is minuscule, one we can look at maxi-mini thinking; if individual traders take risks by overpaying for assets. Finally, we could have studied overconfidence on an individual level in order to investigate if it increases turnover. However, as we aimed to examine market, not individual, behaviour we left out these kinds of investigations.

In conclusion, we aimed with this thesis to increase the understanding of the financial crisis. Contrary to common belief our results have not indicated a link between bonus incentives and bubble formation. However, this does not bring to a close the discussion that the bonus structure has taken part in the financial crisis. Nevertheless, we can question the strongly negative picture towards the bonus systems that the world media creates. Perhaps a smaller bonus, such as in our market, is a good enough incentive to create competitiveness and increase the efficiency of markets without causing bubble formation. Even so, in a world of imperfect markets people might behave differently than in controlled settings and therefore we cannot fully link the subjects' behaviour in our experimental market to the real world.

SUMMARY

In this thesis we have examined what effect a bonus incentive can have on the long-term market equilibrium of an experimental asset market, as well as if bonuses can exacerbate bubbles. In the ongoing debate of possible causes of the financial crisis of 2007-09, bonuses are being blamed for magnifying bubble formation and we wanted to investigate the supposed causality. In contrast to previous studies, we find little evidence of bubble formation in our markets. We interpret our results as a consequence of a highly sophisticated subject pool, as well as a successful reduction in decision error. We do not find any evidence that a bonus incentive aggravates bubbles or creates speculation within our markets; however, there is an increase in market activity. We also find that subjects have a tendency to be overconfident; however we cannot link it to speculation or decision error. Rather, overconfidence can explain the increase in competitive behaviour among the subjects.

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APPENDIX

Table 8 Amplitude

Treatment	Round	Session 1	2	3	4	5
T1	2	0.2362	0.5452	0.0648	0.0170	0.7603
	3	0.0549	0.5190	0.1238	0.0349	0.3913
T2	1	0.1786	0.0329	0.1254	0.1048	0.6937
	2	0.0170	1.0590	0.0698	0.0571	0.1365
	3	0.0349	0.0381	0.0429	0.0667	0.2619
T3	1	0.7619	0.0690	0.0734	0.1173	0.0556
	2	0.4881	0.0302	0.0238	0.0667	0.1365
	3	0.3444	0.0190	0.0222	0.0631	0.1263

Turnover

Treatment	Round	Session 1	2	3	4	5
T1	1	2.5833	3.1667	3.0417	3.4583	4.6250
	2	2.8750	4.2917	3.5833	3.3333	3.8333
	3	3.0417	4.4583	2.0000	3.1250	3.7917
T2	1	1.8333	3.7083	2.1250	1.6667	2.7917
	2	3.3333	1.9167	2.0417	2.2500	2.8333
	3	3.1250	1.0417	1.2917	1.5833	1.5417
T3	1	4.2500	2.0833	1.9583	2.6667	3.8333
	2	3.5417	1.7083	1.9583	2.4583	2.8333
	3	1.9583	1.6250	2.6667	2.1250	3.2083

Normalized Average Price Deviation

Treatment	Round	Session 1	2	3	4	5
T1	1	2.4195	13.8666	1.0473	1.6646	12.0450
	2	2.0491	10.6387	1.7265	0.4457	9.6163
	3	0.7913	14.6510	2.9038	1.1747	7.5089
T2	1	1.3556	1.0824	2.9524	2.0403	6.4266
	2	0.4457	5.1757	1.2981	0.6778	1.2021
	3	1.1747	0.8264	1.9861	0.6771	1.7653
T3	1	12.6540	1.3819	1.8580	1.2820	0.5482
	2	10.8255	0.7521	0.3472	0.9675	1.2021
	3	5.8861	0.7299	0.7451	1.6814	2.7866

INSTRUKTIONER

Generella instruktioner

Det här är ett spel i mikroekonomisk spelteori där du kommer att delta i en fiktiv aktiemarknad där du kan köpa och sälja aktier. Om du följer dessa instruktioner och har ett bra omdöme kan du tjäna mycket pengar. Det är upp till dig hur du väljer att spendera de resurserna du får i början av spelet. Alla siffror anges i tiotals ören.

Beskrivning av aktiemarknaden:
Det kommet att vara totalt 6 personer i varje marknad. I varje rum spelar tre marknader, ni kommer alltså inte att veta vilka personer i rummet ni spelar mot. Det är absolut förbjudet att prata under experimentet. Om ni bryter mot denna regel kommer ni att skickas hem utan pengar.
Pengarna som visas på skärmen är i tiotals ören. 300 ”pengar” är alltså lika med 30 svenska kronor.

En tredjedel av er kommer att börja med 3 aktier och 355 ”pengar”, en tredjedel med 4 aktier och 250 ”pengar” och de resterande med 5 aktier och 145 ”pengar”. Alla har ett förväntat värde på 670 pengar per period.

Varje marknad har 15 perioder där ni kan köpa och sälja aktier och varje period varar i 2 minuter. Aktierna antas ha ett liv på 15 perioder och din aktieportfölj kommer att föras över från en period till en annan. Efter sista perioden har aktierna inget värde längre.

I slutet av varje period delas det ut en utdelning som med 25% sannolikhet kan anta något av värderna { 0, 3 , 9 , 16 } Det förväntade värdet per period är alltså 7 pengar per aktie. Din vinst per period kommer att vara den totala mängden pengar du har i slutet på perioden plus utdelningen på aktierna i din portfölj.

Hur experimentet går till:
Aktiemarknaden som beskrivits ovan kommer att upprepas tre gånger. Innan spelet börjar kommer ni att få göra en testomgång för att lära er hur spelet fungerar. Denna gång kommer ni inte att tjäna/förlora några pengar.

Innan spelet börjar på riktigt kommer ni att behöva svara på en fråga. I slutet av experimentet kommer ni även att få svara på frågor angående kön, inriktning på handels, årskurs, on ni har erfarenhet av finansbranschen. Ni kommer också att få ange namn, inskrivningsnummer, adress och kontonummer. Om du inte har ditt kontonummer med dig kommer vi att maila dig efteråt för att be om det.

KOM IHÅG ATT NI INTE FÅR KOMMUNICERA UNDER EXPERIMENTETS GÅNG!

Tabell över väntevärdet på dina aktier
För att räkna ut väntevärdet per aktie under en aktiemarknad (15 rundor) kan du använda nedanstående tabell till din hjälp.

TABELL ÖVER VÄNTEVÄRDEN (för en aktie per period)

Antal perioder	Nuvarande period	Antal perioder kvar	x	Förväntad utdelning/ aktie	=	Medelvärdet/ aktie om du inte säljer den vidare
15	1	15		7		105
15	2	14		7		98
15	3	13		7		91
15	4	12		7		84
15	5	11		7		77
15	6	10		7		70
15	7	9		7		63
15	8	8		7		56
15	9	7		7		49
15	10	6		7		42
15	11	5		7		35
15	12	4		7		28
15	13	3		7		21
15	14	2		7		14
15	15	1		7		7

- Kolumn 1; indikerar den sista perioden (15) i marknaden.
- Kolumn 2; indikerar den perioden du befinner dig i och som vi beräknar aktiens väntevärde för.
- Kolumn 3; beräknar antalet perioder som du har kvar att spela, räknar från 15 och ner.
- Kolumn 4; beräknar den genomsnittliga utdelningen för varje period.
- Kolumn 5; beräknar det genomsnittliga väntevärdet per aktie per period. Detta värde minskar med den genomsnittliga utdelningen per period.

Till exempel, anta att det är fyra perioder kvar. Då det finns en sannolikhet på 25% var och en av de fyra utdelningarna inträffar, kommer den förväntade utdelningen att vara är 7 och aktiens värde att vara 28 ”pengar”. Om du håller en aktie i 4 perioder kommer den totala förväntade utdelningen att vara $4 \times 7 = 28$

Hur du ska beräkna din vinst
Din vinst kommer varje period att vara lika med värdet av din utdelning som du får i ***slutet på varje period*** gånger antalet aktier du har i din portfölj.

VINST PER PERIOD = UTDELNING PER AKTIE × ANTALET AKTIER PER PERIOD

När du sedan spenderar dina kontanter i din portfölj för att köpa X antal aktier kommer värdet av dina pengar att minska i period 15 till den summa du har köpt aktier för. Om du istället säljer X antal aktier kommer värdet av dina kontanter att öka med den summa du har sålt aktier för.

Din ihoptjänade summa per aktiemarknad kommer att vara lika med din vinst för alla 15 perioder samt den summa pengar du har is slutet av alla 15 perioder.

TOTALT IHOPTJÄNADE SUMMA PER AKTIEMARKNAD=

VINST PERIOD 1 + VINST PERIOD 2+ VINST PERIOD 3 + VINST PERIOD 4 + VINST PERIOD 5 +

VINST PERIOD 6 +VINST PERIOD 7 + VINST PERIOD 8 + VINST PERIOD 9 + VINST PERIOD 10 + VINST PERIOD 11 + VINST PERIOD 12 + VINST PERIOD 13 + VINST PERIOD 14 + VINST PERIOD 15 + VÄRDET AV KONTANTERNA I SLUTET AV PERIOD 15.

Då vi kommer att spela totalt 3 stycken aktiemarknader kommer din totala ihoptjänade summa för spelet att vara lika med summan av utdelningarna för alla 15 perioder gånger 3, samt värdet av dina kontanter i slutet av varje marknad gånger 3. Denna summa måste du räkna ut själv, det kommer inte datorn att göra åt dig. Vi kommer däremot att veta exakt cad alla har tjänat.

Det förväntade värdet för alla rundor, dvs. utdelning och kontanter, är 2010 ”pengar” (201 konor)

Information om datorskärmen

Längst upp på skärmen

Tid: Visar hur många sekunder av perioden som är kvar. Tiden tickar ned från 120 sekunder.

Period: Visar vilken period (av 15) som spelet just nu är i.

Pengar: Visar hur mycket pengar du har i tiotals ören.

Aktier: Visar hur många aktier du har

Knapparna längst ned på skärmen

Jag vill sälja för… skriv in en summa som du kan tänka dig att sälja en aktie för och klicka på knappen.

Jag vill köpa för… skriv in en summa som du kan tänka dig att köpa en aktie för och klicka på knappen.

Sälj Tryck på säljknappen om du vill sälja en aktie för den markerade summan i kolumnen ”Säljanbud”

Köp Tryck på köpknappen om du vill sälja en aktie för den markerade summan i kolumnen ”Köpanbud”

Kolumnerna i mitten av skärmen

Säljanbud Visar alla säljanbud. Det lägsta priset som någon kan tänka sig att sälja för visas längst ned

Köpta aktier Visar priset för alla aktier som har köpts/sålts under perioden.

Köpanbud Visar alla köpanbud. Det högsta priset som någon kan tänka sig att köpa för visas längst ned.

Vinstrapport: I slutet av varje period visas hur mycket (inklusive utdelning) som du har tjänat ihop.