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Abstract

This paper addresses the question of how public announcements can affect social welfare in an experimental asset market with costly private information acquisition. More specifically, we analyze how public information affects (i) the aggregate profits and (ii) the level of inequality in the distribution of profits across subjects. Using the data of Ruiz-Buforn et al. (2018), we show that public information disclosure always increases aggregate profits, since it crowds out private information reducing the informational costs. Nevertheless, the effects on the level of wealth inequality are ambiguous. They depend on the relative precision of public and private information and, interestingly, on the realization of the public signal. Thus, public information disclosure leads to a trade-off between increasing aggregate profits and reducing the inequality level.

Keywords: Public information; Asset market experiment; Inequality; Crowding-out

JEL: D63; D82; D83; G1

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1 Introduction

Releasing public information is among the most important workhorses of regulatory institutions to promote financial market quality and stability. Following the financial crisis of 2008, regulatory efforts focused on providing more precise public information (Goldstein and Yang, 2019). However, the overall effects of public information are still under debate. On the one hand, more public information allows market agents to make more efficient decisions. On the other hand, public information crowds out the production of other information sources. Additionally, agents might rely heavily on public announcements, so that prices can overweight such information. Broadly viewed, these unintended effects reduce the informativeness of prices and the power of regulatory policies.

Theoretical literature suggests that agents overweight public information because it provides information on other agents' beliefs. Morris and Shin (2002), for example, model agents' overreaction to public information in a beauty contest framework, and conclude that the welfare effect of increasing the precision of public information is ambiguous when agents have access to private information. Colombo and Femminis (2008) go one step further and evaluate the welfare effect of public disclosure when agents choose the precision of costly private information. Public disclosure crowds out the acquisition of private information, leading to cost savings that compensate for the negative welfare effect due to the reduction of private information. Therefore, more precise public disclosure improves welfare when the marginal cost of private information exceeds that of public information. Colombo et al. (2014) generalize the previous results in a more flexible framework with strategic complementarities or substitutabilities. Kool et al. (2011) demonstrate the existence of the crowding-out effect without relying on higher-order expectations. More recently, Goldstein and Yang (2019) address the real-efficiency implications of releasing public information in a theoretical model where prices convey information to real decision makers. They conclude that the effect of public disclosure depends on the kind of information. A more precise disclosure impacts negatively on real-efficiency when the public information is about a factor that agents want to learn. Conversely, the disclosure improves welfare when agents already know the factor.

Given the difficulties of an empirical analysis of the effects of public information in real financial markets, laboratory methods provide a valuable and effective approach to complement the theoretical results, evaluating the impact of public information. Despite the relevance of this issue, relatively few experimental papers analyze the unintended consequences of public disclosure. For example, Cornand and Heinemann (2014) test the model of Morris and Shin (2002) and, find evidence that agents put more weight on the public signal than the private signal. Baeriswyl and Cornand (2014) vary the precision public information and the degree of strategic complementarities to also test the predictions of Morris and Shin (2002). The experimental contributions typically test the coordination models, which have already built-in the overweighting phenomenon as an equilibrium outcome. Unlike our study, this strand of literature induces an explicit coordination motive to the agents in an environment with payoff externalities. Moreover, previous contributions evaluate the impact of public information in a framework with final consumption, whereas this condition is absent in our experimental design.

We use the experimental data of Ruiz-Buforn et al. (2018) to investigate the welfare effect of public disclosure. Ruiz-Buforn et al. (2018) study how agents react when public information is released to the market. Agents trade risky assets whose dividend depends on the realization of the state of nature. Moreover, they can purchase private signals about the asset dividend. The authors observe that agents overreact to the public signal and reduce the demand for private information, decreasing price informativeness. The overweighting of public information in the laboratory asset market of Ruiz-Buforn et al. (2018) is an important observation because this setting is closer to real financial markets than coordination models and, it does not explicitly include the overweighting phenomenon.

The strand of experimental literature devoted to the analysis of information aggregation on financial markets has not paid attention to the impact of public information. Important early studies include the seminal paper by Sunder (1992), who finds evidence of the noisy rational expectations equilibrium model for the information and asset markets. Other experimental studies investigate the value of information in financial markets by asking whether having more information make traders better off. Copeland et al. (1992) define two information levels, finding that the market value for information approaches to zero in markets with homogeneous states of the world. However, in more complex environments informed traders make more profits than uninformed ones. Huber et al. (2008) show that only the best-informed traders significantly make more profits in a cumulative information system. The experiment of Ruiz-Buforn et al. (2018) differs from previous literature in the simultaneous presence of private and public information. Page and Siemroth (2017) implement a similar market where agents trade Arrow-Debreu assets and, they can purchase private signals. However, they mainly study the environmental factors and traders' characteristics relevant in the information acquisition.

The present paper investigates the welfare effect of public information in a laboratory financial market. In particular, we wonder whether public information affects the costs of information acquisition and the level of inequality in wealth distribution. To that aim, we vary the relative precision between public and private information. According to the Efficient Market Hypothesis (EMH) (Fama, 1970), the answer to the second question should be negative. Since prices fully reveal all information dispersed on the market, there are no differences in profits. However, if the answer is affirmative, the next question is in what direction the effect is. A public announcement can affect the traders' demand for private information as well as the efficiency of prices in transmitting information and, ultimately, the profit distribution. In case we observe a reduction in wealth inequality, public information can be a useful tool to reduce costs of acquisition of private information. Conversely, if public information leads to an increase in inequality, institutions face the trade-off between increasing the aggregate profits and reducing wealth inequality.

The reminder of the paper is organized as follows. Below, we introduce an overview of inequality as welfare measure. Sections 3 and 4 describe the experimental design and working hypotheses. Section 5 presents the results. Finally, Section 6 provides a concluding discussion.

2 Welfare and inequality distribution

Several studies defined the desirable equilibrium that might occur, while there are few studies discussing how it should be distributed. To wit, two zero-sum game frameworks might have the same level of aggregate welfare even they might be completely different on the distribution of gains and losses. By considering a simple laboratory financial market context (see Hey and Morone, 2004), if agents are endowed with the same level of money and information, we can expect that, under rationality and risk-neutrality, doing nothing is the unique symmetric equilibrium. To demonstrate this, we can easily consider that, given D is the value of the dividend and a is the initial asset endowment, the expected outcome of each agent will be $a \times E(D)$ in case of do nothing equilibrium. In the case of trading, exchanges might only arise if $E(D)$ of one subject is greater than $E(D)$ of the other, which turns to be theoretically inconsistent if we consider that all the agents create their belief on the same type of information. By rejecting risk neutrality, we can state that different risk propensity leads to an excess of trading. In case of a constant-sum game, the aggregate welfare does not change. Thus, it might be noteworthy not only to consider the aggregate welfare but also to analyze the distribution of gains and losses and the inequality distribution of profits.

This states the need of ranking social distribution by inferring on its form (Atkinson, 1970). Formally, given $i = \{1, ...n\}$ as the number of market players and $s_i \in S_i$ as the choice made by a subject that belongs to the set of possible strategies (S_i), each subject tries to maximize his own profit by finding his own best response: $\forall i \in \{1, ..., n\} \ \exists \ p_i(s_i, s_{-1}) \geq p_i(s_i', s_{-i})$. Here, p is the pay-off that comes from that choice and s_i' is a generic choice different from s_i. From a welfare point of view, we have to collect all individual pay-offs, that is $W(s) = \sum_i^n p_j(s)$. By definition, in a zero-sum game gains exactly counterbalance losses; therefore, given two different frameworks, we can not rank the distribution by simply observing the mean (i.e. $W(s) = 0$). One possible solution is that, by observing two distributions with the same mean, we can infer by observing their Lorenz (1905)'s curve, which compares the ideal level of redistribution (where each percentile has the same amount of wealth) even if there might be some difficulties in shaping the social utility curve. Gini (1909) and Dalton (1920) suggested to compare the actual level of income distribution with the ideal one.

By considering the social welfare as a function of the monetary pay-off x, we can define $W(s(x)) = f(x)$ as the distribution of social wealth and find the desirable distribution $f^*(x)$ which maximize social utility function $U(x)$. Given a fixed level of wealth $\overline{x}$ the cumulative distribution for a continuous function is given by:

$$\frac{\int_0^{\overline{x}} U(x)f(x)d(x)}{U(\mu)} ,$$

where $\mu = \sum x_i/n$, and $U(\mu)$ is then the utility deriving from ideal pay-off distribution. Hence a distribution will be strictly preferred to another one the closer $\int_0^{\overline{x}} U(x)f(x)d(x)$ is to $U(\mu)$.

In a zero-sum game, this happens only if subjects' actions approach to the do nothing equilibrium. Stating that, the higher are the losses and the concentration of them (the higher are the gains), the higher will be the inequality and the farthest will be $f(x)$ from a uniform distribution. To clarify, an environment where both losses and gains are equally spread among players is preferred to the one with high losses (gains) collected by a few agents. In particular, the Gini Index is calculated as follows:

$$G = 1 - 2\int_0^1 (L(x))dx \; . \tag{1}$$

Intuitively, Lorentz curve's area varies from 0 (case of extreme inequality) and 1/2 (case of equal distribution).

3 Experimental design and procedures

We use the data of the laboratory experiment of Ruiz-Buforn et al. (2018) to evaluate the welfare effects of releasing public information in an experimental asset market. The experimental design is inspired by Hey and Morone (2004) and Ferri and Morone (2014).[1] In each one of the ten market periods, every subject is endowed with 1000 units of

[1]The experiment is conducted using z-Tree (Fischbacher, 2007).

experimental currency (ECU) and 10 assets (a).[2]

The asset market is implemented as a single-unit double auction, where N subjects can buy and sell Arrow-Debreu assets.[3] The value of the dividend can be either 0 or 10 ECU with equal probability.[4] At the beginning of each trading period the state of the world is randomly determined by the experimenter. Each trading period lasts 3 minutes, after which the value of the dividend is revealed. However, at any moment within the trading period, subjects can purchase noisy private signals about the state of the world at the fixed cost of $c = 4$ ECU each. The purchased private signals are presented to the subjects taking the value 10 or 0. The probability of getting a signal suggesting a dividend 10 is p when the state of the world is $D = 10$ and the probability of getting a signal suggesting a dividend 0 is $(1-p)$. We vary the parameter $p \in \{0.6, 0.8\}$ to analyze the impact of the precision of the private signals on the purchase activity of the subjects. Following Hey and Morone (2004), the "do nothing" is the only possible equilibrium in this setting. The underlying reasoning lies in the constant-sum-game nature of the framework. If agents have the same attitude to risk, there is no incentive to trade and, therefore, no agent has the incentive to purchase private information.[5]

To examine the effect of public information disclosure on welfare, we consider the public signal S as our treatment variable. Just like private signals, the realization of the public signal takes the value 10 or 0 and, it is positively correlated with the dividend. For example, if subjects observe a public signal equal to 10, they can infer that the dividend is expected to be 10 with probability P and 0 with probability $(1 - P)$. The precision of the public signal is $P \in \{0.7, 0.8\}$ depending on the treatment. We vary the relative precision of the public signal with respect to the private signal to study its effect on market performance.

Table 1 provides an overview of our five treatments, which are denoted by the precision

[2] Subjects will pay-back to the experimenter the cash endowment at the end of each market period.

[3] Table 1 lists the number of subjects and groups in each treatment. All markets in the experiment are populated by 15 subjects, except for ten markets in treatment T(0.6,0.8) and treatment T(0.8) that are populated by 10 and 13 subjects, respectively.

[4] Cash, dividends, prices and profits during the experiments are designated in experimental units (ECU) and converted into Euro at the end of the session. One experimental currency unit is equivalent to 2 cents of Euro.

[5] See Hey and Morone (2004) and Ruiz-Buforn et al. (2018) for a more detailed explanation.

of the private and public signals. In the baseline treatments, subjects can purchase costly private signals and, this is the unique information that they observe. The quality of private signals is *low* ($p = 0.6$) or *high* ($p = 0.8$) depending on the treatment, T(0.6) and T(0.8) respectively. In the second set of treatments, i.e. T(0.6,0.8) and T(0.8,0.8), besides the private information acquisition, subjects observe a public signal with precision $P = 0.8$ at the beginning of every market. Thus, we can evaluate whether and how public information affects market performances and social welfare. Finally, we implement a treatment where the precision of the public signal is lower than the quality of private information, T(0.8,0.7). Despite this scenario is not likely, it is an interesting treatment to test the impact of the relative precision of the public signal with respect to a single private signal on profit distribution and acquisition of private information. Indeed, regulatory institutions can consider the precision of the public information as a control variable (Morris and Shin, 2005). Public information can be released with lower precision than the maximum level available to the institution. Theoretical literature suggests that an optimal level of transparency might exist, which can be lower than the maximum level of transparency available to the regulatory institution.[6]

Table 1: Overview of treatments

	Treatment	#Subjects	#Groups	#Markets
Low quality	T(0.6)	30	2	20
	T(0.6,0.8)	25	2	20
High quality	T(0.8)	28	2	20
	T(0.8,0.8)	30	2	20
	T(0.8,0.7)	30	2	20
	Total	143	10	100

The experiment took place in the LEE (*Laboratori d'Economia Experimental*) at University Jaume I in Castellón. A total of 143 undergraduate students from Economics and Business Administration in at least their second year of study were recruited. The treatments consist of 2 groups of inexperienced subjects who could only participate in one

[6]See the literature on the effect of transparency on the impact of public information (e.g. Baeriswyl and Cornand, 2014; Myatt and Wallace, 2014).

session. When subjects arrived at the laboratory, the instructions were distributed and explained aloud using a Power Point presentation.[7] This was followed by one practice period, so that subjects got familiar with the software and the trading mechanism. At the end of every market, dividends were paid out. The profit for each subject i in each market m is computed as the cash $Cash^1_{m,i}$ and assets $a^1_{m,i}$ held at the end of the trading period minus the endowment of cash $Cash^0_{m,i}$. The final value of an asset depends on the dividend in the market D_m.

$$\pi_{m,i} = (Cash^1_{m,i} - Cash^0_{m,i}) + D_m \cdot a^1_{m,i} \tag{2}$$

Each subject's final payoff was computed as the accumulated profit in the 10 periods, and paid cash at the end of the session. The average payoff was about 20 Euro and each session lasted around 90 minutes.[8]

4 Working hypotheses

By means of this experiment, we investigate the implications for social welfare of public information disclosure in a financial market. As a first and intuitive measure of social welfare, we consider the sum of individual profits. The constant-sum nature of the experiment makes easy to compute the value of the welfare (W_m) in each market as the sum of profits across subjects:

$$W_m = \sum_{i=1}^{N} \pi_{m,i} = D_m \, N^a - c \cdot N^s_m \ , \tag{3}$$

where N^s_m refers to the total number of purchased signals during a trading period, respectively. Since the total number of assets ($N^a = a \cdot N$) and the cost of each private signal are constant, the variability in the value of social welfare depends solely on the variability in the total number of purchased private signals. Therefore, evaluating the impact of public information on welfare leads to consider its effect on the demand for

[7] In Appendix A, we show the translated instructions and screenshots.

[8] Note that subjects could make losses. To avoid some of the problems associated with subjects making real losses in experiments, subjects received a show-up fee of 3 Euro.

private information, which is approximated by the number of purchased signals.

The first hypothesis we consider is whether the aggregate cost of information acquisition is significantly affected by the release of a public signal. The theoretical literature points out that releasing public information might crowd out private information demand. Kool et al. (2011) use a rational expectation asset market, which is inspired by Diamond (1985), to demonstrate the presence of a crowding-out effect. They conclude that the central bank should reduce transparency if the precision of the public signal lies within an intermediate range of values. Excessive transparency may undermine the target of more predictable and less volatile financial markets since the crowding-out effect leads to a higher forecast error variance. More recently, Goldstein and Yang (2019) demonstrate the presence of crowding-out in a model related to the framework of Amador and Weill (2010). They point out that depending on the type of released information, one might observe a "crowding-out" or a "crowding-in" of public information on the demand for private information.[9] In a different vein, Colombo and Femminis (2014) prove the existence of a crowding-out effect of public information on the equilibrium acquisition of private information in a coordination setting.

Based on the theoretical literature, we can state the first hypothesis:

Hypothesis 1. *The release of public information always improves welfare due to the crowding-out effect.*

The intuition behind this result can be explained as follows: the public signal helps investors to forecast the fundamentals, reducing the marginal value of private information and, therefore, its demand. So, releasing public information crowds out private information demand. To be more precise, we refer as crowding-out or crowding-in to the change in the number of purchased private signals as compared to the benchmark treatments. In our hypothesis, we additionally assume that, like Grossman and Stiglitz (1980), prices reveal private information, so that the value of acquiring additional information decreases even further. The Hypothesis 1 is far from trivial since the presence of public information can in principle trigger an increase in private information demand as Goldstein and Yang

[9] See the review of Goldstein and Yang (2017).

(2019) demonstrate. Hellwig and Veldkamp (2009) show that, depending on the nature of the strategic interaction, traders want to know what the others know, or they want to know what the others do not know. So, they might have different incentives to acquire more or less private information.

Another important aspect of welfare that we would like to consider is the level of inequality in the distribution of wealth, which is generated by the trading activity. Distributional aspects are absent in the definition of social welfare of eq. (3). The inequality in wealth depends on the distribution of profits among traders. The release of public information can affect the overall market informativeness. Moreover, it might significantly alter the efficiency of the market in aggregating information into prices and distort the allocation of assets. Such misallocation of assets might skew the profit distribution and, ultimately, increase wealth inequality.

According to the measure of the welfare of eq. (3), the existence of a crowding-out effect and the resulting cost reduction of information acquisition is welfare improving. Besides the increment of welfare, one has to take into account the potential consequences of private information loss on market informativeness and, its impact on market efficiency. The reduction of market informativeness might distort the performance of the market in the allocation of assets and increase wealth inequality. In a coordination setting, Colombo et al. (2014) show that public information has two opposite effects on welfare. It reduces the costs of acquiring private information and deteriorates the informativeness of prices as endogenous public signals. Depending on the prevailing effect, public information improves or worsens social welfare.

In the experimental setting of Ruiz-Buforn et al. (2018), the presence of public information does not alter market informativeness when comparing the baseline and the public information treatments. They observe that the public signal compensates for the loss of private information due to the crowding-out effect. Assuming that the *market is efficient*, the release of public information is welfare improving even if one considers its impact on the inequality in the distribution of wealth. In order to justify it, we rely on the efficient market hypothesis. The EMH states that prices are able to fully reflect all available information (Fama, 1970). Many theoretical models show that if traders are better informed that other traders within the rational expectations equilibrium, those traders do not earn extra profits. In other words, in competitive markets (with rational agents and some frictions), the better-informed traders are not able to make use of this informational advantage in making higher net profits than uninformed traders. The distribution of profit is independent of the level of information. Market prices disseminate the information possessed initially by some informed traders to all traders. Accordingly, the net profit of traders should be largely independent of their information level when one assumes a fairly high degree of market efficiency. The literature on experimental finance has shown under which conditions such scenario is observed (Sunder, 1995; Powell and Shestakova, 2016). In particular, Sunder (1992), in his seminal paper, gives experimental support to the predictions of rational expectations equilibrium and its consequences. Taking stock of the previous literature, if we assume that the release of public information does not alter the overall market informativeness and the degree of efficiency, we can state our second hypothesis:

Hypothesis 2. *The release of public information does not alter wealth distribution and the level of inequality.*

Operatively, we should not observe a significant difference in the inequality level of profit distribution between the baseline and public information treatments independently of the realization of the public signal (i.e. correct or incorrect). However, even though the market informativeness remains unchanged as in our experiment, the public signal can impair the aggregation of information. The excess of reaction of traders to public information might distort asset allocation and profit distribution. There is a set of studies claiming that public information acts as a focal point (Morris and Shin, 2002) and, then, prices overweight that information rather than efficiently aggregating and disseminating the information dispersed in the market. Allen et al. (2006) show that prices depend on higher-order beliefs and, as a consequence, asset prices overweight public information and underweight private information. In a different setting, Goldstein and Yang (2019) state the possibility of overweighting of public information in a framework of endogenous information acquisition. The complex interplay between the contemporaneous presence of public information and private information can significantly distort prices and allocation, as experimentally shown by Ruiz-Buforn et al. (2018). Prices do not reveal all information present in the market, distorting the possibility of inferring the fundamental value from the price system. Such distortion might skew the profit distribution and increase wealth inequality.

This line of thoughts leads us to present an alternative to the second working hypothesis on the effect of public information on the inequality of wealth among traders:

Alternative Hypothesis 2. *Releasing public information increases wealth inequality, eventually decreasing social welfare.*

We conjecture that two opposite effects of releasing public information exist when we consider different measures of social welfare: (i) a reduction in the cost of private information acquisition while the level of market informativeness is unchanged (welfare-improvement effect) and, (ii) a negative impact on the level of inequality (welfare-worsening effect). We have observed in Ruiz-Buforn et al. (2018) the strong distorting effect of the public signal on prices. We go one step further in this paper, analyzing whether the level of wealth inequality is affected by the distorting effect on prices.

5 Results

5.1 Summary statistics

The data contain the information acquisition and the trading activity in 100 markets of the experiment of Ruiz-Buforn et al. (2018). Table 2 and Figure 1 provide summary statistics per treatment. At first sight, the "do nothing" equilibrium does not describe the trading behavior of the subjects of this experiment. On average, subjects purchase between 0.8 and 2.4 signals per capita depending on the treatment, with more acquisition in the baseline treatment of high-quality information, T(0.8). Moreover, this is the treatment with more subjects who purchase at least one private signal (66.8%). By contrast, the public information treatment of low-quality information, T(0.6,0.8), is the treatment with less acquired signals. Between the 42% and 67% of subjects purchase at least one signal.

Table 2: Summary statistics per treatment

	T(0.6)		**T(0.6, 0.8)**		**T(0.8)**		**T(0.8, 0.8)**		**T(0.8, 0.7)**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Information acquisition										
Acq.inf. (dummy)[1]	0.42	0.50	0.47	0.50	0.67	0.47	0.58	0.49	0.62	0.49
Number of signals p.c.	1.32	2.24	0.82	1.22	2.39	2.65	1.73	4.19	1.20	1.58
Trading activity										
Trade volume[2]	111.75	23.79	83.50	19.50	61.43	17.19	94.12	26.59	74.78	12.10
Transaction price										
Dividend=0	5.93	1.25	5.22	3.44	1.83	2.49	4.48	2.51	2.48	2.18
Dividend=10	6.34	1.42	5.05	3.67	8.01	1.95	7.55	1.65	7.96	2.45

[1] Acq.inf. takes value 1 when a trader purchases at least one signal during the trading period and, it takes value 0 otherwise.
[2] Trade volume denotes the number of trades during the trading period.

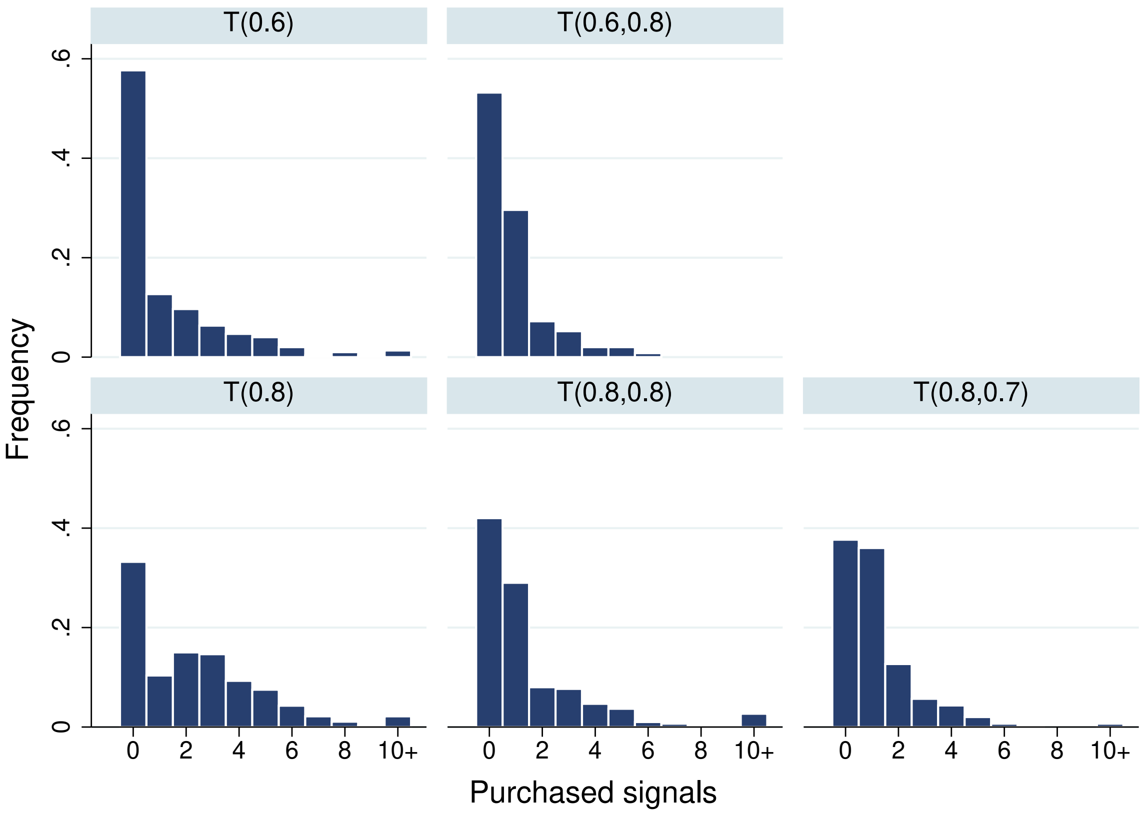


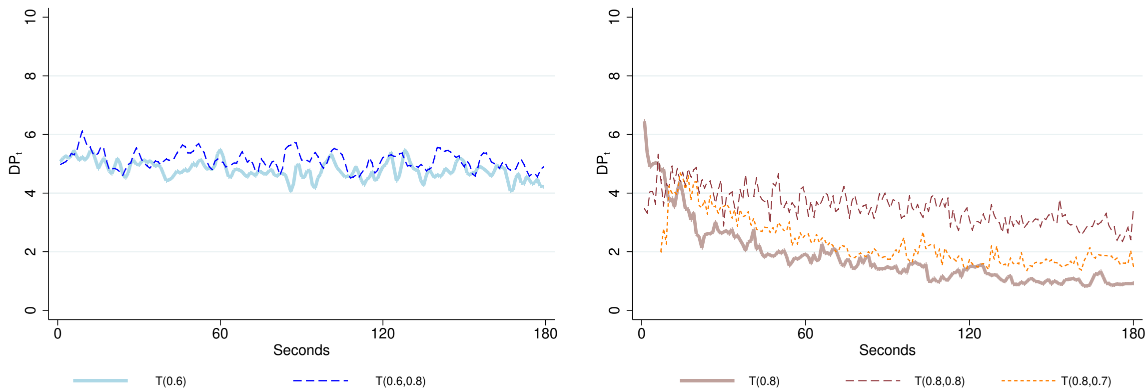
Figure 1: Histogram of the purchased signals

5.2 Trading activity

We first assess how transactions prices aggregate the information on the underlying dividend. Table 2 reports some statistics of the activity volume and the mean price averaged over periods for each treatment. Figure 2 plots how much prices reflect the underlying value of the asset over time by treatment. We compute the time evolution of the mean absolute distance between prices and dividend averaged across markets in each treatment. Let us denote the market price at time t in the market m by $P_{t,m}$. DP_t stands for the average across markets of the distance between price and dividend in each second of the trading period:[10]

$$DP_t = \frac{1}{M} \sum_{m=1}^{M} |D_m - P_{t,m}| \,, \tag{4}$$

where M is the number of markets in each treatment.



(a) Low-quality private information (b) High-quality private information

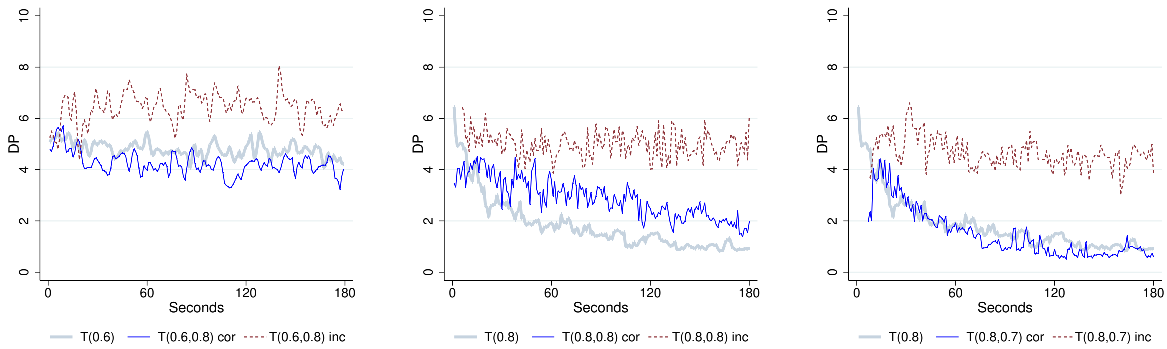
Figure 2: Distance between prices and dividend averaged across markets.

Figure 2 shows that prices do not fully reveal the dividend value. Considering the last trading minute, the discrepancy between prices and the dividend is larger in the treatments with low-quality private information (Panel a). The time evolution of observed price slowly converges to the dividend in treatments with high-quality private information, which suggests that prices aggregate the information dispersed in the market (Panel b). Comparing baseline treatments and public information treatments, one can note that a

[10]In the seconds without transaction, we consider the price of the last trade. We omit the treatment variable for notational convenience.

public signal does not help prices to converge to the dividend. Indeed, if one look at Panel (b), prices perform worse in treatments with a public announcement than in the baseline treatment.

We turn to a more detailed look on how the market performance might change depending on the success of the public announcement in predicting the state of the world. Differentiating between both scenarios, we address the reasons for the deterioration of prices in aggregating the information on the underlying dividend. Figure 3(a) shows the average distance between prices and dividend, comparing the baseline and public information treatments depending on the realization of the public announcement. We distinguish between a correct (*cor*) public announcement and an incorrect (*inc*) public announcement. Each line corresponds to one scenario: thick line indicates the T(0.6) treatment, thin-solid line and dashed line indicate the scenario where the public announcement is correct and incorrect, respectively, in treatment T(0.6,0.8). In Figures 3(b,c), the same line patterns are used to represent treatments with high-quality information.[11]



(a) Low-quality priv. inf. (b) High-quality priv. inf. (c) High-quality priv. inf.

Figure 3: Distance between prices and dividend averaged across markets.

Figure 3(a) shows that differences on price convergence between the baseline treatment and treatment with a correct public announcement are negligible. An incorrect public announcement, on the other hand, pushes prices systematically away from dividend. Moreover, the price-dividend distance does not exhibit any tendency of convergence to the dividend value. In treatments with high-quality information, a public announcement of the same precision of private information never improves price convergence on

[11]Note that the number of markets in eq. (4) changes depending on the realization of the public signal.

average (Figure 3(b)). However, a public announcement with lower precision than private information improves price convergence when correct (Figure 3(c)). The overall picture we draw from our results shows that the impact of public announcements is measurable and relevant. Interestingly, a public announcement might distort the market price even when correct. Ruiz-Buforn et al. (2018) shows that such phenomenon is characterized by an overweighting of the public signal compared to the private information, giving experimental support to an extensive theoretical literature.[12]

5.3 Information acquisition and welfare

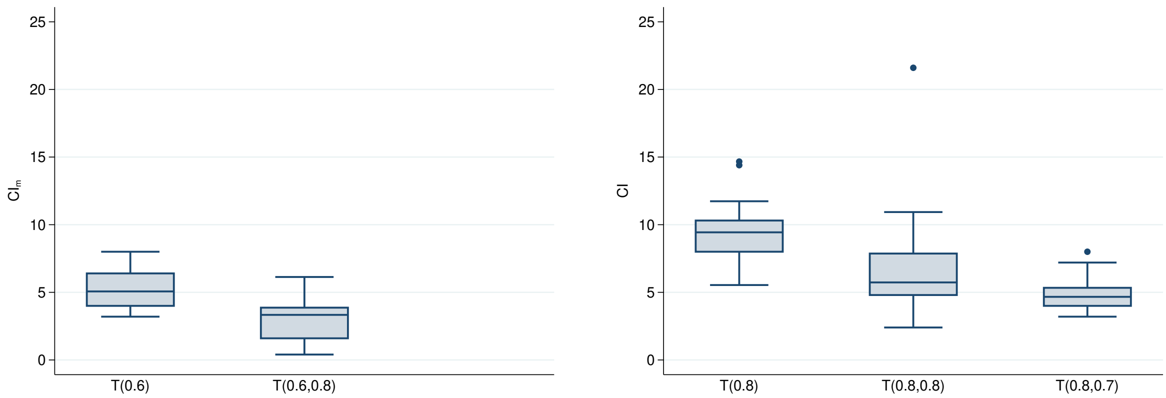
We now turn to test our first hypothesis regarding the effect of public information on social welfare. We compute the per capita costs of purchasing private signals in each market:

$$CI_m = c \cdot \frac{N_m^s}{N_m} \tag{5}$$

where N_m refers the population size of market m and N_m^s denotes the number of purchased signals in that market. Figure 4 shows the costs of acquiring private information at an individual level (per capita costs) in each treatment. In both scenarios, high and low quality private information, the public announcement significantly reduces the aggregate cost of private information acquisition. This leads to an increase in aggregate market profit and, ultimately, to an increase of social welfare. More precisely, the per capita cost of information acquisition is always significantly reduced when public information is released to the market ($p < 0.01$, Mann-Whitney test). Moreover, a Mann-Whitney test indicates that the difference of informational costs between treatments T(0.8,0.7) and T(0.8,0.8) is significant at the 5% level. This suggests a non-linear relationship between the precision of the public signal and the crowding-out effect in private information acquisition. A regulatory institution can exploit such a non-linear effect tuning the transparency of the public information to reduce information costs and improve social welfare.

Based on these observations, we cannot reject the Hypothesis 1 that the release of

[12]See, for example, Morris and Shin (2002); Allen et al. (2006); Colombo et al. (2014).



(a) Low-quality private information (b) High-quality private information

Figure 4: Per capita cost of private information

public information reduces informational costs and, therefore, improves social welfare. This effect is relevant and robust under different relative precision of private and public information.

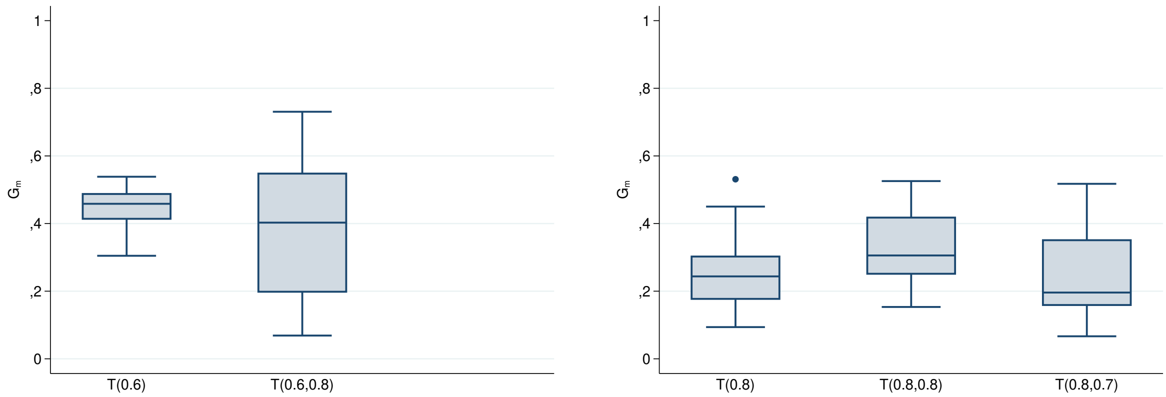
5.4 Wealth distribution and degree of inequality

In this section, we measure social welfare according to the level of inequality of wealth distribution. We consider Hypothesis 2 and test whether the degree of inequality remains invariant when a public signal is released to the market. To evaluate the degree of inequality, we compute the Gini index G_m, which we adjust to account for attributes with negative values according to Raffinetti et al. (2015). [13]

Figure 5 shows the distribution of Gini index across markets per treatment. At first glance, it is evident that the distribution of profits among traders is not invariant across treatments as Hypothesis 2 states. Figure 5(a) reveals that public announcements do not significantly affect inequality in profits. However, the variability in the Gini coefficients enhances in T(0.6,0.8). Comparing treatments with high-quality private information, the level of inequality significantly increases in the public information treatment. A Mann-Whitney test reveals that the level of inequality is significantly different at 5% in

[13] Data is transformed to homogenize profits between markets where dividend is 10 and dividend 0. Since each trader is endowed with ten risky assets and $E[D] = 5$ is the expected dividend without information, we normalize the individual profits as the $\pi'_{m,i} = \pi_{m,i} + 10 \cdot E[D]$ if $D = 0$ and $\pi'_{m,i} = \pi_{m,i} - 10 \cdot E[D]$ if $D = 10$. In such a way, the ex-post average profit is $< \pi'_{m,i} >= 50$ minus the individual cost of information acquisition.

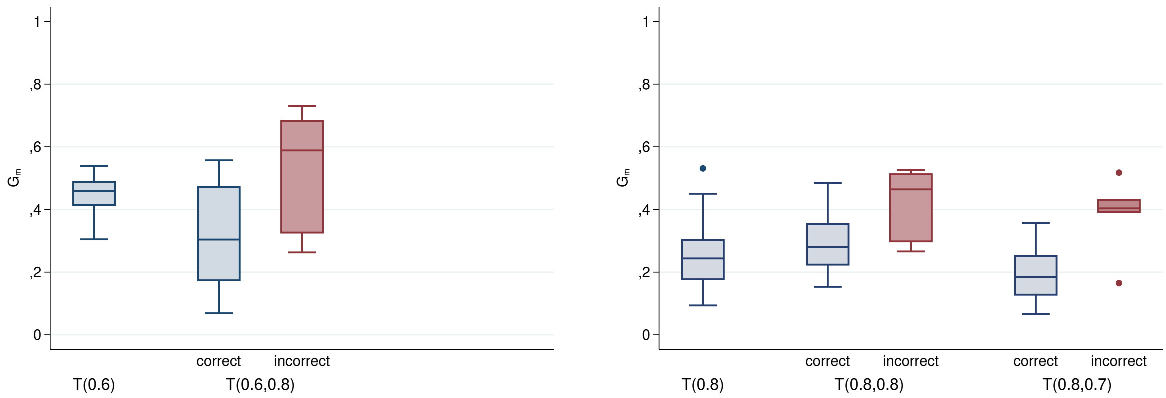
treatment T(0.8) and T(0.8,0.8). The Gini index is instead not significantly different when the public announcement has lower precision than the private information, i.e. in T(0.8,0.7). We can reject the Hypothesis 2 that public announcements do not affect inequality. Hypothesis 2 can be rejected in favor of the Alternative Hypothesis 2 that releasing public information increases wealth inequality.



(a) Low-quality private information (b) High-quality private information

Figure 5: Gini coefficient.

In order to get a better picture of how public announcements increase the level of inequality, we separately analyze whether the public announcement is correct or it points towards the wrong dividend value. Such analysis attempts to identify systematic differences under the two possible scenarios. One can claim that the authority releasing public information cannot control ex-ante whether the signal is correct or incorrect. However, if we merely consider the aggregate outcome, we implicitly assume that the effects on the market and the inequality level of profits are linear in aggregate variables like consumption or investment. Although we do not include the effect of inequality on aggregate variables in our setting like Colombo and Femminis (2014) or Vives (2017), our analysis sheds some light on the impact of public information on wealth distribution. A disaggregated analysis allows us to understand the relative magnitude of changes in the level of inequality in both scenarios. Figure 6 presents Gini coefficients in each treatment, differentiating between "correct" and "incorrect" public announcements. One can see that a correct public announcement reduces inequality when the quality of private information is low and this effect is statistically significant ($p = 0.043$, Mann-Whitney test). On the other hand, an incorrect announcement increases inequality, although not significantly. The opposite effect occurs in treatment with high-quality private information. Whereas a public announcement does not significantly improve inequality when correct, an incorrect public announcement significantly increases inequality when the public information is as precise as the private information ($p = 0.011$, Mann-Whitney test). We can reject now the hypothesis that public announcements do not have impact on inequality when the quality of private information is low and this information ends up being correct.



(a) Low-quality private information (b) High-quality private information

Figure 6: Gini coefficient.

What happens when public announcements are noisier than private information? We have previously observed that informational cost savings are greater in treatment T(0.8,0.7) than T(0.8,0.8). Now we wonder whether benefits persist from the perspective of inequality measures. Figure 6(b) shows that a correct public announcement reduces the level of inequality, although not significantly. The impact of an incorrect public announcement is again not significant. It is interesting to note that the distributions of the Gini coefficients in T(0.8,0.8) and T(0.8,0.7) are statistically different at the 1% level (Mann-Whitney test) when public information is correct.

Why does inequality increase?

From Figures 3 and 6, a lower level of inequality in the profit distribution seems to be associated with prices closer to the dividend value. According to our visual inspection, we conjecture that the Gini coefficient (G_m) is positively correlated with the distance of price from the dividend. We compute it as the mean absolute deviation from the dividend in all the market period (DP_m) and during the last 30 seconds in the market[14] (DP_{lm}):

$$DP_m = \frac{1}{180}\sum_{t=1}^{180} |D_m - P_{t,m}| \quad (6)$$

$$DP_{lm} = \frac{1}{30}\sum_{t=150}^{180} |D_m - P_{t,m}| \quad (7)$$

Table 3 shows the correlation between both variables for each treatment. The Spearman's correlation coefficients confirm that markets with higher values of DP_m show higher Gini coefficient values. This result is statistically significant, except for treatment T(0.6) that is marginally significant at 10%. Markets that do not reveal the fundamental values yield higher levels of inequality.

Table 3: Correlation between DP and Gini coefficients in each market by treatment.

	Low-quality		High-quality			
DP[1]	T(0.6)	T(0.6,0.8)	T(0.8)	T(0.8,0.8)	T(0.8,0.7)	All treatments
DP_m						
Spearman-ρ	0.39	0.84	0.90	0.76	0.88	0.87
p-value	0.09	0.00	0.00	0.00	0.00	0.00
DP_{lm}						
Spearman-ρ	0.28	0.81	0.42	0.80	0.75	0.81
p-value	0.24	0.00	0.07	0.00	0.00	0.00
Observations	20	20	20	20	20	100

[1] DP_m is the mean absolute deviation during the entire trading period
DP_{lm} is the mean absolute deviation during the last 30 seconds of the market

The intuition behind these results relies on the same premises of the Alternative Hypothesis 2, i.e. prices overweight public information creating profits opportunities. Ruiz-Buforn et al. (2018) find that public information is the main determinant of price dynamics. They observe that an incorrect public signal pushes prices far from the dividend comparing to the baseline treatment. Since the trading activity in our experiment satisfies a zero-sum property, the profits of one trader are the losses of the other trader.

[14]We consider the last 30 seconds so that the market has sufficient time to aggregate the dispersed information.

Therefore, transactions at prices far beyond the value of the asset lead to a more dispersed distribution of profits among traders, while transactions at prices close to the dividend generate comparable profits. Following this line of thoughts, a public signal may increase the level of inequality when pushes prices away from the dividend. This is compatible with the observed higher level of inequality in T(0.8,0.8) compared to T(0.8).

6 Conclusion and discussion

The purpose of this paper is to evaluate the impact of public announcements on welfare in a laboratory asset market. Regulatory institutions essentially release information to discipline the market, reducing the potential adverse effects of information asymmetries. However, the literature shows that public information might have unintended consequences. For instance, prices can overweight such information and, therefore, do not fully reveal the information dispersed on the market. This paper shows that the overweighting effect increases the level of inequality of wealth distribution, which is measured using the Gini index. This effect of public information on the distribution of profits changes depending on the relative precision of private and public information. Whereas the Gini coefficient does not change when a public announcement is released in a market with low-quality private information, the level of inequality increases when traders have access to high-quality private information.

On closer inspection, we notice that the increment in inequality is mainly caused by a misleading public announcement. In fact, the impact of correct public information is not significant when high-quality private information is available. Besides to the detrimental effect of public announcements on the level of inequality, we point out the clear positive benefits due to the informational cost savings. A public announcement always reduces the total cost of private information acquisition, which is due to the crowding-out effect already observed in Ruiz-Buforn et al. (2018).

In this paper, we have shown the contemporaneous presence of two opposite effects on welfare. The precise evolution of the cumulative effect and the design of a comprehensive experimental setting are left for future research.

Acknowledgments

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A Appendix

A.1 Instructions of the experiment

English translation of instructions as well as English translation of the computer screens as seen by the subjects in each treatment.

Welcome. This is an economic experiment on decision making in financial markets. The instructions are simple and if you carefully follow them, you can earn a considerable amount of money. Your earnings will be personally communicated to you and paid in cash at the end of the experiment.

During the experiment your gains will be measured in experimental units (ECU) that will be translated into Euro at the end of the experiment using an exchange rate of 1 € for every 50 ECU accumulated, plus a fixed amount for participating 3 €. The corresponding amount in € will be paid in cash at the end of the experiment.

At the beginning of the experiment, it has been assigned a number to each one of you. From now on, that number will identify you and the rest of the participants. Communication is not allowed among the participants during the session. Any participant who does not comply will be expelled without payment.

THE MARKET

You are in a market together with 14 other participants.

At the beginning of each period, your initial portfolio consists of 10 assets and 1000 ECU as cash. Each participant has the same initial portfolio.

The experiment consists of 10 periods of 3 minutes each. In each period, you and the other participants will have the opportunity to buy and sell assets. You can buy and sell as many assets as you want, although each purchase or sale offer involves the exchange of a single asset. Therefore, the assets are bought and/or sold one at a time.

INFORMATION AND DIVIDENDS

At the end of each period, you will receive a specific dividend for the assets you hold in your portfolio. **The value of the dividend can be 0 or 10 with the same probability.**

Thus, without additional information, the value of the assets can be 0 or 10 with a probability of 50%.

Moreover, you can **acquire a private signal** on the value of the dividend at the end of the period. The signal you will receive will be 0 or 10:

- **A private signal equal to 0** means that with a probability of 80% the value of the dividend will be 0 at the end of the period.[15]
- **A private signal equal to 10** means that with a probability of 80% the value of the dividend will be 10 at the end of the period.

The **cost of the signal is 4 ECU**. During each period, you can buy as many signals as you wish. This will be your private information and therefore you will be the only one able to see it.

[*Only in the public information treatments:*] In addition, you will have a public signal that will be correct with a probability of 80%, that is:

- **A public signal equal to 0** means that with a probability of 80% the value of the dividend will be 0 at the end of the period.
- **A public signal equal to 10** means that with a probability of 80% the value of the dividend will be 10 at the end of the period.

[15] The values of the different probabilities are changed in accordance to the different treatments.

[*Only in the common information treatments:*] In addition, you will have a free signal that will be correct with a probability of 80%, that is:

- **A signal equal to 0** means that with a probability of 80% the value of the dividend will be 0 at the end of the period.
- **A signal equal to 10** means that with a probability of 80% the value of the dividend will be 10 at the end of the period.

At the end of each period, your profit will be the cash you have at the end of the period plus the dividends for the assets you own, minus the cash you had at the beginning of the period, that is, 1000 ECU.

Your payment at the end of the session corresponds to the accumulated profit during the 10 periods.

If at any time you have any questions or problems, do not hesitate to contact the experimenter. Remember that it is important that you understand correctly the operation of the market, since your earnings depend both on your decisions and on the decisions of the other participants in your same market.

A.2 Screenshots

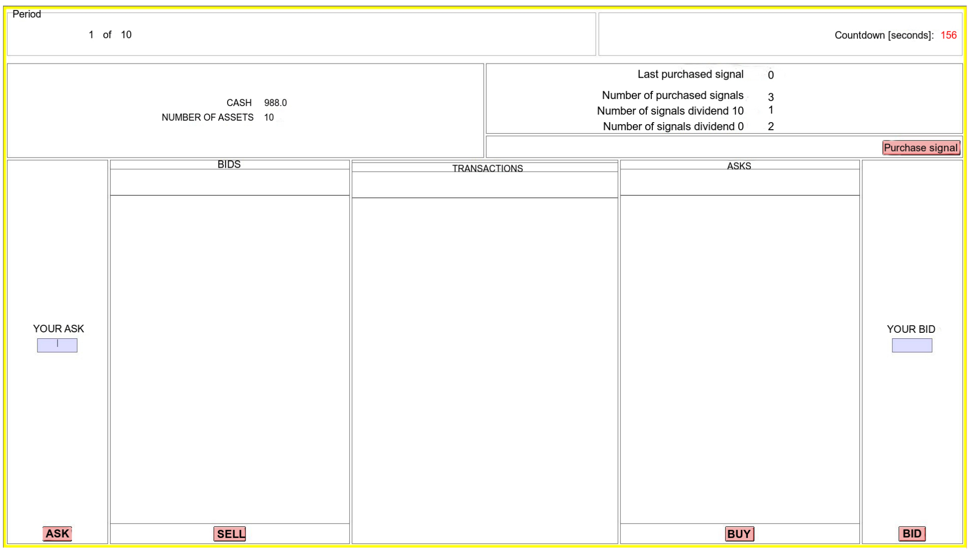

Figure 7: Screenshot of baseline treatments, T(p)

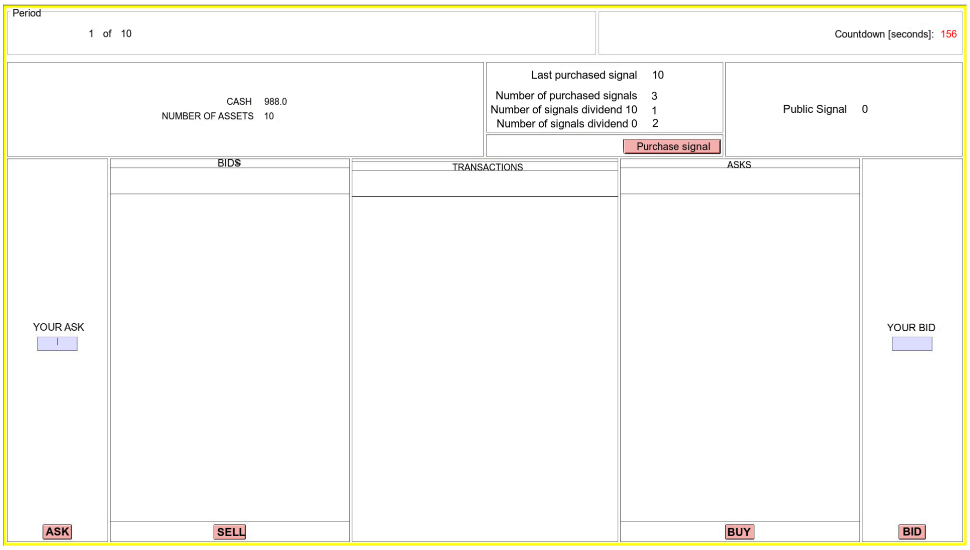

Figure 8: Screenshot of public information treatments, T(p,P)

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