THE ROLE OF PUBLIC INFORMATION ON THE EFFICIENCY OF FINANCIAL MARKETS

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ABSTRACT:

The current economic situation has sparked a debate about the role of the rating agencies in market performance. A crucial issue in the operation of this financial system is the way in which private and public information is generated, distributed and used and how it is incorporated into asset prices. In this study we use laboratory experiment to investigate the role of public information on the efficiency of financial markets. The main focus of the paper is to analyse if the presence of imperfect and exogenous private and public information improve o reduces market efficiency. We conclude that the introduction of a public signal with high quality than private signals, and the release of more public information improve price efficiency. Presence of public signals ensures an efficient transmission of information so market converges to the efficient equilibrium. It is observe that public information coordinates trading activity.

INDEX:

1. INTRODUCTION:

Financial markets have traditionally been analyzed under different conditions trying to understand their behaviour and how to reach and efficient market. The efficient markets hypothesis has historically been one of the mainstays of academic finance research. The general concept of the efficient markets hypothesis is that financial markets are "informationally efficient"- in other words, that asset prices in financial markets reflect all relevant information about an asset. For these reason a crucial issue in the operation of financial system is the way in which private and public information is generated, distributed and used and how it is incorporated into asset prices.

The current economic situation has sparked a debate about the role of the rating agencies in market performance. Before this economic recession any information revealed by these rating agencies has a major impact on the market, and prices reacted in a very short time. The debate on rating agencies is about the method used for qualify the value of the assets, which with the outbreak of the economic crisis it has been found that the information released by this companies was not correct and many investors made losses. Many academics and regulators wondered why many investors follow the recommendations of these agencies without corroborate the information. Did all investors who participate in the market buy private information or they only follow the market behaviour? What is the role of public information in these markets?

Inspired by the debate on which role have played rating agencies in the current financial crisis, in our paper we use laboratory experiment to investigate the effect of realising imperfect and free public signal in a financial market with the presence of a costly private signal and also imperfect about the future value of the dividend. The main focus of the paper is to analyse if the presence of private and public information improve o reduces market efficiency. Moreover we will study the effect of public signals in the demand of private information and how efficient are prices with the aggregation of information.

There have been many researchers who have analyzed the effect of the presence of different sources of information in financial markets. Taking into account Morris (2002) research, he demonstrate that public information is a double edged-instrument, because it conveys information on the fundamentals of a financial assets, but at teh same time, it serves as a focal point in coordinating the traders´ activity in a market. Following Morris (2002) theory, in our experiment we can see the interaction between private and public information.

Another important paper is Sunder and Plot (1992) research which studied the impact of the presence of an information market (as a second market) and an assed market. In their experiment they defined as an insider those players who completely know the future value of the dividend, so they have privilege information. They conclude that when every traders know that there are some insiders traders buy the do not know how many of them there are, information is not revelled in a efficient way so market prices no revel any information.

The most similar experiment literature to our study is Hey and Morone (2003) experiment. They made traders decided to trade with a risk asset whose dividend at the end of the period depends on two states of the world with the same probability of occurrence, given the imperfect information available in the market. With these experiment they conclude that the aggregation of information improves when the quality and also the quantity of information available in the market is higher.

There are not too many experiment literature take attention to such interaction of information. However we can mention some other studies which can help us to understand other market behaviour under different conditions. In our experiment the information released is imperfect but there are studies like Plott (1982) where the information available in the market is perfect and they also want to try to find put under which conditions this perfect information is efficiently incorporate into prices. In their experiment their determinate as in *insiders* those agents who are completely informed about the true value of the dividend, and *noninsiders* those who are uninformed. They conclude that "traders are able to decipher the true state of the dividend by simply observing market price".

One important finding is that, even under the best circumstances, information aggregation and/or dissemination (when occurs) is not instantaneous, since the traders need some time to observe the market activity, form conjectures, test them and modify their strategies. Therefore, there is an incentive for costly information creation due to the noisy revelation of information in asset markets (see Grossman and Stiglitz [1980]). In those cases there is market for information parallel to an asset market, as we will see in our experiment.

In general, the experimental literature focuses on the problem of the market efficiency in aggregating private information into prices. As we have said before there are not too much studies where the effects of public and private information in the market is evaluated due to the further investigation required. Our experiment is focused in this debate to try to find out what is the role of public information in the efficiency of the market.

2. EXPERIMENTAL DESIGN

In this section we will describe the characteristic of the experiments analysed. The market is made up of 17 subjects. The experiment consists in three treatments. At the beginning of each trading period, all of the subjects are endowed with 100 units of experimental currency (EU) and 10 units of assets. At the end of the trading period the asset pays a dividend that depends on two possible 'states of the world´ which are *S* and *T*, each with equal probability. If the state of the world is *S* the dividend is equal to 10, and if the state of the world is *T*, the dividend is equal to 0. The true value of the world in not revealed until the end of the period, but they can however, buy private signals or observe the public ones.

At any moment when the trading period has start, subjects can buy a private signal which has a cost of 4 EU. Additionally, only in those treatments with public information, subjects have access to a public signal, that has no cost to them and it is common to all subjects in the market. Such signal is made public before the trading period starts. Both of these signals do not totally reveal the true state of the world, they are partially informative. These signals take either the value 0 or the value 1, where each of them represents a probability of occurrence which the dividend could be 0 or 10.

Before starting the experiment subjects are informed about these probabilities. The probability of getting a private signal 1 (0) is p if the true state of the world is S (T) and the probability of getting a private signal 1 (0) is $1 - p$ if the state of the world is T (S). In this way, if a subject purchases a signal that results to be 1 (0), he can infer that the asset dividend at the end of the trading period is expected to be 10 (0) with probability p and 0 (10) with probability 1−p. Following the same reasoning, in the second and in the third treatment we introduce one public and two public signals respectively, so the probability of getting a public signal 1 (0) is P if the state of the world is S (T) and the probability of getting a public signal of 1 (0) is 1 − P if the state of the world is T (S). This means that, if a subject observes a public signal equal to 1 (0), he/she can infer that the asset dividend at the end of the trading period will be 10 (0) with probability P and 0 (10) with probability 1 − P.

The different treatments implemented and each of the probabilities of success of the true value of the dividend in each signal in each period is displayed in Table 1:

TREATMENT	p	P
1	0.6	-
2	0.6	0.8
3	0.6	0.66

From table 1 we see that in the three treatments we have private signals with a fixed quality which is accurate by 60%. In the second treatment, a part from the private signals, there is a public signal available for all the subjects and it is at least better than the private signals because the public ones is accurate by 80%.
In the third treatment, in addition to the private signals, the public authority release two public signals which are independent among them, and each of them has 66% accuracy.

Taking into account the accuracy of each signal type we can say that the rating agency or the public authority are endowed with and invest more resources in collecting and processing information compared to a private trader. For this reason public signals are more accurate about the future value of the dividend. Despite this, our experimental design allows for a private trader to invest in several private signals that, in aggregate, can make private information to be more accurate that the public signal for that particular trader. Therefore, we assume that the production of a public signal has lower cost for the public institution that for the private trader. For that, subjects must pay if they want to use a private service, and those companies can cover their cost with those incomes.

Another important characteristic is that private information has a cost and its information is only revealed to those who have bought the signal, while public information is freely revealed to all traders at the beginning of the period.

The experiment was programmed using the Z-Tree software (Fischbacher [2007]).
When the subjects arrived to the laboratory the instructions were distributed and explained aloud using a Power Point presentation and questions were answered. The experiment consisted in three independent treatments, the fist one has eight trading periods (markets) and the two remaining have seven trading periods. Each period lasts two and a half minutes. At the beginning of each trading period the dividend was randomly determined by the experimenter (but not revealed to the traders) and paid out at the end of the period.

During the trading period subjects can buy and sell as many assets as they want- as long as they have money. Every bid, ask, or transaction concerned only one asset. Agents will end up with a stock of money and assets that can be greater or less than that with which they started that period.
At the end of each market period the true dividend for that period is announced and the appropriate dividend distributed to the asset owners. Each subject will get profit when the amount of money obtained at the end of the period is higher than the initial which in this case are 1.000 UE. On the other hand, subjects can make losses. So profit was computed as the difference between their initial money endowment (M = 1000) and the money held at the end of the trading period. Parallel to the asset market, there is an information market where subjects can purchase as many private signals as they wanted during a given trading period, as long as they had enough money.

Every subject get paid in Euros at the end of the experiment, and their benefits will correspond to the accumulate profits of all periods and a fixed amount of 5 Euros for participating in the experiment. The exchange rate is 1 Euro for every 50 points accumulated.

3. HOW WE EXPECT THE MARKET WORKS?:

There have been many experiments on financial market to analyze the presence of public and private information in a market, and to observe its effect on price and demand information from players. Each of these experiments has different characteristics, different information cost or other signals quality. Although in each of them has obtained different conclusion but there are some theories that can explain some market behaviours, which are equal for all the financial markets.

All players will try to sell their assets at a high price and buy a low price. Is they are sure or they believe that the dividend will be 10, they will decide to accumulate shares, but nevertheless if the believe that the dividend will be 0 they will decide to sell their assets. We must remember that in a perfect market an oversupply of a product decreases the price, and an excess demand has the opposite effect on the price.

Taking in to account John D. Hey and Andrea Morone considerations we can describe the following theory emphasizing two things; the price converge, and the two possible strategies for traders in a financial market. With this theory we can describe which will be the market behaviour according to the information available.

First that the price in the market 'should' converge to the true value of the dividend – if the market correctly aggregates the information available to the agents. If the true state of the world is that the dividend is 10 the price 'should' converge to 10; if the true state of the world is that the dividend is zero the price 'should' converge to zero. However, we have no theory which tells us that the price will converge to the true value of the dividend.
After this experiment they have no evidence on which will be the optimal behaviour of agents in this experiment. Obviously, a subject who pays for a signal will be greater informed about the true dividend and it seems to have advantages. Despite this, the private signal is costly and many subjects will decide not to buy private information. In this case an alternative strategy is to follow the theorem of Grossman and Stiglitz, and to use the price of trades as an indicator of information obtained by others.
Therefore each subject has two possible strategies: buy signals before others to be more informed and lead the market; do not buy signals but follow the behaviour of other subjects and the market prices. Thereby if the market correctly aggregates the information privately available, price tend to converge to the true dividend. This, in a sense the idea defended by Grossman and Stiglitz.
This second strategy to follow the behaviour of other subjects has been described as herd behaviour in non-market context. Banerjee (1992) and Bikhchandani et al. (1992), among others, introduced this herd behaviour in the finance literature and highlighted its possible consequences for the overall functioning of financial markets and information processing by individuals. Both of them showed that this herd behaviour may result from private information not publicly shared. Therefore they observed that the market price converge to the wrong dividend when the herd behaviour appears.

The phenomenon of herding was first studied in psychology. For instance, Asch (1952) studied the impact of an individual's social environment on his decision behaviour and observed that "*within individuals groups often abandon their own private signal to rely predominantly on group opinion. Moreover, this form of behaviour increases with the unpredictability of earning".* Since analysts tend to herd their pessimistic forecasts, we assume that they will only deviate from their unbiased estimate if their private signal is lower than the public signal.

Asch (1952) continued explaining this theory saying that *"Information-based herding occurs when analysts lack confidence about their private information and there exists (a lot of) uncertainty about the quality of public information. As a consequence, analysts abandon their private signal (which is needed to optimally update the available information), and follow the herd that maintains an inefficient consensus*".

In general, evidence of herding was documented, but difficulties in measuring herding made it difficult to give a decisive answer about the degree of herding.

4. EFFICIENT MARKET BENCHMARK:

Using the Bayesian inference, we can compute the probability of getting the different possible dividends. We can compute the probability which corresponds to the case of the dividend equal to 10 conditioned on number of signals purchased by all traders at any instant of time in the treatment, which we denote as IT = {i1, i2, ...it, ..., iT }. We refer to IT as the market information set. When the variable takes the value −1, it suggests that the dividend is equal to 0, and when takes value 1, it suggests that the dividend is equal to10.

We are going to use the same Bayesian inference formula as S. Alfarano, E. Camacho and A. Morone (2011) use in their research about the role of public and private information in a laboratory financial market.

Bayesian Inference with private information:

We are going to use the following formula of the Bayesian inference:

$$\Pr\,(D = 10|I_T) = \frac{\Pr(I_T\,|D=10)*\Pr(D=10)}{\Pr(I_T)} \qquad (1)$$

D = 10 refers to the case of the dividend equal to 10. Pr(D = 10|IT) probability that the dividend is equal to 10 conditioned to the information available in the market at time T. Pr(D = 10) is the prior probability of the event D = 10 without information. Pr(IT) is the marginal probability:

$$\Pr\,(I_T) = \Pr(I_T\,|D = 10) \cdot \Pr(D = 10) + \Pr(I_T\,|D = 0) \cdot \Pr(D = 0). \qquad (2)$$

We can compute the probability that the dividend is equal to 10 using the following relation:

$$\Pr(D = 0|I_T) = 1 - \Pr(D = 10|I_T) \qquad (3)$$

because we only have two possible dividends.

The values to the different terms of these equations as a function of:

- *p* is the probability that a single private signal is correct;
- *q = 1− p* is the probability that a single private signal is incorrect;
- *NT* is the number of signals in the information set available up to time T;
- *nT* is the number of 1s and NT − nT is the number of -1s in the information set.
- Since we compute the probability Pr(D = 10|IT), the signals -1s and 1s refer to the true state of the world D = 10. In other words, the case it = 1 suggests that the dividend is 10, on the contrary, the case it = −1 suggests an asset worths zero.

In the following, when not necessary, we will omit the time variable T from the variables nT and NT. The first term of equation (1) is given by:

$$\Pr(IT \mid D = 10) = p^n \cdot q^{N-n} \quad (4)$$

Given that we only have two states of the world and they can occur with the same portability, the prior probability is given by:

$$\Pr(D = 10) = \Pr(D = 0) = \frac{1}{2} \quad (5)$$

The marginal probability in equation (2) takes then forms:

$$\Pr(I_T) = \frac{1}{2} p^n \cdot q^{N-n} + \frac{1}{2} p^{N-n} \cdot q^n \quad (6)$$

Putting together equations. (1), (4), (5) and (6), we obtain:

$$\Pr(D = 10 \mid I_T) = \frac{p^n \cdot q^{N-n}}{p^n \cdot q^{N-n} + p^{N-n} \cdot q^n} \quad (7)$$

as the aggregate net private signal available at time T, the previous equation takes the form:

$$\Pr(D = 10 \mid IT) = \left[1 + \left(\frac{q}{p}\right)^{\eta T}\right]^{-1} \quad (8)$$

and

$$\Pr(D = 0 \mid IT) = 1 - \Pr(D = 10 \mid IT) = \left[1 + \left(\frac{p}{q}\right)^{\eta T}\right]^{-1} \quad (9)$$

According to equation (8), we can identify several interesting cases:

- If p = 1 and therefore q = 0, Pr(D = 10|IT) = 1, which is independent of NT, when not zero. It is the case of fully informative signals.
- If q = p = 0.5 then Pr(D = 10|IT) = 0.5. Purchasing signals does not provide any new information compared to the starting condition of equiprobability of the two states of the world.
- If ηT = 0, i.e. an equal number of 1s and -1s, Pr(D = 10|IT) = 0.5. This is obviously the case at the beginning of the trading period when there are no signals in the market, and also might arise by chance during the experiment.

Bayesian inference with private and public information:

The previous Bayesian inference equations are based on the condition of constant quality of signals. In our experiment private signals have a fixed quality of *p=0,60* in all treatments.

In two of our treatment we have a public signal of quality P ≥ p. In order to account for the impact of the public signal in the Bayesian inference, let us define as P the probability that the public signal is correct and Q = 1− P, the probability that the public signal is incorrect. The variable S will take the value 1 if the public signal suggests a dividend equal to 10 or −1 if it suggests a dividend equal to 0. Equation (4) is then modified as follows:

$$\Pr(IT, S = 1\ |D = 10) = P\ \cdot [p^n\ \cdot q^{N-n}] \qquad (10)$$

and

$$\Pr(IT, S = -1\ |D = 10) = Q\ \cdot [p^n\ \cdot q^{N-n}] \qquad (11)$$

Using equation (10) and (11), we can easily modify eq. (8) in order to take into account the public signal:

$$\Pr(D = 10|IT, S) = \left[1 + \frac{Q^S}{P}\ \left(\frac{q}{p}\right)^{\eta T}\right]^{-1} \qquad (12)$$

Efficient market price

For compute the price efficiency we will continue using the Bayesian price determinate by S. Alfarano, E. Camacho and A. Morone (2011). In their research they defined as an efficient market when "*all available and relevant information is incorporated into the price of the asset at each instant of time".* In our experimental, those means that the information set used by traders includes all information purchased by the traders, IT

The equilibrium price is given by:

$$Bt = 10 \cdot \Pr(D = 10|IT) + \ 0 \cdot \Pr(D = 0|IT) = 10\ \left[1 + \left(\frac{q}{p}\right)^{\eta T}\right]^{-1} \qquad (13)$$

In the presence of a public signal S equation (13) can be re-written as:

$$Bt = 10 \cdot \Pr(D = 10|IT, S) + \ 0 \cdot \Pr(D = 0|IT, S) = 10\ \left[1 + \left(\frac{Q}{P}\right)^S \left(\frac{q}{p}\right)^{\eta T}\right]^{-1} (14)$$

Equation. (13) and (14) represent a situation where, when a subject buys a signal, this information is incorporated into the price correctly and instantaneously as if such information would be available to all subjects in the market.

5. RESULTS:

Probably the easiest way to summarize the results of our experiments is to display the trading activity in all the markets for the 3 treatments analyzed. As we can see in the Appendix 1, each of the graphs represents a period of each of the three treatments.
All graphics in the vertical axis shows the price at which the transaction occurred, and the horizontal axis shows the number of shares that have taken place in an orderly manner. The bold solid line (either 10 or 0) above each market period shows the actual true dividend (revealed to the participants at the end of the trading period).

To analyze the dynamics of each of these three markets we will focus on these aspects of the experiment; the information demand, the price efficiency, the distribution of net profits, and the relation between net profit and net private signals

- **INFORMATION MARKET DEMAND:**

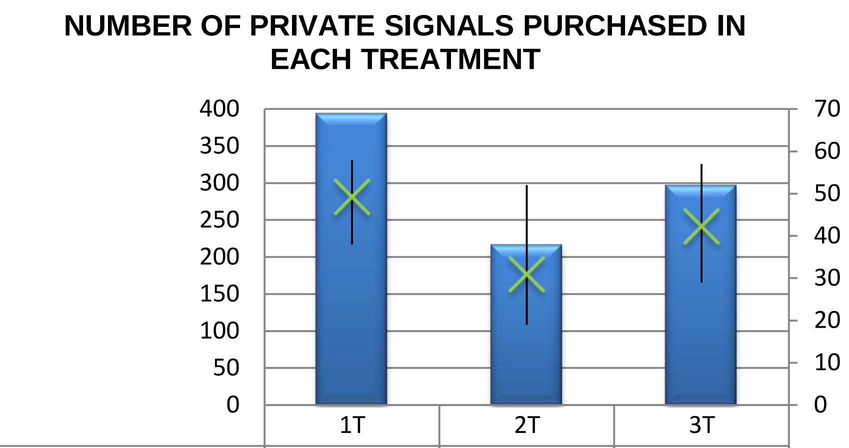
One of the most important aspects of our experiment is the quality and the amount of information available that varies in each of the markets. Each of the subjects will not know the value of the dividend until the end of the period so we want to analyze under which conditions the available information is enough to discover the true value of the dividend. In particular we will focus on analyze the variation in demand from private signals in each market and how this demand is affected by the presence of public information.
Unlike other publication carried on about the role of public and private information in financial markets, in our experiment the quality of the private signal is the same in all the three markets.

Demand of private signals

As we have said before, the quality of the private signals remains constant through the three treatments, with an efficient level of 60%. The graph below shows the distribution of private signals purchased in each treatment and the effect of the present of public information in their demand. It is apparent from the figure that the ambiguity that occurs in the first treatment on the future value of the dividend makes the demand of private signals be located at the highest point. In general, subjects are averse to such situations with ambiguity as shown in "The Ellsberg Paradox," in which he states that subjects prefer quantifiable risks to those who are unknown. Ellsberg in his experiment explained that the uncertainty of knowing the future outcome can be presented in two ways: through risk situations and situations with ambiguity. Risk situations have a certain probability of a certain outcome, while ambiguous situations have a greater degree of uncertainty.

There have been many researchers who have analyzed the presence of ambiguity and risk in financial markets. In one of these analyzes on the financial market Leippold concluded that traders react asymmetrically to the ambiguous information.

When ambiguous information is provided but with potential or positive consequences, subjects act as if they were not entirely sure of the accuracy of the information. However when presented with an ambiguous negative information but act as if it were accurate.



	1T	2T	3T
PRIVATE SIGNALS VOLUME	394	216	296
Maximum number of signals	58	52	57
Minimum number of signals	38	19	29
Averege number of signals	49,25	30,85714286	42,28571429

In this first treatment just over 56%of the subjects decides to buy private information. In this way this subjects have more information and it is more accurate. Considering that, why other subjects do not purchase private signals to be more informed? We can define this as an asymmetry distribution of information. Plot and Sunder (1982) defined as an "insiders", those investors with privilege information about the potential value of the dividend (we have to remember that in their experiment the information released is perfect). They studied the transmission of information in markets with the presence of insiders and noninsiders. Their study reveals that efficient markets may disseminate information from the perfectly informed investors to those uninformed. This information is transmitted through price and the volume of demand or supply of assets. This transmission of information reduces the uncertainty mentioned before. Therefore Plot and Sunder concluded that the market is able to extract information from insiders and transmit this information to the market to give advantage to all subjects. A competitive markets lead to an efficient location using price as a factor in information.

We have to considerer that obtaining private information is costly so many players decided not to buy this information and follow market signals.

Presence of Public Information

Another interesting point of the analysis relates to the impact that the presence of a free public signal has on the traders' behavior in the information market, and how the acquisition of private signals is affected by the presence of a free public signal of better or similar quality that a private signal.

As it is show in the graph above, when we introduce a public signal the number of purchased signals is significantly minor. However, when the quality of the public signal is higher to the single private signal (Treatment 2) the reduction on the number of signals purchased is more pronounced that in the situation where the public signal released in the market has similar accuracy that a single private signal (Treatment 3). Then, we can analyze this behavior in more detail.

As we have said, in the second treatment when we introduce a public signal, that is more efficient than the private ones, demand of private information decrease. This situation arises for two reasons: the private information cost and his lower quality. These private signals have lower quality so the ambiguity of the future values of the dividend is higher, for these reason subjects will decide not to invest in private signals. According to the figure, subjects trust more on the public signals and prefer to spend less on private information with lower quality. Therefore it is demonstrate that there is a substitution of part of market information provided by several private signals with a single public signal.

In the third treatment there are two public signals, both with higher quality than the private ones. However this public signals are less efficient than in the previous treatment, and their quality is not very high with respect to private ones.
Analyzing the graph we can see that the demand for private information is higher than in the second treatment, but not as higher as the first one.
It seems to be that providing more public information creates more ambiguity to subjects, because each public signal can give different values. We must consider that if every public signal indicates a different value of the dividend (for example, signal A indicates a dividend of 10 and signal B indicates a dividend of 0), in this case traders do not have additional information. They will be in the same situation as in the first treatment, which the probability of each dividend is 50%, so they will purchase private signals according to this situation. For these reason in this third treatment there is an increase in the number of private signals, because with no further information (when each public signals take different values) traders try to be more informed buying private information.

We concluded that fixing the quality of the private signal, we observe that the greater demand for private information takes places when in the market is not further information and subjects want to reduce the ambiguity of not knowing the true value of the dividend (Treatment 1). Furthermore the release of public information into a financial market provokes a decrease on the demand of private information. This phenomenon is observed in both, in Treatment 2 with one public signal and in the Treatment 3 with two public signals. The higher quality and the free disposition of the public signals make subjects be more confidence in them.

However when we have more public information but it haves less quality, and public signals can give contrary information of the dividend, subjects purchase again private signals due to the ambiguity created of the future dividend value.

However, it remains an open question; any type of public information realest to the market provokes a clear decrease in private signals demand? We must clarify that the demand of private signals not only depends on the release of public information, but it also depends on the quality of such information at its quantity. The more accurate is the public information the lower will be the demand of private signals. Despite this, an excess of public information available on the market creates a greater ambiguity, because every public signals can take different values, so subjects decide to prevent this situation by buying private signals.

Two public signals with different values:

In the third treatment traders have aces to more free and public information because they have two independent signals, but their efficiency is similar to the private signals (p =0, 60 and P= 0, 66). We can think that if traders have more public signals they would not have incentive to buy private information, but how traders react when they have two public signals with different values or when both indicate the same value of the dividend?
Imagine that signal *A* indicates a dividend of 10 and signal *B* indicates a dividend of 0, in this case traders do not have additional information about what will be the dividend, and they are in a situation with ambiguity. They will be in the same case as in the first treatment, where the probability of each dividend is 50%, so they will purchase private signals to try to find out what will be the dividend.
We can analyze the demand of private information when each signal take different values and compare this with the demand of private information in the first treatment because the ambiguity situation is the same.

In the following table appears the number of private signals purchased in each period of the three treatments and the average of signals displayed by treatment. In this third treatment two of the seven periods (*Period 4* and *Period 5)* show this situation where every public signal takes a different value (those which are marked in green). In these two periods, signal *A* show a dividend equal to 0 and the signal *B* show a dividend equal to 10. In these both periods the demand for private signals exceeds the average of signals purchased in the third treatment (in Period 4 the number of signals purchased is 59 which is higher than the average signals of the period, 59> 42, 28. In Treatment 5 the number of signals purchased is 57 which is also higher than the average signals of the period 57 > 42, 28). Therefore we can say that in the situations where public signals give opposite values the demand of private information get the highest values. We can compare the average of signals purchased in these two periods with the average demand of private signals in Treatment 1. In Treatment 1 the average of private purchased is 49, 25 and the average of signals purchased in these two periods of Treatment 3 is 58 as we can see in the table.

Therefore we can say that when public signals are contrary traders increase their demand for private signals more than usual. In this situation the knowledge on the value of the dividend are the same as in Treatment 1(probability of each dividend is 50%), but having two public signals which do not added information creates a greater uncertainty for traders. It is a risk that can not be quantified so in these cases traders decided to buy more signals than usual to be more informed.

Public information is the same for everyone so everyone in these cases has the same ambiguity. Trader knowing that will buy more signals to be more informed than the other traders about the value of the dividend and to be able to adjust their purchase´s and sale´s prices. In this third treatment, the secondary market where traders buy information has the most important role. Depend on how fast traders buy signals and what are the values obtained they will be able to react faster in the market and get higher profits. However we have to remember that private information is not perfect so maybe the final dividend it is not what the signal indicate. For these reason traders a part for observing their private signals also take in to account what the other players do because maybe they can think that the imperfect information that they have buy is incorrect and the information that other player is more accurate. So in these two periods that we have analyzed, how the market and prices displayed around all the period will have a very important role to try to find out what will be the dividend. Moreover if the information is efficiently distributed through the market traders who did not buy information can use the price of trades as an indicator of information obtained by others.

PERIOD	TREATMENT 1	TREATMENT 2	TREATMENT 3	Average of signals
1	46	33	29	**36**
2	38	52	33	
3	58	29	31	
4	53	21	59	**58**
5	41	34	57	
6	55	28	30	
7	54	19	57	
8	49			
Average of signals	**49,25**	**30,85714286**	**42,28571429**	

Number of private signals purchased in each period of the three treatments and the average of signals displayed by treatment.

<u>Two public signals with equal values:</u>

In the other hand, how is affected the demand of private information when the two public signals indicate the same value of the dividend?. In this third Treatment five of the seven periods, signal A and B indicate the same value of the dividend (those which are market in orange). We have to remember that these signals are efficient in a 66%, so when both show the same dividend is like having one public signal with an efficiency of 80%.

For this reason we can compare the demand of private signals in those treatments with the demand of private signals in the second period when we only have one public signal with an 80% of efficiency.

Firstly we can say that the demand of signals in these seven periods does not exceed the average signal of all treatment. Whit this data we can already see that when the two public signals indicate the same value, the demand for private information is not as high as in the previous situation. Traders therefore have public information that reveals the potential value of the dividend so the uncertainty is less.
As we have said before this situation is equal to Treatment 2, because if the two signals show the same value is like having one only signal. For this reason we can compare the average of demand of private information in these seven periods of the third treatment (which is 36) with the average private signals in Treatment 2 (which is 30, 85). The average of private signals in these seven periods is higher than the average of signals of all Treatment 2. If the two public signals show the same value of the dividend why traders continue buying private information? In this third treatment the efficiency of the public signal is minor (P= 0, 66) and similar to the efficiency of private signals (p= 0, 66) for that maybe some traders do not end up relying on the public information provided. They also can think that having two equal public signals is like having two private signals because their efficiency is similar, so they will continue buying signals to try to be more informed.

In these traders' behavior we can apply the Leippold theory that we mentioned before which say traders react asymmetrically to the ambiguous information. When there is some positive information or conditions in the market (like having two public signals whit the same value) subjects act as if they were not entirely sure of the accuracy of the information. They do not trust in these positive results and therefore they continue buying signals. However when there is a negative information (like having two public signals with different value) they act as if it were accurate. We have seen this behavior in Period 4 and 5 of Treatment 3 where traders buy a largest number of signals because there is a higher risk of make losses.

- **ANALYSIS OF THE PRICE EFFICIENCY**

In this section, we analyze if the market price converge to the Bayesian benchmark in a market with costly private information and also to the introduction of public information. In other words, given the information available in the market, we want to compare what the subjects have done in the experiment and what they could have done to get an efficient market.

To analyze this price efficiency we had calculate the Bayesian benchmark for each trading period of the three markets, and we have compared it with the average price of each trading period. As we have said before and taking into account John D. Hey and Andrea Morone (2004) theory, the price market 'should' converge to the true value of the dividend to become a efficient market. So we can see this efficiency represented in the Bayesian benchmark.

This Bayesian benchmark represents the optimal price that market should achieve given the information available in the market. When the dividend is 10 the Bayesian benchmark should converge to 10; and when the dividend is zero the Bayesian benchmark should converge to zero.

We can see the results of this comparison in the following graphs. Each of the graphs represents a treatment. The vertical axis shows the price, and the horizontal axis shows each treading period of the treatments. The blue line represents the average price of every period, and the green line represents the Bayesian benchmark of each period according to the information available in the market. The sort red lines indicate if the dividend of the every period was 0 or 10, and thus allow us to know if the price is adjusted to the future dividend. In the graph also appears the net private signal of each period.

Treatment 1

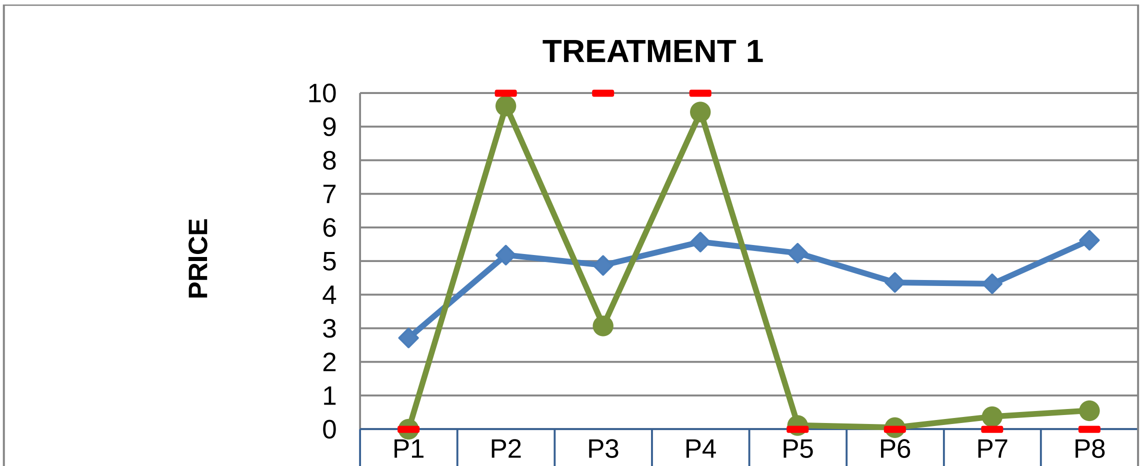
Observing the first graph which is referred to the first treatment we can see that, independently of which has been the dividend, the average price throughout the whole treatment do not have too much volatility. Why subjects react in this way? Some of the subjects did not buy signals, so they are guided by market signals. Without knowing what could be the future dividend they are not willing to earn less than 4 o 5 UE per share which that could be interpreted as the average profit knowing that the dividend can only be 0 or 10.
The other subjects who buy signals observed the values advised but they also take in to account how rest of the traders act. Those traders are more informed than the rest, and they more or less know if market is acting according to the future dividend.

In this type of financial markets the dissemination of information is not always perfect and immediate, and sometime market does not transfer the information of informed traders (those who buy signals) to those uninformed. In this third treatment this situation is described because the price does not converge to any dividend value, so traders did not use the information purchased in a good way. However those informed traders can use their knowledge of the value of the dividend and give incorrect information to the market, and for these reason the prices do not converge to the true dividend. Maybe along periods traders who did not buy information and observed the market behavior to try to find out the dividend will realize that informed traders use their privileged position to deceiving them about the true value of the dividend. We can identify this as a learning process where subjects begin to understand market signals and to detect false information or behavior. This is a slow process and subjects may not identify these situations after a few periods. On the other hand each trader do not know how many informed traders are in the market, and although they have purchased private signals tend to follow the market behavior (observing prices) before considering the values of their signals. This could explain traders' behavior in this treatment.

As we can see on the graph the Bayesian benchmark always converges to the future value of the dividend given market information. However there is one period (*Period 3*) in which this efficiency is not met.

We can observe this behaviour in a more detailed form. To calculate the Bayesian benchmark we take into account the number of private signals presents in each treatment. We calculate how many signals indicate that the dividend will be 0 and how many indicates that the dividend will be 10. Focusing the third period, we have a negative net private signal equal to -2. This situation indicates that in this period there are more incorrect than correct signal i.e. the final dividend was 10 but there are 30 private signals which show that the dividend will be 0 and 28 signals which show that the dividend will be 10. According to this information the Bayesian benchmark takes a value of 3, 1 which is far from the dividend due to the higher number of incorrect information.

As we have mentioned before Bayesian benchmark depends on the number of net private signals. If the net private signals is negative means that there is more incorrect information and the Bayesian will not converge to the true value of the dividend as in this case. Additionally the more number of positive net private signals are in a period the more adjusted will be the Bayesian benchmark to the dividend as we can show in the graph.



	P1	P2	P3	P4	P5	P6	P7	P8
Average	2,7	5,2	4,9	5,6	5,2	4,4	4,3	5,6
Bayesian Benchmark	0,0	9,6	3,1	9,4	0,1	0,1	0,4	0,6
Dividend	0	10	10	10	0	0	0	0
Net Private Signals	20	8	-2	7	11	13	8	7

Figure 1

Knowing what is the efficient price given the information released in the market; we have to compare it with the average price that players have achieved in each treatment. We can observe this phenomenon by comparing the evolution of the blue line to the green line. As we have said before the blue line does not have too much volatility and it does not follow the value of the dividend. In this treatment we can see that there is a great divergence between what should have happened in the market and the balance achieved by traders.

In conclusion we have to say that with the information available in the market traders have enough information to know what will be the true dividend, as we have seen in the Bayesian benchmark. Moreover this information was not efficiently distributed among the market and traders.

Those who buy information use their privilege situation to show incorrect information to the market about the dividend. The rest of traders need learning process to understand market behaviour and to be able to interpret false information. However traders who buy signals do not use this information to get an efficient equilibrium and they prefer to set prices for buying and selling over half of the possible value of the dividend. They are only willing to win or lose half the value of the dividend, independently of which is the future value of the dividend.

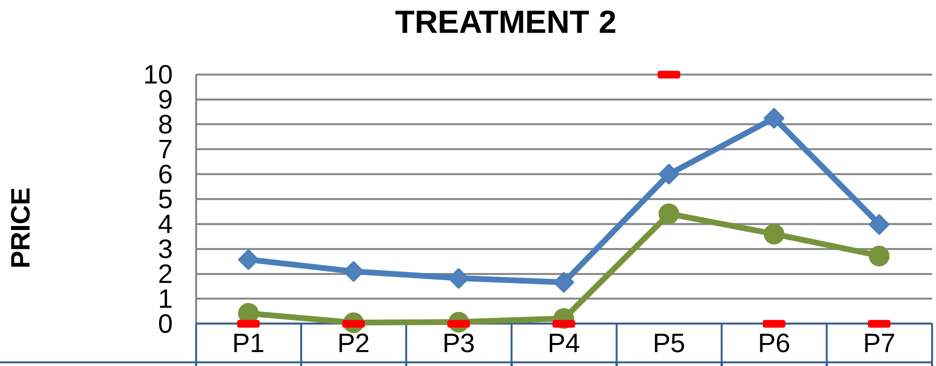
Treatment 2

This second graph is referred to the second treatment where traders have public and private information. With the information available in the market the Bayesian benchmark efficiently converge to the future value of the dividend in the first four treatments. However in the last three treatments this converges is not met. If we take into account the net private signals in the first four periods their values are positive so there is more correct than incorrect signals purchased, so the Bayesian benchmark has enough good information to converge to the true value. In the other three treatments the net private signals is negative so the Bayesian benchmark does not reach to converge to the true dividend.

Taking in to account this data, traders have enough good information to get a efficient equilibrium in the first four treatments, but in the last three treatments they do not have enough correct information to get an efficient equilibrium due to the among of incorrect signals.

Comparing the average price with the Bayesian benchmark, in the first four periods we can say that the price converge roughly towards and efficient equilibrium given the information available, because the average price is between 1, 8 UE and 2, 6 UE and the dividend in this periods is 0. In the other three periods the average price is higher and it does not converge to the Bayesian benchmark. We can also explain this trader's behavior observing the net private signals. As we have said in all these three treatments the net private signals are negative, so the information available in the market does not reflect the true value of the dividend. Traders were not properly informed because there are more incorrect than correct signals so they bull and sell assets believing that the dividend will take the opposite value. For these reason the average price tends to converge to the wrong way according to the true value of the dividend.

Despite this the average price follows the Bayesian benchmark. Therefore given the information available in the market the average price in each period is almost adjusted to the efficient equilibrium determinate by the Bayesian benchmark. We can say than in this treatment, traders use the information available in a efficient way and it reveled in the market. The learning process about we have talk before has had a positive effect in this treatment because traders, after the first treatment have learn how to understand market behavior and they have apply this knowledge in this treatment.



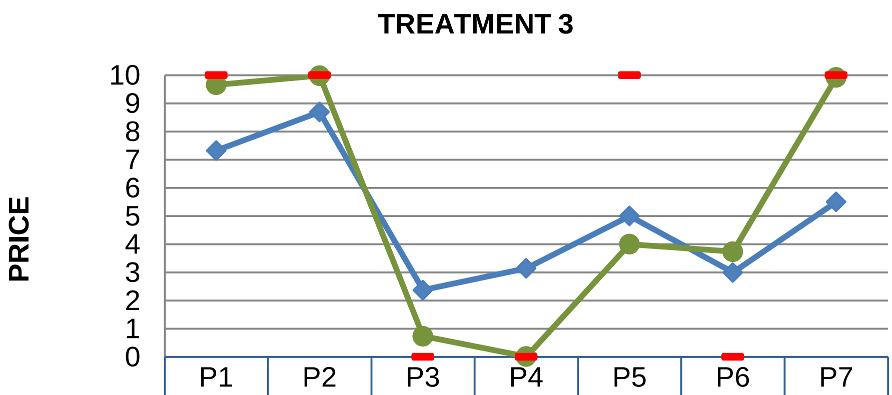
	P1	P2	P3	P4	P5	P6	P7
Average	2,6	2,1	1,8	1,7	6,0	8,2	4,0
Bayesian Benchmark	0,4	0,0	0,1	0,2	4,4	3,6	2,7
Dividend	0	0	0	0	10	0	0
Net Private Signals	5	10	9	7	-4	-2	-1

Figure 3

<u>Treatment 3:</u>

This third graph is referred to the third treatment where traders have two public signals and costly private information. What attracts the attention of this graph is the volatility of the average price among the treatment. As we can observed in the graph, and a feature we have seen in the rest of the treatments, is that the Bayesian benchmark converges to the true dividend when the net private signals takes a positive value and it moves away from the dividend when the net private signals has a negative value. In period 5 and 6 there are more incorrect information than correct so the Bayesian benchmark cannot converge to the true dividend.

With the information available in the market traders get an average price near to the efficient price determinate by the Bayesian benchmark. So traders have use the information displayed in a good way and it led them to approach their prices to the equilibrium.



	P1	P2	P3	P4	P5	P6	P7
Average	7,3	8,7	2,4	3,1	5,0	3,0	5,5
Bayesian Benchmark	9,7	10,0	0,7	0,0	4,0	3,7	9,9
Dividend	10	10	0	0	10	0	10
Net Private Signals	5	9	3	17	-1	-2	21

- **PRICE DESVIATION REGARDING BAYESIAN PRICE**

Apart from observing what should be the efficient price according to the information available, we can quantify the deviation from what the traders could have achieved using efficiently all available information and what they really do in their trading activity. We can calculate the deviation between the market price and the Bayesian benchmark. As a measure of market efficiency we use:

$$E_{BPR} = \frac{1}{150}\sum_{t=1}^{150}\frac{|\mathrm{B_t} - \mathrm{PR_t}|}{10}$$

where Bt is the Bayesian price, *PRt* is the average market price and t denotes the seconds in a trading period.

We can calculate this deviation for each treatment and observed if the traders have been able to use the information available to find out the correct dividend and get a price equilibrium which we have determinate by the Bayesian benchmark. The table below shows the results of the deviation between the average price and the Bayesian price, to see how far or close have been traders to the equilibrium. The smaller the number is the nearest will be the market to the equilibrium. The results in the three treatments are approximately 0 but the treatment with less deviation were Treatment 2 and Treatment 3, so the prices achieved are closer to the efficient Bayesian prices. In these two treatments we have public signals and costly private signals so the greater availability of information makes traders be more efficient in incorporating information into prices.

	Treatment 1	**Treatment 2**	**Treatment 3**
$\boldsymbol{E_{BPR}}$	0,01232	0,00995	0,009702

However in Treatment 1 traders have move away from the efficient equilibrium because they did not use the information available in a good way and also they only try to win or lose at most the half potential value of the dividend without take into account the values of signals. In this case at the beginning of the treatment traders only know that the dividend could be 0 or 10 with equal probability and if they want more information they have to buy imperfect private signals. So in this treatment traders have less information than in the other two treatments with public signals. Therefore we can conclude that the efficiency of prices in incorporating the information increases with the quantity (and quality) information available to the traders in the market.

- **DISTRIBUTION OF NET PROFITS IN EACH TREATMENT:**

The main objective of the experiment is achieving as many profits for each treatment. Each subject can follow different strategies but everybody wants to maximize their profits. After having analyzed the demand of private information with the presence of public information, the efficiency of prices and the deviation regarding Bayesian efficient price we can observe what have been the profits in all the periods.

One of the most interesting aspects is to analyze trader´s profits in different treatments and see how affects the presence of private and public information on them. The three following graphs show the net profit of each of the 17 traders in each of the periods of the three treatments.

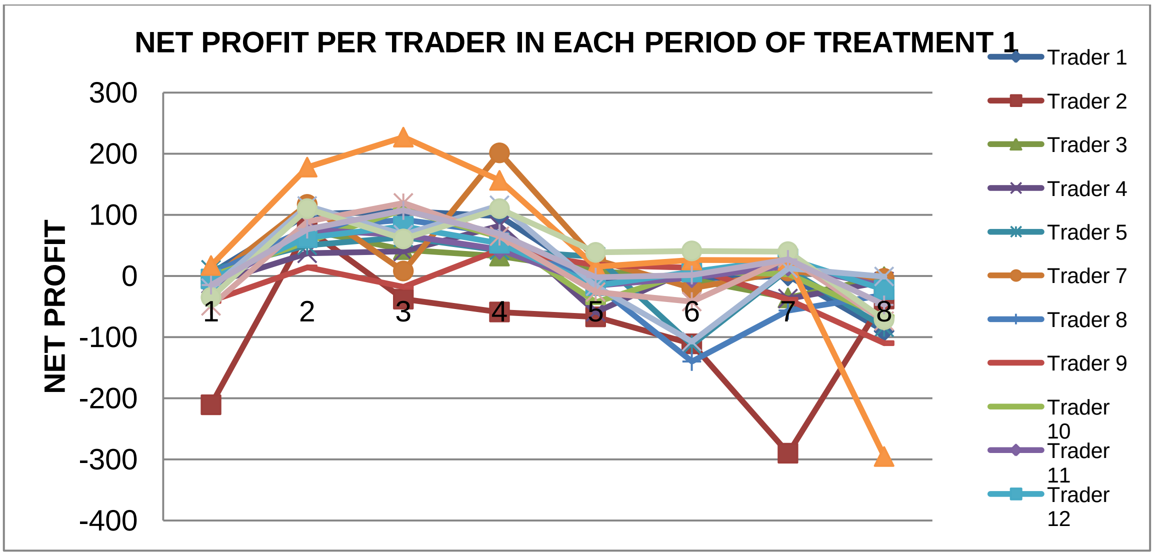
We have to remember that private information has a cost (4UE) so we can calculate the net profit with the following equation:

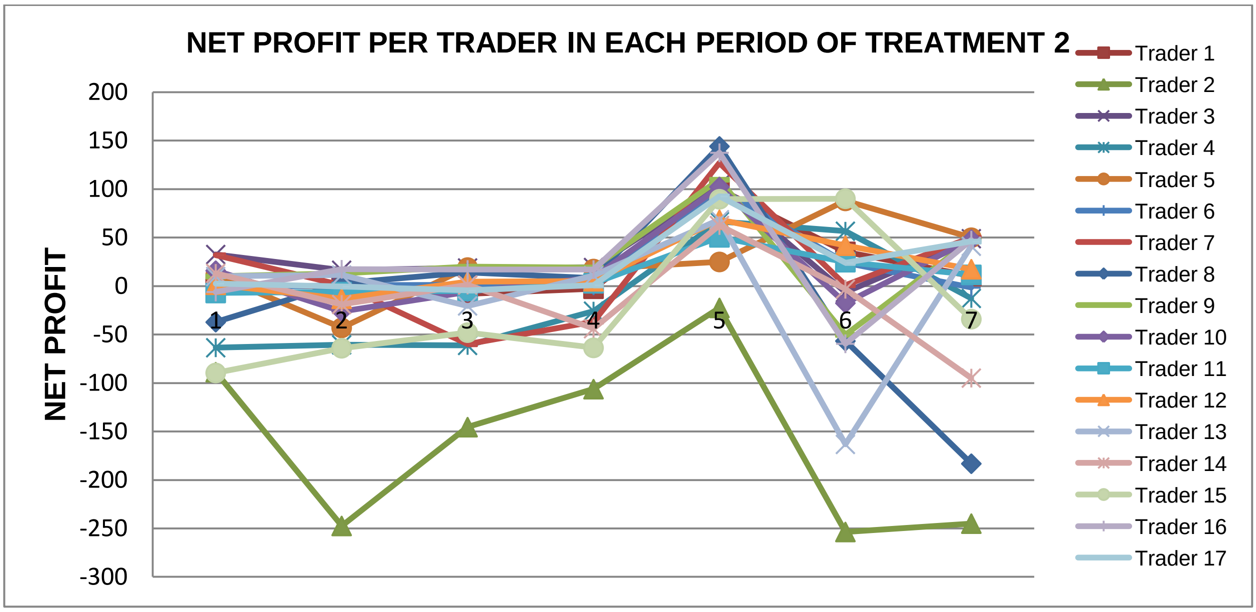
Net profit = Profit – 4 x Number of signals purchased in the period

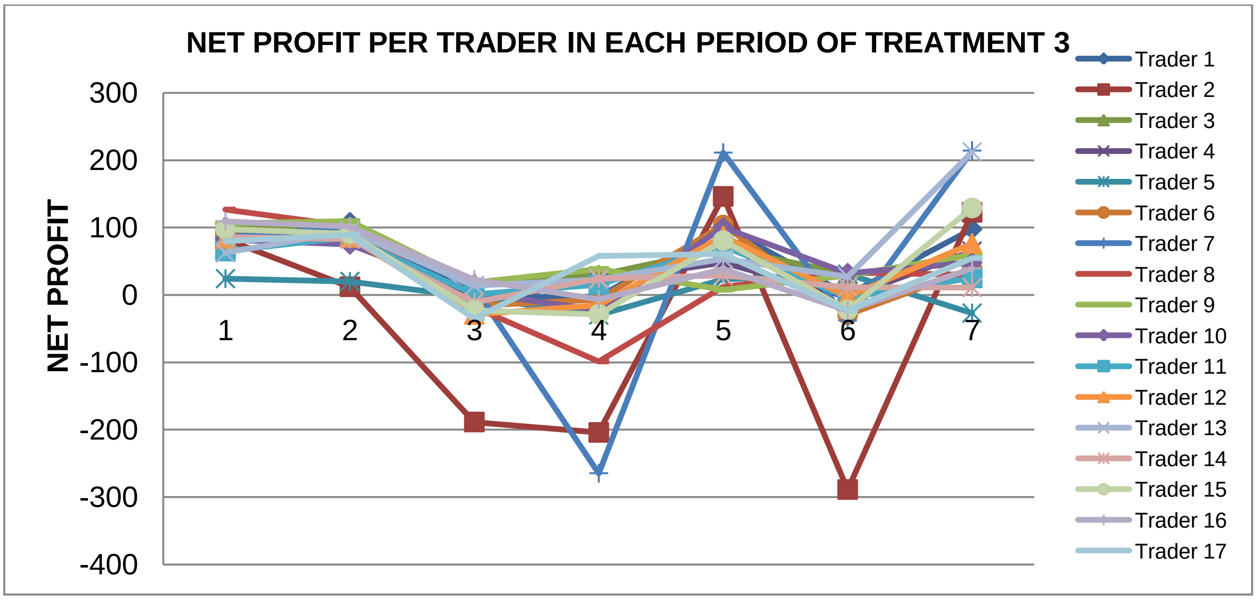
As we have said every trader has a strategy and acts independently so each of them will have different profits. However as we can see in the graph is seems that all traders tend to follow the same distribution of profits. We can analyze profits distribution taking into account the information released in each treatment and the net private signals.
In the first graph related to Treatment 1, most traders made higher profits in the first four treatments, besides in Treatment 3 most of them reduce their profits due to the negative value of the net private signals. At the end of the treatment is where traders get fewer profits. How we can explain this? If we observe Figure 1, in the last periods of this treatment the dividend is equal to 0 so at the end of these periods asset did not give profitability and their profits are minor.

In the second treatment it seems that most of traders follow the same distribution of profits around all the treatment. The highest profit takes places for most traders in Period 5. In this period according to Figure 2 the average price reach a high level and also the dividend is equal to 10 so profits are higher. In Period 6 there is a decrease on profits because although the price in that period is the highest of the treatment the dividend was 0 so traders do not reach many benefits.

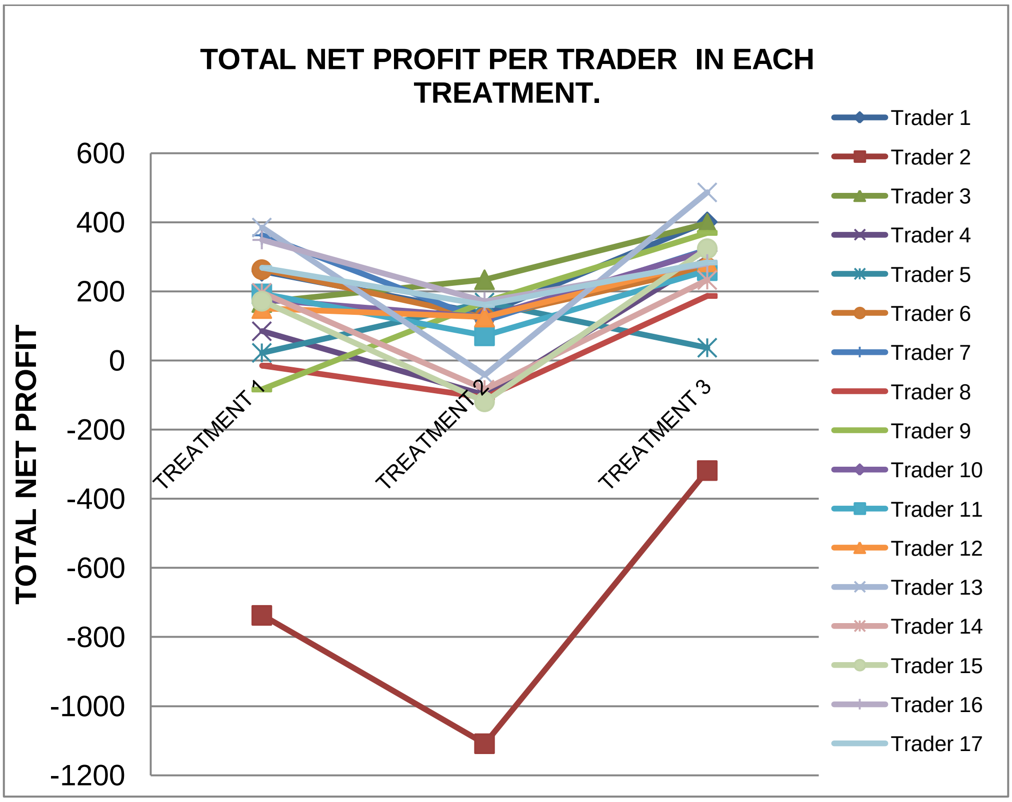
In the third treatment most of traders get fewer profits in Period 3, Period 4 and Period6. What have in commune those periods? If we observe Figure 3 we can realize that only on those periods the dividend was equal to 0 so traders did not gaet more profits at the end of those periods.







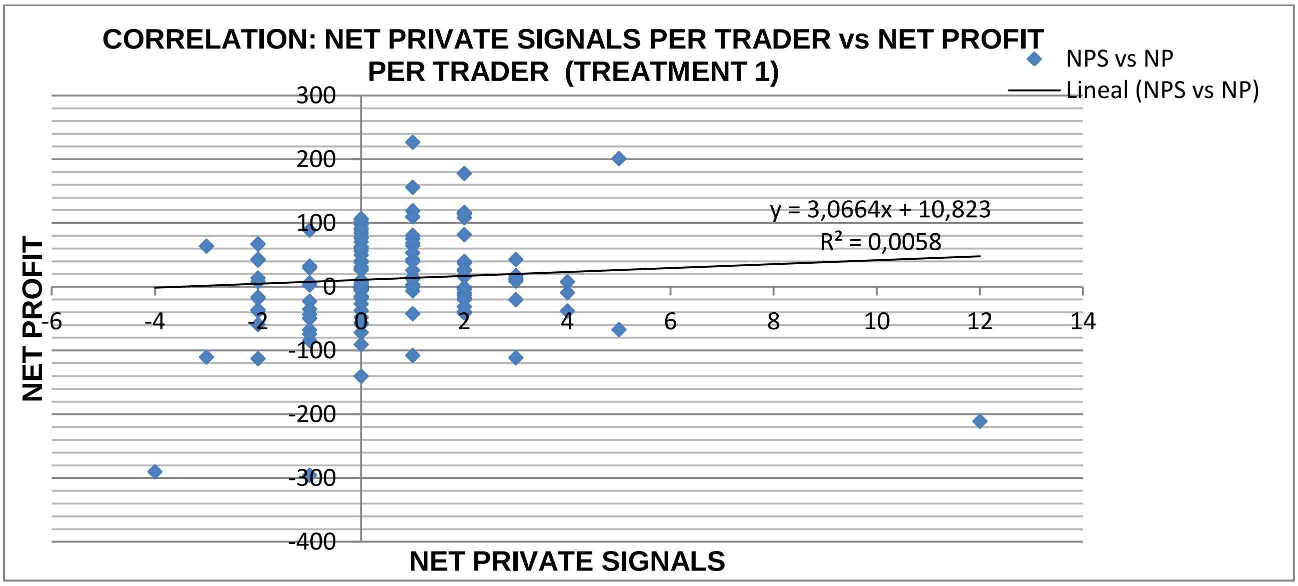
After having analyzed the different profit distribution per each trader in each period we can summarize these three graphs in one graph. The shows the total net profit that each trader has obtained in each of the treatments. It can be clearly seen that the period of most traders has les total net profit is in Treatment 2. What happened in this treatment? If we observe Figure 2 in six of the seven periods the final dividend is equal to 0 so in this treatment is where traders have obtained the lower profitability to the assets. On the other hand, in Treatment 3 most traders obtained the higher amount of net profits. That is because the dividend is equal to 10 in 4 periods and as we have said before this treatment has the lower deviation between prices and the efficient equilibrium determinate by Bayesian prices, so traders have been more efficient in incorporating information into prices.

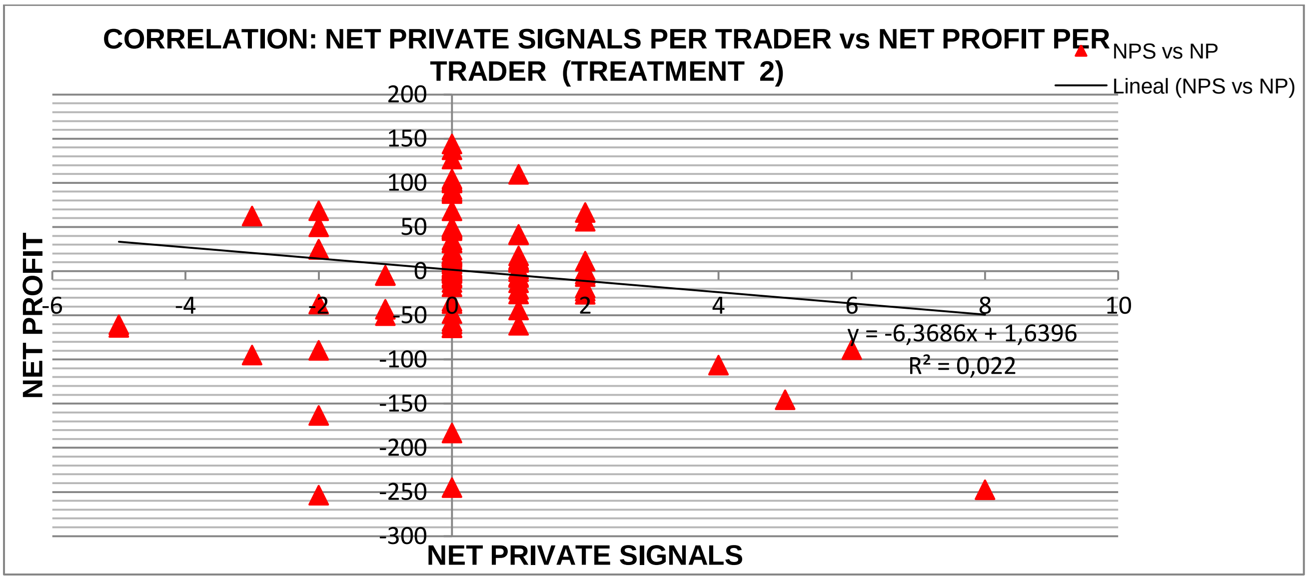


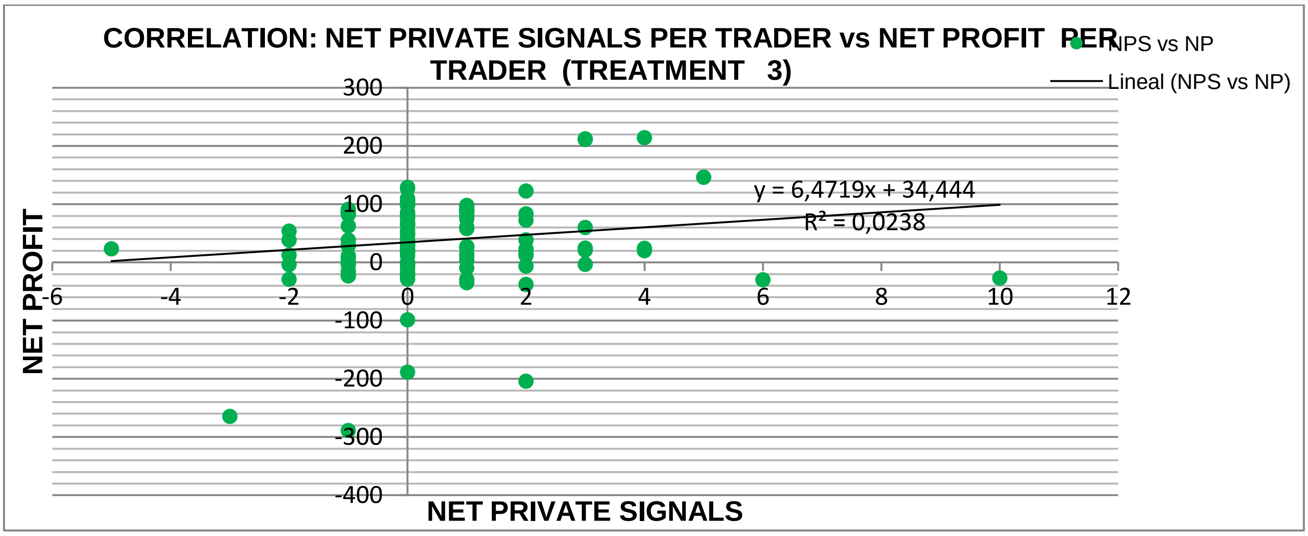
- **<u>RELATION BETWEEN NET PROFIT AND NET PRIVATE SIGNALS</u>**

Throughout the whole experiment traders buy private information trying to find out what will be the dividend. Depending on the value taken by these signals they will decide to buy or sell assets, and make bid and ask at determinate prices according to the information they have. For these reason it is important to find out if there is any relation between the net private signals available for each traders and their net profits.. As we have described in other section net private signals is the different between the number of correct signals and number of incorrect signals. A higher and positive number of net private signals indicate that traders have more information and it is accurate (there are more correct signals than incorrect).

We can use this following graph to so see this correlation and how it changes in each treatment. The vertical axis in each graph shows the net profit and in the horizontal axis are represented the net private signals. In the experiment participated 17 subjects so each of them would have a net private signals and a net profit for each of the periods played. In the first and third treatment the slope of the lines, which determine the distribution of the correlation between the two variables, is positive. It means that an increase in net private signals causes an increase on the net profit of each trader. However in the second treatment this relation is negative so a high level of net private signals causes a decrease in the net profit of traders.
Furthermore, graphs if we observe R^2 in the three treatments the correlation between these two variables, is very low in all of them, and the slow of the lines are also low. So we can say that the net private signals have no effect (or almost no effect) in the net profit of traders.


CORRELATION: NET PRIVATE SIGNALS PER TRADER vs NET PROFIT PER TRADER (TREATMENT 1)
NPS vs NP
Lineal (NPS vs NP)
y = 3,0664x + 10,823
R² = 0,0058
NET PROFIT
NET PRIVATE SIGNALS
300
200
100
0
-100
-200
-300
-400
-6
-4
-2
0
2
4
6
8
10
12
14


CORRELATION: NET PRIVATE SIGNALS PER TRADER vs NET PROFIT PER TRADER (TREATMENT 2)
NPS vs NP
Lineal (NPS vs NP)
y = -6,3686x + 1,6396
R² = 0,022
NET PROFIT
NET PRIVATE SIGNALS
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-6
-4
-2
0
2
4
6
8
10


CORRELATION: NET PRIVATE SIGNALS PER TRADER vs NET PROFIT PER TRADER (TREATMENT 3)
NPS vs NP
Lineal (NPS vs NP)
y = 6,4719x + 34,444
R² = 0,0238
NET PROFIT
NET PRIVATE SIGNALS
300
200
100
0
-100
-200
-300
-400
-6
-4
-2
0
2
4
6
8
10
12

6. CONCLUSION:

The current economic situation has create a debate about the role that rating agencies have plays in the financial markets and how investors have been following their predictions, and transfer those information to the market. In this paper we have use a laboratory experiment to investigate the role of public information on the efficiency of financial markets. We want to analyze what is the effect in the efficiency market when we add a public signal with higher quality (than private signals) and what occurs if we increase the amount of public signals released.

The efficient markets hypothesis has historically been referred when all relevant and available information is correctly incorporate into prices. Taking in to account this hypothesis we want to analysis this aggregation of information in financial markets. We have proportionate to the traders of the experiments exogenous and imperfect information about the two possible values which can take the dividend at the end of the period. We want to investigate how traders react when they have different sources of information as costly private signals and free and public signals.

We have show that with a fixed quality of privet signals the presence of public signals decreases the demand of private information due to the highest quality of the public information. However when traders have access to more public signals, each signal can take different values so this ambiguity of the future value of the dividend causes an increase in demand of private information.

Following that we have studied how the released of a noisy public signal affects the efficiency of prices in aggregation information. We observed that with the introduction of public information the prices follow the equilibrium determinate by the Bayesian price. So the market based their prices specially taking into account the public information and not taking into consideration private signals. Furthermore when we analyzed the variation between the price determinate by the market and the efficient equilibrium, in those treatments with public signals this deviation is insignificant. So we can conclude that public information helps traders and market to reach an efficient equilibrium given the information available. Moreover with the presence of public signals the information available in the market is perfectly distributed among all traders
We can refer to Morris (2002) to interpret our results. He said that "*public information has a double-edge instrument, coordinating trading activity and conveying fundamental information".*

The presence of correct information allows market to converge to the true value of the dividend; however it has been demonstrate that with present of incorrect information the equilibrium reached is not efficient. Furthermore we have show that there is no correlation between profits and the net private signal , so profit depends on the price reached in the market and the value of the dividend.

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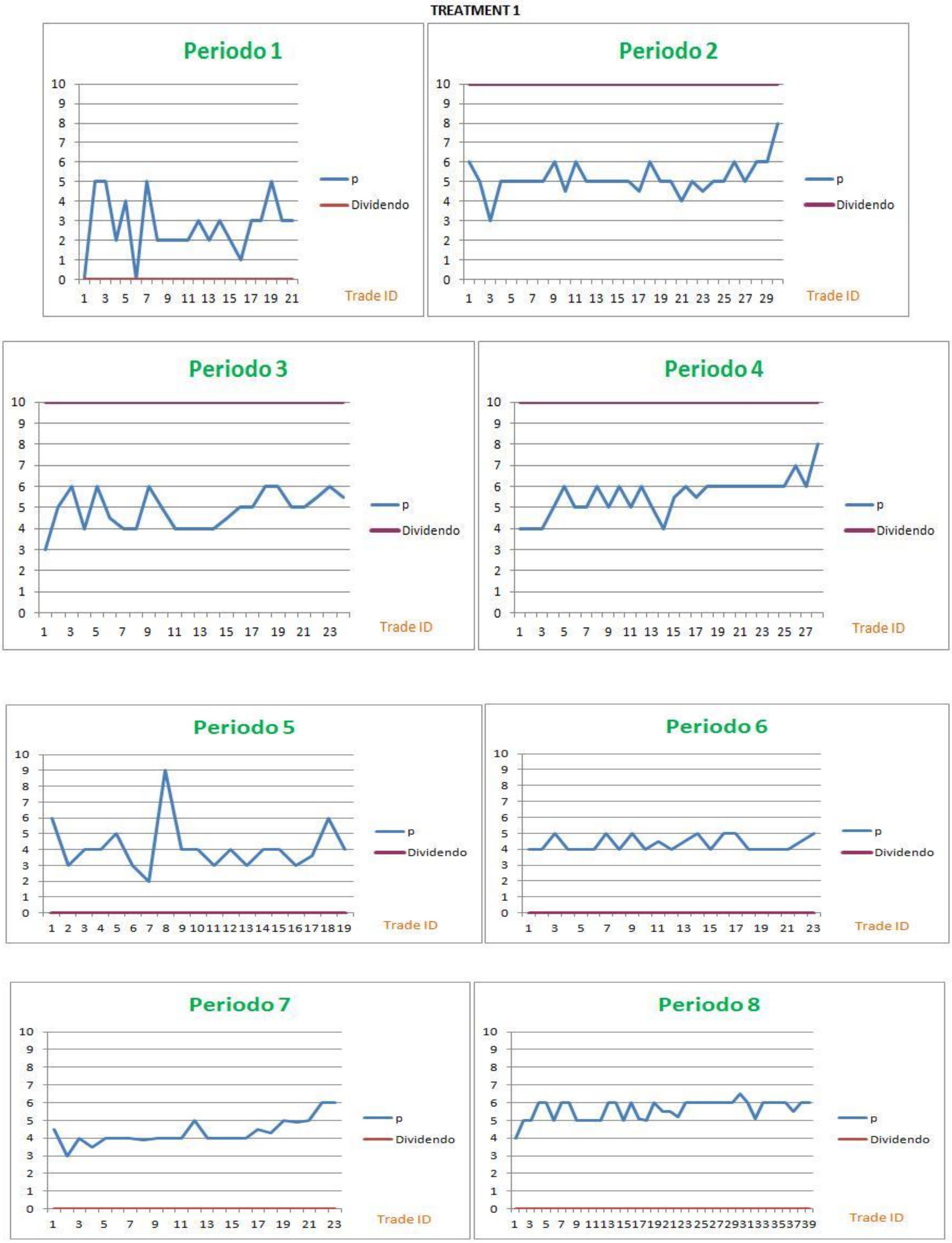
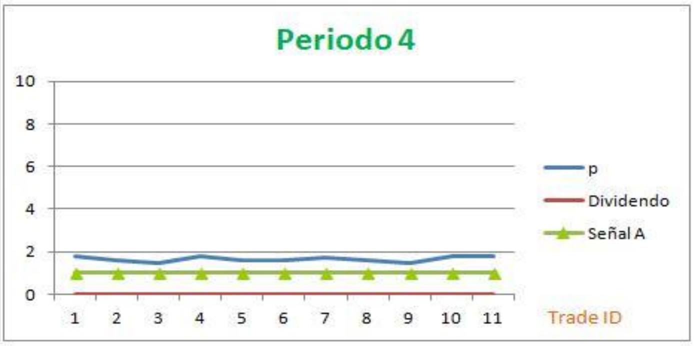
8. APPENDIX:

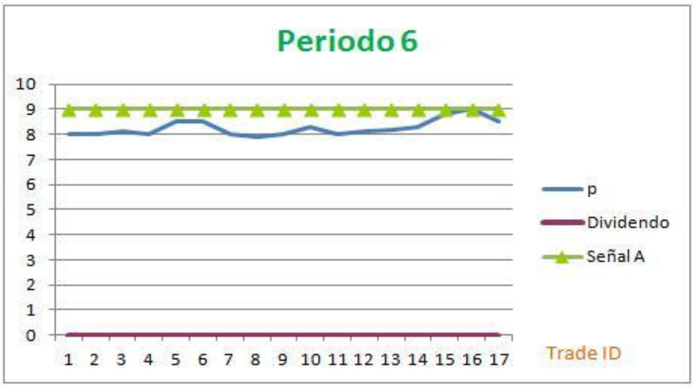
APPENDIX 1: **Trading activity in all markets.**
TREATMENT 1



APPENDIX 1: TREATMENT 2

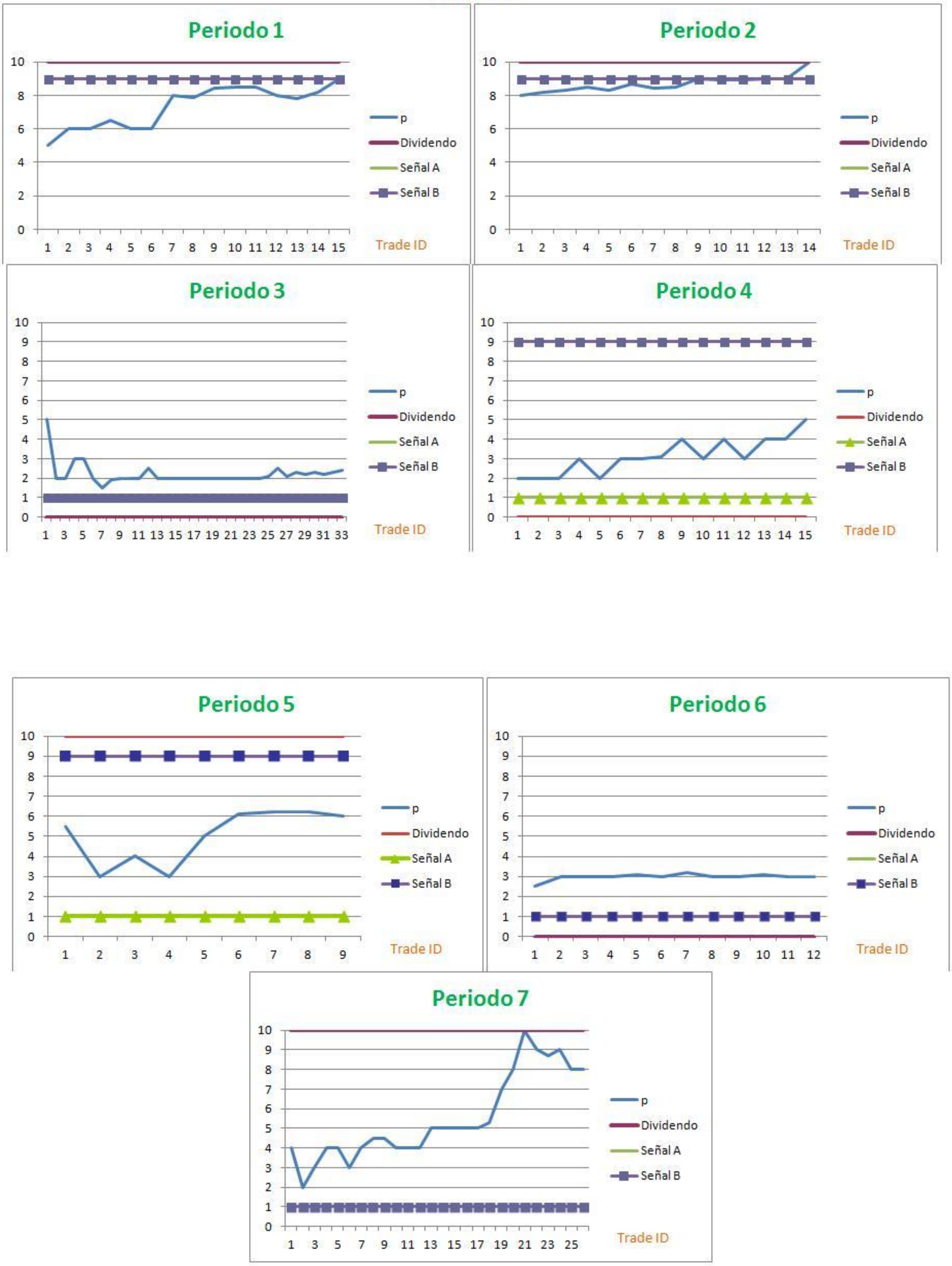
TREATMENT 2:





APPENDIX 1: TREATMNET 3:

TREATMENT 3



APPENDIX 2:

Profit and signals purchased per each trader in each period of Treatment 1

TREATMENT-1																		
Subject	**Profit P1**	**Signals P1**	**Profit P2**	**Signals P2**	**Profit P3**	**Signals P3**	**Profit P4**	**Signals P4**	**Profit P5**	**Signals P5**	**Profit P6**	**Signals P6**	**Profit 7**	**Signals P7**	**Profit 8**	**Signals P8**	SIGNALS PURCHASED	COST OF SIGNAL
1	4,8	0	101	0	106	0	98	0	-4,5	0	-4,5	0	0	0	-42	0	0	0
2	-114,8	24	108,6	8	42	20	5	16	-31	9	-51	15	-258	8	10	12	112	448
3	15,4	3	87,5	3	63	5	52,5	5	21	3	14	5	-20	4	47	2	30	120
4	-4,8	2	77	10	72	8	98	4	-35	6	24	3	-5	8	39	4	45	180
5	10,0	0	50	0	63	0	50	2	39	2	-88,5	6	27	4	-36	9	23	0
6	6,5	0	84,1	0	102	0	89	0	-1	0	-1	0	-1	2	-1,5	1	3	0
7	-6,0	0	133	4	24	4	221	5	50,5	6	16	9	24	4	44	4	36	0
8	3,0	0	78	0	92	0	70,5	0	-14,5	0	-140	0	-56,5	0	17	2	2	0
9	-9,0	8	29,9	4	14	8	71	7	30	3	34	5	1	10	-62	3	48	192
10	4,0	1	64,5	2	116,5	2	76	3	-31	3	7	0	7	1	-19	1	13	52
11	-10,0	2	80	1	75	2	51,5	2	-8	2	5	2	24	2	32	2	15	8
12	-5,0	0	62,5	0	85	1	57,5	1	-16	0	10,5	1	28	0	25,5	1	4	0
13	25,0	2	186	2	239	3	168	3	27	3	38	3	33	2	-247,4	3	21	8
14	-12,0	2	122	2	83,5	4	124	2	-0,79	4	-87,5	5	32,5	5	47	4	28	8
15	-45,0	1	93	1	123,5	1	69	1	-26,5	0	-38	1	34	1	-26	1	7	4
16	-31,0	1	114	1	60,5	0	114	1	38,5	0	41	0	44	1	-23,5	0	4	4
17	-15,0	0	76,5	0	107	0	73	1	-2	0	1,5	0	35	2	0,6	0	3	0

Total net profit per trader in each period of Treatment 1

Subject	Net profit P1	Net profit P2	Net profit P3	Net profit P4	Net profit P5	Net profit P6	Net profit P7	Net profit P8	TOTAL NET PROFIT
1	4,8	101	106	98	-4,5	-4,5	0	-90,23	**210,6**
2	-210,8	76,6	-38	-59	-67	-111,1	-290	-37,8	**-737,1**
3	3,4	75,5	43	32,5	9	-6,1	-35,9	-1,2	**120,2**
4	-12,8	37	40	82	-59	12	-37	-9	**53,2**
5	10	50	63	42	31,4	-112,5	10,8	-84	**10,7**
6	6,5	84,1	102	88,8	-1,3	-1	-9,1	-49,5	**220,5**
7	-6	117	8	201,3	26,5	-20	8	-4	**330,8**
8	3	78	92	70,5	-14,5	-140	-56,5	-31	**1,5**
9	-41	13,9	-18	43	17,9	13,7	-39	-110	**-119,5**
10	0	56,5	108,5	64	-43	7	2,9	-67,31	**128,6**
11	-18	76	67	43,5	-16	-2,9	16	-16,3	**149,3**
12	-5	62,5	81	53,5	-16	6,5	28,3	-22,5	**188,3**
13	17	178	227	156,3	15	26	25,4	-295,4	**349,3**
14	-20	114,4	67,5	115,6	-16,79	-107,5	12,5	-0,9	**164,8**
15	-49	89	119,5	65	-26,5	-42	29,8	-73,9	**111,9**
16	-35	110	60,5	110	38,5	40,9	39,7	-71,5	**293,1**
17	-15	76,5	107	69	-2	1,5	27	-47,4	**216,6**

APPENDIX 2:

Profit and signals purchased per each trader in each period of Treatment 2

Subject	Profit P1	Signals P1	Profit P2	Signals P2	Profit P3	Signals P3	Profit P4	Signals P4	Profit P5	Signals P5	Profit P6	Signals P6	Profit 7	Signals P7	SIGNALS PURCHASED	COST OF SIGNALS
1	0	0	0	0	-8	0	-3	0	100	0	35	0	10,5	0	0	0
2	-48,7	10	-151	24	-85	15	-66	10	26	12	-206	12	-204,9	10	93	372
3	32,7	0	17	0	19	0	19	0	104,5	0	-6,5	0	49	0	0	0
4	-43,5	5	-40,5	5	-49	3	-14	3	83	4	73	4	-5	2	26	104
5	19,5	2	-15	7	19	0	18	0	65	10	88	0	50	0	19	76
6	-1,6	0	0,9	0	1	0	0,49	0	101	0	24	0	-1,5	0	0	0
7	32	0	1	0	-60	0	-37	0	127	0	1	0	50	0	0	0
8	-29,1	2	3	0	14	0	8	0	144	0	-57	0	-183,1	0	2	8
9	14	1	17	1	20	0	19	0	113,8	1	-46	1	47,5	0	4	16
10	16	0	-10	4	2	2	9	0	102,3	0	-17,5	0	48	0	6	24
11	-3	1	-6	0	-0,9	1	3	0	58	2	33	2	20	2	8	32
12	1,5	0	-9	1	5	0	5	0	68,5	0	46	1	21,5	1	3	12
13	14	1	15,5	1	-0,39	5	15	1	77	2	-155	2	45	1	13	52
14	25,2	3	-3	4	9	2	-16	7	75	3	21	6	-83	3	28	112
15	-73,5	4	-48	4	-48	0	-64	0	90	0	90	0	-34	0	8	32
16	6	3	17	0	17	0	17	0	138	0	-59	0	47,5	0	3	12
17	6,5	1	3,5	1	-0,5	1	0,8	0	93	0	24	0	46	0	3	12

Total net profit per trader in each period of Treatment 2

Subject	Net profit P1	Net profit P2	Net profit P3	Net profit P4	Net profit P5	Net profit P6	Net profit P7	TOTAL NET PROFIT
1	0	0	-8	-2,6	100	35,4	10,5	135,3
2	-88,7	-247,3	-145,4	-106,2	-22,4	-253,5	-244,9	-1108
3	32,7	16,5	18,8	19,3	104,5	-6,5	49	234,3
4	-63,5	-60,5	-61,11	-25,7	66,6	56,7	-12,6	-100,1
5	11,5	-43	19,2	17,7	25	88	50	168,4
6	-1,6	0,9	1,2	0,49	100,9	24,1	-1,5	124,49
7	32	1	-59,9	-36,6	127,1	1	50	114,6
8	-37,1	3	14	8,3	144,2	-56,6	-183,1	-107,3
9	10	13	20,1	19,2	109,8	-50,2	47,5	169,4
10	16	-26	-6	8,7	102,3	-17,5	48	125,5
11	-7	-6,1	-4,9	3	50,4	24,8	11,7	71,9
12	1,5	-13	4,7	5,1	68,5	41,8	17,5	126,1
13	10	11,5	-20,39	10,8	68,6	-163,2	41,2	-41,49
14	13,2	-18,91	1,2	-43,81	62,6	-3,1	-94,8	-83,62
15	-89,5	-64	-47,9	-63,6	89,7	90,2	-34	-119,1
16	-6	17,4	17,2	17,1	137,6	-59,4	47,5	171,4
17	2,5	-0,5	-4,5	0,8	92,6	24	46	160,9

APPENDIX 2:

Profit and signals purchased per each trader in each period of Treatment 3

Subject	Profit P1	Signals P1	Profit P2	Signals P2	Profit P3	Signals P3	Profit P4	Signals P4	Profit P5	Signals P5	Profit P6	Signals P6	Profit 7	Signals P7	SIGNALS PURCHASED	COST OF SIGNALS
1	101,0	0,0	107,7	0,0	-3,0	0,0	-3,1	0,0	101,5	0,0	0,0	0,0	97,6	0,0	0,0	0,0
2	107,2	6,0	52,0	10,0	-124,7	16,0	-124,2	20,0	182,1	9,0	-244,9	11,0	170,5	12,0	84,0	336,0
3	100,0	0,0	101,1	0,0	17,3	0,0	33,4	1,0	69,2	0,0	31,1	0,0	48,9	0,0	1,0	4,0
4	89,9	1,0	93,7	1,0	-5,5	1,0	32,7	3,0	63,8	4,0	0,8	1,0	72,9	2,0	13,0	52,0
5	64,0	10,0	60,0	10,0	8,5	3,0	10,0	10,0	43,2	5,0	30,8	0,0	53,0	20,0	58,0	232,0
6	93,0	1,0	95,0	1,0	-12,3	1,0	1,5	2,0	103,7	0,0	-17,5	3,0	50,2	3,0	11,0	44,0
7	86,0	0,0	101,1	0,0	11,4	0,0	-252,7	3,0	239,1	7,0	-14,0	6,0	246,1	8,0	24,0	96,0
8	126,6	0,0	102,1	0,0	-18,0	0,0	-98,8	0,0	60,4	12,0	33,0	0,0	30,0	0,0	12,0	48,0
9	106,5	0,0	109,5	0,0	18,7	0,0	46,5	2,0	35,7	7,0	28,9	0,0	71,9	3,0	12,0	48,0
10	86,1	1,0	86,9	3,0	7,7	1,0	-3,0	5,0	100,0	0,0	32,1	0,0	47,7	0,0	10,0	40,0
11	73,0	2,0	89,7	1,0	5,1	1,0	23,1	2,0	80,5	2,0	4,1	2,0	37,0	3,0	13,0	52,0
12	83,4	0,0	89,3	1,0	-21,1	2,0	-11,0	1,0	91,3	1,0	1,5	1,0	76,4	0,0	6,0	24,0
13	74,5	3,0	98,7	1,0	17,9	1,0	38,9	4,0	61,6	2,0	31,1	1,0	224,2	3,0	15,0	60,0
14	98,1	3,0	94,8	3,0	5,0	4,0	36,4	3,0	48,7	5,0	23,4	3,0	22,9	3,0	24,0	96,0
15	101,7	1,0	94,8	1,0	-22,6	0,0	-28,9	0,0	80,5	0,0	-22,2	0,0	128,9	0,0	2,0	8,0
16	109,3	0,0	101,6	0,0	22,6	0,0	1,2	2,0	46,2	2,0	-19,2	1,0	39,3	0,0	5,0	20,0
17	83,7	1,0	93,4	1,0	-31,0	1,0	62,0	1,0	64,5	1,0	-19,0	1,0	54,5	0,0	6,0	24,0

Total net profit per trader in each period of Treatment 3

Subject	Net profit P1	Net profit P2	Net profit P3	Net profit P4	Net profit P5	Net profit P6	Net profit P7	TOTAL NET PROFIT
1	101	107,7	-3	-3,1	101,5	0	97,6	401,7
2	83,2	12	-188,7	-204,2	146,1	-288,9	122,5	-318
3	100	101,1	17,3	29,4	69,2	31,1	48,9	397
4	85,9	89,7	-9,5	20,7	47,8	-3,21	64,9	296,29
5	24	20	-3,5	-30	23,2	30,8	-27	37,5
6	89	91	-16,3	-6,5	103,7	-29,51	38,2	269,59
7	86	101,1	11,4	-264,7	211,1	-38	214,1	321
8	126,6	102,1	-18	-98,8	12,4	33	30	187,3
9	106,5	109,5	18,7	38,5	7,7	28,9	59,9	369,7
10	82,1	74,9	3,7	-23	100	32,1	47,7	317,5
11	65	85,7	1,1	15,1	72,5	-3,9	25	260,5
12	83,4	85,3	-29,1	-15	87,3	-2,5	76,4	285,8
13	62,5	94,7	13,9	22,9	53,6	27,1	212,2	486,9
14	86,1	82,8	-11	24,4	28,7	11,4	10,9	233,3
15	97,7	90,8	-22,6	-28,9	80,5	-22,2	128,9	324,2
16	109,3	101,6	22,6	-6,8	38,2	-23,2	39,3	281
17	79,7	89,4	-35	58	60,5	-23	54,5	284,1

APPENDIX 3

TOTAL NET PROFIT PER TRADER IN EACH TREATMENT:

Subject	TREATMENT 1	TREATMENT 2	TREATMENT 3
1	258,8	135,3	401,7
2	-737,1	-1108,4	-318
3	168,2	234,3	397
4	85,2	-100,11	296,29
5	22,7	168,4	37,5
6	263,5	124,49	269,59
7	362,8	114,6	321
8	-14,5	-107,3	187,3
9	-83,5	169,4	369,7
10	176,59	125,5	317,5
11	193,3	71,9	260,5
12	150,8	126,1	285,8
13	385,3	-41,49	486,9
14	196,71	-83,62	233,3
15	172	-119,1	324,2
16	349,5	171,4	281
17	268,6	160,9	284,1

APPENDIX 4:

Net private signals of each trader in each period of Treatment 1

Subject	Net private signals 1	Net private signals 2	Net private signals 3	Net private signals 4	Net private signals 5	Net private signals 6	Net private signals 7	Net private signals 8
1	0	0	0	0	0	0	0	0
2	12	0	-2	-2	5	3	-4	4
3	1	1	1	-1	3	1	-2	2
4	2	2	2	2	0	3	0	4
5	0	0	0	-2	0	-2	0	-1
6	0	0	0	0	0	0	2	-1
7	0	2	-2	5	0	3	4	2
8	0	0	0	0	0	0	0	2
9	2	-2	-2	3	3	3	2	-3
10	1	0	2	-3	-1	0	-1	-1
11	0	1	-2	-2	-2	0	2	0
12	0	0	1	1	0	-1	0	-1
13	2	2	1	1	1	1	2	-1
14	2	2	-2	2	2	1	1	2
15	-1	-1	1	1	0	1	-1	-1
16	-1	1	0	1	0	0	1	0
17	0	0	0	1	0	0	2	0

APPENDIX 4:

Net private signals of each trader in each period of Treatment 2

Subject	Net private signals 1	Net private signals 2	Net private signals 3	Net private signals 4	Net private signals 5	Net private signals 6	Net private signals 7
1	0	0	0	0	0	0	0
2	6	8	5	4	2	-2	0
3	0	0	0	0	0	0	0
4	-5	-5	1	1	2	2	0
5	2	-1	0	0	-2	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	-2	0	0	0	0	0	0
9	1	1	0	0	1	-1	0
10	0	2	2	0	0	0	0
11	1	0	-1	0	-2	-2	0
12	0	1	0	0	0	1	1
13	1	1	1	1	-2	-2	1
14	1	2	2	1	-3	2	-3
15	-2	0	0	0	0	0	0
16	1	0	0	0	0	0	0
17	1	1	-1	0	0	0	0

Net private signals of each trader in each period of Treatment 3

Subject	Net private signals 1	Net private signals 2	Net private signals 3	Net private signals 4	Net private signals 5	Net private signals 6	Net private signals 7
1	0	0	0	0	0	0	0
2	2	2	0	2	5	-1	2
3	0	0	0	-1	0	0	0
4	-1	1	1	3	0	-1	0
5	4	4	3	6	-5	0	10
6	1	-1	-1	2	0	1	-1
7	0	0	0	-3	3	2	4
8	0	0	0	0	-2	0	0
9	0	0	0	2	-1	0	3
10	-1	1	1	-1	0	0	0
11	0	1	-1	2	2	-2	1
12	0	-1	-2	-1	1	-1	0
13	-1	1	1	2	-2	1	3
14	-1	-1	0	3	-1	1	-1
15	1	1	0	0	0	0	0
16	0	0	0	0	-2	-1	0
17	1	1	1	1	1	-1	0

APPENDIX 5: **Purchased signals distribution along the three treatments**

TREATMENT	PERIOD	NUMBER OF TRADER WHO BUY SIGNALS	SIGNALS	NET PRIVATE SIGNALS	SIGNALS EQUAL TO 1	SIGNALS EQUAL TO 0	DIVIDEND	SIGNAL A	SIGNAL B
1	1	10	46	20	13	33	0		
1	2	10	38	8	23	15	10		
1	3	10	58	-2	28	30	10		
1	4	12	53	7	30	23	10		
1	5	8	41	11	15	26	0		
1	6	8	55	13	21	34	0		
1	7	9	54	8	23	31	0		
1	8	10	49	7	21	28	0		
TOTAL OF SIGNALS			**394**						
2	1	8	33	5	14	19	0	0	
2	2	8	52	10	21	31	0	0	
2	3	7	29	9	10	19	0	0	
2	4	3	21	7	7	14	0	0	
2	5	6	34	-4	15	19	10	1	
2	6	6	28	-2	15	13	0	1	
2	7	5	19	-1	10	9	0	0	
TOTAL OF SIGNALS			**216**						
3	1	9	29	5	17	12	10	1	1
3	2	12	33	9	21	12	10	1	1
3	3	8	31	3	14	17	0	0	0
3	4	9	59	17	21	38	0	0	1
3	5	6	57	-1	28	29	10	0	1
3	6	8	30	-2	16	14	0	0	0
3	7	3	57	21	39	18	10	0	0
TOTAL OF SIGNALS			**296**						