

Cingl, Lubomír

**Working Paper**

## Does herd behavior arise more easily under time pressure? Experimental approach

IES Working Paper, No. 1/2012

**Provided in Cooperation with:**

Charles University, Institute of Economic Studies (IES)

*Suggested Citation:* Cingl, Lubomír (2012) : Does herd behavior arise more easily under time pressure? Experimental approach, IES Working Paper, No. 1/2012, Charles University in Prague, Institute of Economic Studies (IES), Prague

This Version is available at:

<https://hdl.handle.net/10419/83445>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

Institute of Economic Studies, Faculty of Social Sciences  
Charles University in Prague

**Does herd behavior arise  
more easily under time  
pressure?  
Experimental approach.**

Lubomír Cingl

IES Working Paper: 1/2012



Institute of Economic Studies,  
Faculty of Social Sciences,  
Charles University in Prague

[UK FSV – IES]

Opletalova 26  
CZ-110 00, Prague  
E-mail : [ies@fsv.cuni.cz](mailto:ies@fsv.cuni.cz)  
<http://ies.fsv.cuni.cz>

Institut ekonomických studií  
Fakulta sociálních věd  
Univerzita Karlova v Praze

Opletalova 26  
110 00 Praha 1

E-mail : [ies@fsv.cuni.cz](mailto:ies@fsv.cuni.cz)  
<http://ies.fsv.cuni.cz>

**Disclaimer:** The IES Working Papers is an online paper series for works by the faculty and students of the Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague, Czech Republic. The papers are peer reviewed, but they are *not* edited or formatted by the editors. The views expressed in documents served by this site do not reflect the views of the IES or any other Charles University Department. They are the sole property of the respective authors. Additional info at: [ies@fsv.cuni.cz](mailto:ies@fsv.cuni.cz)

**Copyright Notice:** Although all documents published by the IES are provided without charge, they are licensed for personal, academic or educational use. All rights are reserved by the authors.

**Citations:** All references to documents served by this site must be appropriately cited.

**Bibliographic information:**

Cingl, L. (2012). “Does herd behavior arise more easily under time pressure? Experimental approach.” IES Working Paper 1/2012. IES FSV. Charles University.

This paper can be downloaded at: <http://ies.fsv.cuni.cz>

# Does herd behavior arise more easily under time pressure? Experimental approach.

Lubomír Cingl\*

\* IES, Charles University Prague  
E-mail: Lubos.Cingl@seznam.cz

January 2012

**Abstract:**

In this paper I explain individual's propensity to herd and infer its relationship to time-pressure by conducting a laboratory experiment. I let subjects perform a simple cognitive task under different treatment conditions and levels of time pressure with the possibility to herd. The order of decision-making sequence is endogenous and the nature of the task is not probabilistic; rather I impose the uncertainty of private signal by different levels of time pressure. This is expected to make participants prone to imitate the behavior of others. The main findings are that the propensity to herd was not significantly influenced by different levels of time pressure. Information cascades arose, but never in a perfect form. Personality traits contributed considerably to the explanation of the model, but their relationship is not straightforward and may need further research. Heart-rate significantly increased over the baseline during performance of a task, but was not correlated to the subjectively stated level of stress, which suggests that time pressure may not automatically induce stress but increase effort instead. Moreover, heart-rate is significantly associated with the propensity to herd, but unexpectedly with a negative sign.

**Keywords:** Information cascades, herding, experimental economics, heart rate measurement, personality traits

**JEL:** C25, C91, D03, D80

**Acknowledgements:**

This research was supported by grant GAUK No. 59110 and also by CERGE-EI assistance by the grant received from the J&T Bank, a.s.. It was also gratefully supported by the possibility of using the heart-rate monitors of the Laboratoř sportovní motoriky FTVS UK, by Dr. Josef Horčic.

## 1. Introduction

The main goal of this paper is to discover the effect of time pressure on the individual propensity to herd, if there is any, and the form of this effect in relationship to varying levels of time pressure and personal characteristics. Revealing the underlying nature of the relationship may be important in the explanation of real-life phenomena such as fads, fashion, but also panic in financial markets. I expect the time-constraint to induce stress reaction which in turn should influence the individual decision-making process (Lundberg (1993)). One of the products of the altered decision-making may be that the subjects are more likely to imitate other's behavior. The underlying mechanism depends on the accepted theoretical explanation of herding as there have been two main approaches proposed: the informational and the behavioral approach. A theoretical synthesis of these two approaches has already been made in Cao and Hirshleifer (2000) and this experiment does not try to resolve the duality between them as has already been made in Baddeley et al. (2007), but rather it focuses on the relationship of time pressure and herding, which has been so far omitted. We hypothesize that the occurrence of herding and information cascades is more frequent under more severe time pressure. In this experiment I also show the important characteristics driving the decisions of subjects whether or not to conform to publicly available information and the interaction with time pressure. I expect emergence of various types of agents' behavior, which is discussed in more detail below: agents with low task-specific confidence and high score in the personality trait Agreeableness are expected to be more likely to follow the herd whereas subjects with high confidence and high scores in Conscientiousness are expected to be less likely to follow the herd.

The task of interest that subjects were to solve appeared first in Falk et al. (2006a) and Falk et al. (2006b) and was modified to meet our needs. The task was to count the number of zeros in a table of 400 symbols, where only ones and zeros occurred. Their performance was rewarded by a fixed-payment for accuracy and by time-dependent payoff for speed. In the treatment condition the subjects, after setting their first guess of the correct number, had an opportunity to see the first guesses of faster subjects, and after this to change their guess to another number. Subjects could decide first whether or not to see the information about the others' results and then whether or not to change their guess. If a subject looked at information about the others' results and changed her guess, it is used as 0/1 proxy for the occurrence of herd behavior, which is then modeled as an explained variable by using logistic

regression. They performed the task under three different types of time-pressure, which is then used as a set of 0/1 explanatory variables.

The behavioral approach suggests that herding is an innate ability of a human species resulting in preferences for conformity. This implies that the decision about whether or not to follow the herd is an instinctive response and as such it should be very quick and the probability to herd should depend on personal characteristics. If this is the case, the varying levels of time pressure should not influence the propensity to herd as decision to herd needs always only very little time to decide upon. Personal characteristics are tracked by the standardized psychometric protocols which is freely available IPIP-NEO (Goldberg (2010)) and which is very similar to standard used NEO-PI-R (Costa and McCrae (1992)).

Tracking of personal characteristics is important for other reasons, e.g. as stress can have a different impact on the performance of people with different attitudes to risk as in Cadsby et al. (2009). Baddeley et al. (2010) found positive association of herding with personality traits associated with risk-taking, namely impulsivity and venturesomeness. Moreover, Borghans et al. (2008) suggest that the protocol identifying individual personality should accompany every microeconomical study as it can seriously affect the results.

The (Bayesian) informational approach on the other hand suggests that herding is a result of a rational use of additional information extracted from the spotted behavior of others. As such, when having not enough time to extract the information both from one's own resources and from the information pool of others, it will depend on what information source is perceived as being more reliable. Maule and Edland (2000) provide a very interesting review of the effects of time-pressure on individual decision making, which as they conclude has been mainly ubiquitous – similarly to other studies. Rieskamp and Hoffrage (2008) as well as Payne et al. (1996) show that the main effect of time-constraint on information-processing is that participants process information faster and with higher selectivity of important facts. Kocher and Sutter (2006) in the framework of an experimental beauty-contest game found that the convergence to equilibrium is faster and the payoffs are higher in the low pressure treatment than in the high time pressure, however during the high pressure treatment the quality of decision making does not decrease.

One form of herding resulting from the rational use of information is the so called information cascade. Information cascades were first comprehensively described and analyzed by Bikhchandani et al. (1992), Banerjee (1992) and Welch (1992), and the first most widely respected test of this claim was carried out by Anderson and Holt (1997). The information cascades and herding behavior that arise due to informational externalities in

general have been subject of many papers: Raafat et al. (2009) provide a high-quality cross-discipline review, Sharma and Bikhchandani (2000) review literature on herding in financial markets and Hirshleifer and Teoh (2003) provide a review of informational cascading in capital markets.

Baddeley et al. (2007) conclude that both approaches have some merit and none of them can be used exclusively. Baddeley et al. (2010) suggest developing a neuroeconomic behavior model with emphasized dual processing and consilience of both the mentioned approaches.

## **2. Methodology**

I conducted a computerized<sup>1</sup> laboratory experiment to test the theoretical predictions which I summarize below. Participants of the experiments had to complete a task of counting zeros from a sheet of 400 symbols under different levels of time pressure (see Appendix for visualization). The experiment consisted of six experimental sessions in two days plus one pilot session that was used for parameter calibration. There were four different within-subject treatments of the task: in the first treatment the subjects were not restricted by time and had two tasks only to practice. In the second treatment three levels of time pressure were introduced, which was represented by a strict<sup>2</sup> time constraint and a time-dependent bonus to motivate the subjects to be fast. The third and the fourth treatments followed the second one, but only one of them was done in each experimental session. The third treatment introduced the core idea of the opportunity to look at the guesses of others who were faster than the subject and then to switch from the original guess to a new one, so in effect there was a counting part and a revision part of the task. The fourth treatment was different to the third one only in that the publicly available information<sup>3</sup> about the others' guesses was improved by including the information about the past performance of a respective subject.

The time pressure had to be imposed both on the counting part as well as on the revision part of the task: time pressure in the counting part served as a generator of uncertainty about one's private information; and time pressure in the revision part was expected to cause effect on individual propensity to herd. If there had been no time pressure in the counting part of the task, everybody would have reached very precise private information

---

<sup>1</sup> Program used was the Z-TREE (FISCHBACHER, U. 2007. z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, 10, 171-178.)

<sup>2</sup> Strict in the sense that if a subject ran out of time, received zero.

<sup>3</sup> Publicly available info was essentially information about private signals of all predecessors revealed to successors.

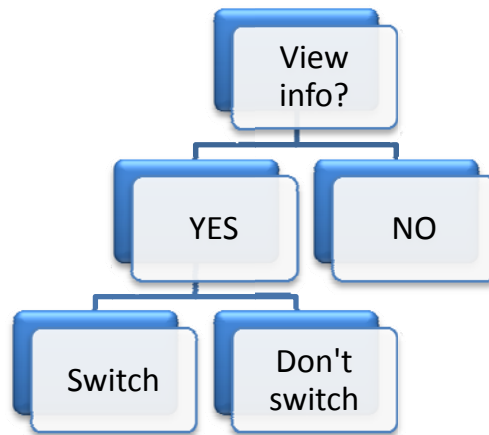


and thus would have had no incentive to revise it by taking inspiration from others. Apart from this, exposure to a time pressure induces physiological stress reaction only after some time (Kemeny (2003)) so having a shortage of time only for the revision would have had no impact on the decision.

In the revision part of the task a subject was able to observe only the results of subjects who were faster than her, which corresponds to situations in the real world, where we almost always observe only actions that were made before our decision. This has certainly had implications for individual strategy concerning the revisions: the faster subjects could have had worse quality of public information, but on the other hand they could have had better individual abilities to solve such task. Strategically thinking subjects usually observed that there was a stable portion of “honest” subjects who always counted until the end and their estimate was reliable, and thus it was worth waiting for them and copying their results.

Heart-rate was used as a proxy of endured stress and it was measured by heart-rate monitors Polar R800 with a precision of 1s. The individual difference of the average heart-rate during the task minus the base-level is used as an explanatory variable in the regression analysis. Heart rate increases are associated with endured psychosocial stress as was shown e.g. by artificial induction of stress in Trier Social Stress Test (Kirschbaum et al. (1993)) and is generally considered to be a sign of increased body activity. The caveat is that increased heart-rate may be a result of other stimuli than stress, which imposes limitation to the explanation of the result. Moreover, for precise measurement of stress this should be combined with other measures like concentration of cortisol in saliva or systolic blood pressure. However, the response of HPA axis to the endured stress in case of release of cortisol is not immediate and its administration is distracting and relatively costly. Measurement of blood pressure would significantly prolong the experiment and it would not be possible to administer during the task, so I decided to use as a measure of stress only heart-rate with the known limitations of this approach.

In this context I define the occurrence of herding as a situation when a participant used information from seeing the guesses of the other participants. This 0/1 variable is meant to be the observable outcome of an unobservable probability to herd, which is the main variable of interest. The subjects could choose whether to see the public information (see the scheme of decision-making flow in the Figure 1. Therefore, apart from the probability to herd, I also model the probability that subjects even wanted to see the public information and self-selected themselves.



**Figure 1: Scheme of decision-making process after setting the first guess**

**Task: Counting Zeros**

The participants performed a simple cognitive effort task introduced in Falk et al. (2006b), which was supposed not to require previously earned skills or any innate cognitive abilities with learning effect. However, subjects with dysfunctions like dyslexia or dyscalculia may have found the task harder than the others as I found out from written feedback. This task was also designed not to involve any emotions and only positive payoffs were possible to eliminate loss-aversion. The signal imperfection is induced by utilizing the subjects' inability to cope with the situation in being under time-pressure. Participants were required to count a correct number of zeros from a table of 400 symbols (zeros and ones only) that appeared on the screen. The numbers are randomly generated from a uniform distribution with variability large enough that accurate guessing is highly improbable.<sup>4</sup> The task is quite tiring and not interesting, as Falk et al. (2006b) point out, so each participant was supposed to solve only eleven tasks in total, including the practice session. After counting the number of zeros, participants were supposed to enter their estimated number (guess) into prepared field.

**Pay-off function**

Pay-off function consisted of a fixed part and a time-dependent part. Similarly as in Falk et al. (2006b), participants were paid fixed amount of 100 ECU (2€) per sheet if counted exactly, 80 ECU if in the range of +/- 1 or 40E CU if in range +/- 2. The size of the time-dependent part was different with each level of stress (see Table 1). The time limit was binding in the sense that if the task was not completed in the given time, participant got zero ECU in total. Also the precision of the guess was binding such that if a participant missed the correct number of zeros by more than two, she received zero from both fixed amount as well as from the time dependent bonus. The fixed part of the payment per task is the motivation for

---

<sup>4</sup> However, at every session there was at least one subject who tried it more than once.

a subject to try to count accurately while the time-dependent bonus part makes the subject count as quickly as possible. Being fast and precise is normally a stressful and demanding on concentration. All subjects are under the same level of time pressure at the time, so the individual performance relative to others should stay the same and the beliefs about other subjects and the probability of their success should not change with different levels of time pressure.

<b>Level of time pressure</b>	<b>Time limit</b>	<b>Time-dependent part (start value)</b>	<b>Factor of decreasing (per second)</b>
Low	150s	400 ECU	-3 ECU
Medium	130s	500 ECU	-4 ECU
High	100s	600 ECU	-5 ECU

**Table 1: Summary of parameters of payoff function.**

### **2.1. Organization of the experiment**

Before start of the experiment, the heart-rate monitors were attached and during the experiment the heart-rate of the participants was recorded with resolution of 1s. After reading the instructions aloud and explaining them in detail, subjects were asked a few questions to check their understanding of the rules. The participants went through three main parts of the experiment that were based on the task described above. The first part included the first treatment the aim of which was to familiarize subjects with the task. The second part included the second treatment and the third part included either the third or the fourth treatment. Each participant was supposed to solve two tasks in the first treatment, three tasks in the second treatment and six tasks in the third or fourth treatment. Participants were informed before each task about the level of time pressure, the time limit for the task and the bonus they could get on a separate introductory screen. Participants saw their payoffs from the task always on a summary screen after each task and this screen also included the cumulative payoff from the treatment. There were also breaks of 60 seconds between the periods with time pressure for both having a rest and calming down the heart rate so that the measurements in the periods would not affect each other. At the end of each period, the participants had to answer a question on their subjective perception of the pressure they were under (Svenson and Benson (1993)). This result would be compared to the data from the heart-rate monitors. Prior to the end of the experiment, the participants had to fill out a questionnaire and at the end they were asked to stay a few minutes at rest with their eyes closed which was necessary to establish a reference level for the heart rate. In total, the experiment lasted less than 2 hours.

Subjects arrive to the lab	
<b>Heart-rate monitors are attached</b>	
Reading instructions aloud confirming questions	
<b>First part - acquainting with the task</b>	
<b>Second part - introducing time pressure</b>	
<b>Risk-preferences protocol - lottery task</b>	
<b>Third part</b>	
Task under time pressure + possibility to revise	Task under time pressure + possibility to revise & information about past performance
<b>Questionnaire</b> personality profile demography	
Sitting quiet 5mins payout & leave	

**Table 2: Timeline of the experiment**

### **Test of task-specific confidence and the lottery card**

Before interaction with the other participants they were asked a question on their judgment about their respective performances<sup>5</sup> in the task in order to measure how confident the participants felt. The answer ranged from one to five with one being the top 20% and five being the bottom 20% and it entered the model in the form of the variable *SelfConfidence*. After they had finished this, the participants were asked to fill out a separate sheet of paper with a “lottery card<sup>6</sup>” based on Dohmen et al. (2009) to find out their attitude to risk. This revealed their certainty equivalent and the general attitude to risk of an individual. To capture the personality profile of participants, I used the “Big Five” factors that are Openness to Experience, Conscientiousness, Extraversion, Agreeableness and Neuroticism. Each factor represents a summary of a large number of specific personality characteristics and most

<sup>5</sup> “Please try to guess, in which part of the distribution of results you are (i.e. if you think, that you are in the top 10%, please click on the "Top20%", which means how close you are to the top).” The scale ranged from one to five with one indicating top 20% and 5 indicating Bottom 20%

<sup>6</sup> See the appendix for the real look of the task.

commonly they are measured with NEO Personality Inventory<sup>7</sup> by Costa and McCrae (1992).<sup>8</sup> At the end of the experiment the subjects then filled in a questionnaire where they answered 50 standardized questions similar to NEO-IP<sup>9</sup> to reveal their personality profile.

## **2.2. Hypotheses description**

### **Effect of time pressure on performance and decision making**

Generally speaking, if participants were perfectly rational, they would neither fail in the task nor would seek information about decisions of other participants. If we relax this assumption by assuming that individual decision-making is based on individual bounded rationality, then we should expect a negative monotonic relationship between the level of time pressure and performance in the task. Gilbert and Kogan (2005) show that learning from others has an impact mostly on worse players, who tend to improve not only results, but also decision making processes. The reasoning should be straightforward: the less time the subject has for completing the task (which corresponds with a higher level of time pressure) the less precise her private information gets and the more relevant to see and use the public information. Rieskamp and Hoffrage (2008) show however that when people are under increased time-pressure, they tend to process information faster and more focused selectively on the more important information. The effect of time pressure on herding will therefore probably depend on the individual assessment of whether the public information may or may not be useful.

*Hypothesis 1: Herding and occurrence of information cascades is more frequent under higher time pressure. Time pressure is a relevant variable in the explanation of the probability of herding.*

### **Personality traits**

Following Baddeley et al. (2007), I expect that individuals with higher scores in the extraversion and agreeableness will tend to follow the crowd with a higher probability than the rest. Openness to experience may be significant for the people who want to see the public information. On the other hand, conscientiousness should be strong for the people with strong individual behavior and thus this dimension should be negatively associated with viewing the

---

<sup>7</sup> Neuroticism, Extroversion, Openness to experience—Personality Inventory—Revised.

<sup>8</sup> I use an inventory of questions very similar to it, however available for free. The battery of 50 personality trait questions used in the experiment is from IPIP project, which is a collaboratory for the development of advanced measures of personality and other individual differences.

<sup>9</sup> HOGAN, R. & HOGAN, J. 2007. *Hogan Personality Inventory Manual, Third Edition*, Tulsa, OK, Hogan Assessment Systems..

information about others' decisions. Neuroticism may be important due to the idea that people high in Neuroticism are nervous and to feel more confident, they may be willing to see and use public information. I include these ideas in the model specification. However, if the behavior-based explanation of herding has any merits in general, it could be proven by a test of joint significance of all personality traits in the regression, which brings the following hypothesis.

*Hypothesis 2: Personality traits as part of the behavior-based approach toward herding significantly influence the probability of herding.*

<b>Factor</b>	<b>Facets</b>	<b>Definition of a factor</b>
I. Openness to Experience	Fantasy, Aesthetics, Feelings, Actions, Ideas, Values	The degree to which a person needs intellectual stimulation, change, and variety.
II. Conscientiousness	Order, Dutifulness, Achievement striving, Competence, Self-discipline, Deliberation	The degree to which a person is willing to comply with conventional rules, norms, and standards.
III. Extraversion	Warmth, Gregariousness, Assertiveness, Activity, Excitement seeking, Positive emotions	The degree to which a person needs attention and social interaction.
IV. Agreeableness	Trust, Straightforwardness, Altruism, Compliance, Modesty, Tender-mindedness	The degree to which a person needs pleasant and harmonious relations with others.
V. Neuroticism (Emotional Stability)	Anxiety, Angry hostility, Depression, Self-consciousness, Impulsiveness, Vulnerability	The degree to which a person experiences the world as threatening and beyond his/her control.

**Table 3: THE BIG FIVE DOMAINS AND THEIR FACETS. SOURCE: HOGAN AND HOGAN (2007)**

### **Risk attitude**

The risk-averse subjects should suffer from a deterioration of performance under time pressure as in Cadsby et al. (2009) and the elevated levels of cortisol stemming from stressful situation may actually promote risk-taking as in van den Bos et al. (2009) or Porcelli and Delgado (2009). Therefore subjects will have a greater incentive to look at the results of others, if they perceive the information valuable, possibly then also using the information. Their subjectively felt stress levels should also be higher than of the risk-neutral or risk-seeking subjects. The fact that they will be presented the public information may lead to more risky decisions, which in the context of the experiment, may lead to a higher frequency of switching from original values to a value conforming to the observed information. The action to switch is faced as leading to subjectively uncertain outcome and due to ambiguity aversion it is perceived as a risky decision (Fox and Tversky (1995)).

*Hypothesis 3: Risk-averse subjects have a higher propensity to look at the public information and their perceived level of stress will be higher than the level of stress perceived by the other subjects.*

### **Endorsement effect**

The effect when the decisions of an important player with a high game-specific reputation in the market make other participants follow her investment decisions is called by Hirshleifer and Teoh (2003) the endorsement effect. In the context of herding literature, this effect is

mostly considered to cause herding in the sense that investment managers under certain circumstances mimic the decisions of other managers thus behaving rationally from their perspective in the labor market as mentioned in Scharfstein and Stein (1990) or Sharma and Bikhchandani (2000). The endorsement effect enters the model in a form of a dummy *Reputation* which equals one when the subjects were able to see in the public information screen also the cumulative earnings of each participant next to the estimate.

*Hypothesis 4: Showing reputational information about players influences propensity to herd through the endorsement effect.*

### **Heart rate**

Heart rate is the frequency of the contractions of the heart muscle and its unit of measurement is frequency per minute. Changes in heart rate refer to higher levels of arousal, which are often somatically mediated, which suggests that when the heart-rate increases, the body is in a state of increased awareness. However, heart-rate as a psycho-physiological variable is a rather rough measure of stress as stated in Lo and Repin (2001).

*Hypothesis 5: Stress induced by the time pressure causes the individual's heart rate to be significantly different from the base level during the performance and is positively correlated with the subjectively stated level of stress.*

## **3. Model description**

The model for explaining the probability of looking at the public information, or, in other words, the binary variable *InfoShown*, is as follows:

$$\log\left(\frac{\Pr[\text{InfoShown}]}{1-\Pr[\text{InfoShown}]}\right) = \alpha + \beta_1\text{Reputation} + \beta_2\text{SelfConfidence} + \beta_3\text{TimeLeft} + \beta_4\text{TP}_{\text{Medium}} + \beta_5\text{TP}_{\text{High}} + \beta_6\text{O} + \beta_7\text{C} + \beta_8\text{E} + \beta_9\text{A} + \beta_{10}\text{N} + \beta_{11}\text{SubjectiveStress} + \beta_{12}\text{Female} + \beta_{13}\text{CE} + \beta_{14}\text{RiskAverse} + \beta_{15}\ln\text{TotProf} + \beta_{16}\text{HR}_{\text{DIF}} + \epsilon$$

The model for explaining the probability of herding, or in other words the binary variable *InfoUsed*:

$$\log\left(\frac{\Pr[\text{InfoUsed}]}{1-\Pr[\text{InfoUsed}]}\right) = \alpha + \beta_1\text{Reputation} + \beta_2\text{SelfConfidence} + \beta_3\text{TimeLeft} + \beta_4\text{TP}_{\text{Medium}} + \beta_5\text{TP}_{\text{High}} + \beta_6\text{O} + \beta_7\text{C} + \beta_8\text{E} + \beta_9\text{A} + \beta_{10}\text{N} + \beta_{11}\text{SubjectiveStress} + \beta_{12}\text{Female} + \beta_{13}\text{CE} + \beta_{14}\text{RiskAverse} + \beta_{15}\ln\text{TotProf} + \beta_{16}\text{HR}_{\text{DIF}} + \beta_{17}\text{score} + \beta_{18}\text{score2} + \beta_{19}\text{TimeDeciding} + \epsilon$$

The model is estimated by using standard logistic regression with robust standard errors. The difference to probit was negligible.



### **3.1. Variables description**

In the model specification, three groups of variables are incorporated: the first group represents the information that was on the screen with the public information, the second group represents the individual personality type and the third group contains other task characteristics that may be important for making the decision. Some variables were added more in an exploratory manner and the sign of their coefficients is not easy to expect.

#### **Dependent variables: *InfoShown* and *InfoUsed***

Variable “*InfoShown*” indicates whether the subject decided to see the public information or not. It was introduced in treatments 3 and 4 and it can take only values 0 or 1. If the subject decided to see the public information, then she had the opportunity to change her estimate according to the new information. There emerges the second explained variable “*InfoUsed*”, which takes value of 1 if the estimate was changed after a participant had seen the public information or 0 if it remained unchanged. I treat it as result of the underlying unobservable probability of herding.

#### **Independent variables**

##### **Time variables: *TimeLeft*, *TimeDeciding***

I construct a variable *TimeLeft* that is the number of seconds participants had on the screen when they entered their original estimate and I expect it to positively influence the probability of viewing the public information *InfoShown*, because generally the subjects would look there *only* if they had some time remaining to do so. A majority of subjects did not have much time to waste so if they had it, they invested it wisely. On the other hand, if already looking at the results of others, the total time they had left should already be irrelevant - either there was useful info or less useful info, but the time to switch the estimate or to go further was not dependent on the total time the subjects had.

Another explanatory dimension of time can be hidden in the time which subjects spent on the screen with the public information. Intuitively, because they were under time pressure, they must have decided fast whether to use the information and change the value, or to go further, as described above. Had they decided to change their estimate, they had to think of the new value, which is already a deliberative process and needs more time, so the variable *TimeDeciding*, which indicates the time the subjects spent on the screen with the public info, is expected to be positively associated with the *InfoUsed*.

##### ***Time Pressure indicator***

The exogenously set level of time pressure (low/medium/high) the subjects endured during the task is indicated by 0/1 dummy variables. It enters the regression as a set of two variables *TP\_Medium* and *TP\_High*<sup>10</sup>. To test Hypothesis 1, this variable should be significant in the explanation of both probability to show the information as well as os probability of herding, especially when indicating the “high” level of time pressure: the variable *TP\_High=1*. The expected sign should be positive as stated in the Hypothesis 1.

**Measure of information: *ScreenInfo* and *GuessSimilar***

To capture the value of the information that the subject saw on the screen, I compute two indices: the index *ScreenInfo* is a measure of similarity of all the results that the subject saw on the screen and *GuessSimilar* is the measure of the similarity of the subject’s original estimate to the observed values. *ScreenInfo* was computed with a simple approach: with the exception of zero, for all pairs of values available on the screen, when two values did not differ by more than one, the index got one point and the summation over all points created the index. The idea is that the more information on the screen, the higher probability for the subject to switch from her original estimate. *GuessSimilar* was computed in a similar fashion: if the subject’s original estimate was not further than one from a value of an estimate on the screen, *GuessSimilar* got one point. Again, summation over all observed values yields the final value of *GuessSimilar*. The meaning is that the more similar one’s guess to others’ guesses is, the less meaningful it is to switch.

**Personality traits: *OCEAN***

From the standardized battery of 50 scale questions I compute the scores for each of the five dimensions. If the personality traits jointly happen to be significant, it will prove the Hypothesis 2 that the individual personality profile is important in the explanation of the probability of herding. Moreover, similarly to the discussion earlier in the text, I expect that the variables behave in these ways:

**Openness to experience** to positively influence the *InfoShown* as this trait is characterized by the desire to explore and keep getting new information, trying things as opposed to conforming. However, this trait says nothing about following the decisions of others, so I do not expect it to influence *InfoUsed*.

**Conscientiousness** to negatively influence the *InfoShown*, because subjects who score well in this dimension should be deliberate and achievement-striving, so I expect that they

---

<sup>10</sup> *Time\_Pressure\_Medium* and *Time\_Pressure\_High*. Due to perfect collinearity this brings, indicator of the treatment with low time pressure, *TP\_Low*, must have been omitted

will go straight for the result. Furthermore, they may rather be followed than to follow so I do not expect it to play a role when explaining the *InfoUsed*.

**Extraversion** to positively influence both *InfoShown* and *InfoUsed*; because the very essence of this trait is sociability which means being curious about the behavior of other subjects (*InfoShown*) and also being adventurous, thus not being afraid of trying new approaches, such as getting and using public information (*InfoUsed*).

**Neuroticism** to positively influence both *InfoShown* and *InfoUsed*, because the positive values of this trait are associated with an emotionally unstable personality that is uncertain about her own outcome, she may want to see additional information about others, and if she sees it, such a person may believe more the judgment of others than her own.

Because the most important characteristics of **Agreeableness** are kind and loving, cooperative, being of trusting nature and able to find the best in others, a person who scored high in this dimension would probably go with the crowd and even in the case of a failure she would find the better side of it: I expect it to positively influence both.

#### **Attitude to risk: CE, RiskAverse**

From the theoretical discussion above as summarized in Hypothesis 5, we can expect that the attitude to risk expressed as a Certainty Equivalent (*CE*)<sup>11</sup> is important when determining the *InfoShown* and also *InfoUsed*, but the effect is uncertain. However, only the significance of this variable is enough to help to break the exclusivity of the information-based approach which is being assumed in seminal papers. Apart from only the variable *CE*, I also introduce a simple dummy *RiskAverse*, which is one if the subject is weakly risk averse – if *CE* is smaller or equal to 16 which means the certainty equivalent was smaller or equal to the expected payoff from the lottery task.

If the nature of revealing the public information is perceived as a risk, the expected sign should be negative. If one takes into consideration that looking at the public information was costly and there was no certain outcome from this kind of investment, similarly to the switching to another value according to the prevalent type of estimates seen by others, it may be perceived to be a version of lottery and the expected sign in the model of explanation of *InfoShown* as well as of *InfoUsed* will be negative.

#### **Other personal characteristics: Female, SubjectiveStress, SelfConfidence, TotalProfit, Reputation**

The stress induced by the time pressure should also be an important variable and as part of Hypothesis 1 it should positively influence the probability of herding - *InfoUsed*.

---

<sup>11</sup> I infer the certainty equivalent from the switching point in the lottery task – see the Appendix.

There appear two measures of it: the subjectively stated level of stress *SubjectiveStress*<sup>12</sup> and the difference of the average level of heart-rate during the task to the base-line heart rate *ObjectiveStress*.

Generally speaking, we can also expect that the subjects with a higher task-specific self-confidence will have lower incentives to look at the public information and if they do, they will be reluctant to conform to the majority. In this case the confidence scale<sup>13</sup> is reversed so the effect of *SelfConfidence* is expected to be positive on both explained variables. The total profit (variable *TotalProfit*) that the subject had already earned may have increased her confidence and she may have had greater incentives to risk and try to view the public information because this, according to the loss-aversion principle, may lead to greater losses as well as greater gains, which normal risk-averse subjects are willing to risk when they have already earned something. Because I expect it to behave similarly to the general behavior of wage-related variables; i.e. that it is likely to be log-normal, I transform it by using a natural logarithm so the new variable *lnTotProf* is normally distributed. Finally, the *Reputation* dummy reflecting additional information about the historical performance of a subject should be significant to prove the existence of the endorsement effect as stated in the Hypothesis 4.

---

<sup>12</sup> Participants had to state their subjectively perceived level of stress after each task on the scale from 1 to 10 with 1 being the least and 10 being the most stressful moment.

<sup>13</sup> Participants had to estimate their relative position in the distribution of payoffs after the first two tasks: the question was: “in which percentile do you think you are? 1=Top 20% to 5=Lowest 20%”.

VARIABLES	LABELS	<i>InfoShown</i>		<i>InfoUsed</i>	
		Significant?	Expected sign	Significant?	Expected sign
<i>ScreenInfo</i>	Score of similarity of others' values among themselves			yes	+
<i>GuessSimilar</i>	Score of similarity of estimate to the others' values			yes	-
<i>Reputation</i>	1 if reputation shown	yes	+	yes	+
<i>TimeDeciding</i>	Time spent on screen with public information			yes	+
<i>TimeLeft</i>	Time left when original estimate set	yes	+	no	
<i>TP_High</i>	1 if High Time Pressure	yes	+	yes	+
<i>O</i>	Openness to Experience	yes	+	no	
<i>C</i>	Conscientiousness	yes	-	no	
<i>E</i>	Extraversion	yes	+	yes	+
<i>A</i>	Agreeableness	yes	+	no	
<i>N</i>	Neuroticism	yes	+	yes	+
<i>SubjectiveStress</i>	Stress (Subjective)	yes	+	yes	+
<i>Female</i>	1 for female	no		no	
<i>CE</i>	Certainty equivalent	yes	+	yes	+
<i>RiskAverse</i>	1 if Weakly Risk Averse	Yes	+	Yes	+
<i>SelfConfidence</i>	Self Confidence	yes	+	yes	+
<i>lnTotProf</i>	Ln (Total Profit)	no		yes	+
<i>ObjectiveStress</i>	Difference of base-line to actual HR	Yes	+	Yes	+

**Table 4: Expected behavior of explanatory variables.**

## 4. Main Findings

### 4.1. Sample

The experiment was attended by 90 participants in total. A majority of participants were Czechs (77.8%) followed by Slovaks (12.2%) and other nationalities (10%). There were 62.2% males, the most common field of study was economics and business (75%) and the median age was 22. Participants were paid privately at the end of the experiment, the average payment was 350 CZK (app. 13.5€) out of which they had a guaranteed show-up fee of 150 CZK (app. 6€). The average payment was about double the average hourly salary in region. Due to the low variation in age, education and nationality I did not consider these to be explanatory variables in the model, however it may be important.

It would be insufficient to state that a subject used the public information only if she switched from the original value to a new one (in case of the *InfoUsed* variable) because a subject could use it to reassure herself that she stands on solid ground – that her estimate was not too far from the others. If I have a look at the situation when the similarity of their original estimates to the numbers they saw on the screen with the public information was high and probably therefore they did not switch, I get 104 cases of using the information additional to the 122 when they switched.

Time Pressure		N
Low	64%	165
Medium	55%	165
High	56%	165
Total	58%	495

**Table 5: Percentage of cases when decided to see public info (*InfoSeen*)**

Time Pressure		N
Low	41%	106
Medium	40%	91
High	47%	92
Total	42%	289

**Table 6: Percentage of choices when they were affected by the info (*InfoUsed*) conditionally on seeing the public info**

From the Table 5 it is visible that the percentage of people using the public information is higher in the *High* level of time pressure. This suggests that the subjects tended to use the public information more often when under higher pressure. However, standard F-test results in that the levels are insignificantly different from each other<sup>14</sup>.

<sup>14</sup> P-value=0.576

<b>variable</b>	<b>explanation</b>	<b>N</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std. Deviation</b>
<i>InfoShown</i>	Decided to see public info	495	0	1	0.58	0.49
<i>InfoUsed</i>	If really used the info	289	0	1	0.42	0.49
<i>ScreenInfo</i>	Score of similarity of others' values among themselves	942	0	74	6.37	11.08
<i>GuessSimilar</i>	Score of similarity of own estimate to the others' values	495	1	15	3.27	2.71
<i>Reputation</i>	Reputation dummy	495	0	1	0.55	0.50
<i>TimeDeciding</i>	Time spent on screen with public information	942	0	67.38	3.34	6.72
<i>TimeLeft</i>	Time left when original estimate set	760	0	157	43.67	32.44
<i>TP_Medium</i>	Medium Time Pressure	760	0	1	0.33	0.47
<i>TP_High</i>	High Time Pressure	760	0	1	0.34	0.47
<i>O</i>	Openness to Experience	942	-4	20	9.99	5.22
<i>C</i>	Conscientiousness	942	-8	16	3.97	5.38
<i>E</i>	Extraversion	942	-13	18	2.83	6.64
<i>A</i>	Agreeableness	942	-6	18	4.57	4.67
<i>N</i>	Neuroticism	942	-20	8	-4.17	5.16
<i>SubjectiveStress</i>	Stress (Subjective)	760	1	10	5.76	2.45
<i>gender</i>	Male	942	0	1	0.62	0.49
<i>CE</i>	Certainty equivalent	864	2	21	14.68	3.42
<i>RiskAverse</i>	Weakly Risk Averse	942	0	1	0.92	0.28
<i>SelfConfidence</i>	Self Confidence	942	1	5	3.16	1.22
<i>TotalProfit</i>	Total Profit	942	0	2017	347.54	397.71
<i>ObjectiveStress</i>	Difference of base-line to actual HR	677	0	53	16.47	9.82

**Table 7: Descriptive statistics of the variables used in the model**

### **Subjects' "Player" profiles**

In the experiment different types of subjects emerged: there were some that benefited from the possibility to see the public information, but also some for whom the information was useless. Out of 90 subjects, there were 13 subjects who never looked at the public info, and 8 out of them performed significantly better than average. This is the "successful" type of subject that would only lose the money by viewing the public info. Apart from this, there was another type of subject who also never used the information, but this one must have had

another motivation as their performance was mostly below average. I call this type “unsuccessful honest”.<sup>15</sup>

On the one hand, there were 33 subjects who did look at the public info each time they had a chance to, but out of those 33 only 5 used always the info, so these “curious and imprecise” subjects were also not the only type of subjects. On the other hand, there were 8 subjects who looked every time, but never switched – the “self-assuring” types. These 8 were mostly highly successful in the task, so they probably just assured themselves that their result was correct.

#### 4.2. Information cascades

Information cascades could have occurred in the third and the fourth treatment in 33 periods<sup>16</sup>. In this setting the cascade occurs when the latter participants switch from their original values and follow values of players that had been faster. There can be a correct cascade, when all the subjects follow a correct number of zeros; or a weakly correct cascade, when the subjects follow a number that is in the tolerated range  $\pm 2$  around the correct value, and an incorrect cascade, when they follow a completely incorrect number. Or, there need not have been any cascade at all. Out of the 33 possibilities, there happened to be no full perfect cascade in the sense that all following participants in a period would look at the public information and switch to the observed value and this value was correct. On the contrary, there were two periods when nobody decided to switch. The mean of *InfoUsed* is 42%<sup>17</sup> per period, which indicates that the empirical probability to use the information was quite low even if the subject already decided to see the public information. Out of all possibilities<sup>18</sup>, subjects switched in 24.5% cases, which is even a smaller portion. However, we can observe in many cases quasi-cascades, sometimes even a reversal of a cascade from an incorrect to the correct one: there were 9 correct quasi-cascades in the sense that we do not consider it a break when a player made a mistake or ran out of time; the most important is that the number followed was the true one. Apart from that, there were 10 weakly correct quasi-cascades when the number followed was not the true one, but it was still in the region  $\pm 2$  and the subjects got paid for it.

---

<sup>15</sup> I found out in feedback that there was a type of player not willing to see the public info due to fear of getting distracted by the results of others and thus performing even worse.

<sup>16</sup> In treatment 3, I had to exclude some observations due to technical problems with the computers in the first session. In the end I have 15 full periods in the third treatment and 18 in the fourth treatment, which gives 33 possibilities of getting a cascade.

<sup>17</sup> Computed from the base of 289 which corresponds to the total number of cases when subjects decided to view the public information.

<sup>18</sup> Computed from the base of 495 which corresponds to the total number of cases when subject could decide to see the information and then use it.



### Was public information useful?

We can have a look at the rate of “success” of switching: if the new estimate brought a higher payoff than the original one. The percentage of successful changes is shown in the Table 8 – we can see that in most experimental session groups the subjects could exploit the information in more than 80% cases. However, group No. 3 was exceptional and had this rate lower than 50%.

Session No.	1	2	3	4	5	6	Total
Mean	81%	86%	<b>44%</b>	88%	82%	85%	76%

**Table 8: Rate of Success of Switching the Estimate**

In this exceptional session No. 3 there were four subjects who randomly guessed the number shortly after the beginning of a period, so they added significant noise to the information seen on the screen to the public information by other subjects. Interestingly, their results were in the first three periods followed by others. As a result, the rate of successful switch in this group was much lower than in the other groups where there were on average 3 incorrect switches, but in this group there were 14 incorrect switches. There were even incorrect cascades when the number followed was far from the true one: it happened in the first part of a period and it was caused by the subjects who guessed the result who were followed by two to three other subjects. However, in the second half of the period, three to four “honest” participants arrived and brought the correct information to light. Then the next subjects mostly either entered the result correctly or did not use the public info at all. This result strongly supports the fragility of cascades in a continuous setting: an incorrect cascade began, but was overrun by the arrival of the information brought by the subjects who counted well and their estimate was more precise. In real life, we also cannot distinguish who, when in a cascade, ignores private information and follows the crowd and on the contrary, who accidentally gets the same result and gets into a cluster of subjects with the same results. The results generally suggest that if subjects expect the arrival of true information to the public, moment of the arrival may, with a high probability, break the cascade.

Decided to view public info ( <i>InfoShown</i> )				
Time Pressure	Low	Medium	High	Total
InfoShown=1	<b>64%</b>	<b>55%</b>	<b>56%</b>	58%
N	165	165	165	495

**Table 9: Comparison of rates of seeing the public information in different levels of time pressure**

### Time Pressure and Information Cascades (Herding)

The rate of cascade creation was independent of time pressure; the same as the rate of switching from the original estimates (see Table 6). Also the rate of viewing the public

information was not significantly different from each other if I simply compared the means as is shown in Table 9 even though the rate seems to be a little higher under the Low level of time pressure. This obviously goes against Hypothesis 1 and the underlying explanatory mechanism of Rieskamp and Hoffrage (2008) who suggest that if people have to work under increasing time pressure, they select faster a smaller amount of information that they consider to be worth it; i.e. they prefer more quality over quantity than in the treatment without time pressure.

	Time Pressure			
	No Pressure	Low	Medium	High
Inaccuracy of original estimates (Mean)	5,68	7,58	13,80	24,45

**Table 10: Inaccuracy of private info as the difference of the first guess to the true value.**

### 4.3. Data from heart-rate monitors<sup>19</sup>

I measured the average heart rate<sup>20</sup> over the task performed (variable *HR\_AVG*); the base rate of the base-line HR<sup>21</sup> (var. *HR\_CALM*) and the resulting difference between these two (*ObjectiveStress*), which should account for the personal physiological differences of different base-line HR levels. The summary statistics of the HR-variables are shown in the Table 11. Some subjects had an average HR almost the same as when they stayed calm in the end, others had peaks as high as 151, which is equivalent to highly demanding physical activity.<sup>22</sup>

	N	Min	Max	Mean	SE (Mean)	Std. Dev.
Average heart-rate during the task	677	59	151	90.94	0.601	15.634
Base-line Heart Rate	677	50	98	74.47	0.391	10.179
Difference of base-line to actual HR	677	0	53	<b>16.47</b>	0.377	9.816

**Table 11: Descriptive Statistics of *HR\_AVG*, *HR\_CALM* and *ObjectiveStress*.**

### Qualitative analysis

Generally speaking, there were different kinds of curves of HR: a majority of them (over 50%) were very legible and fit well to the data (see Figure 2 in the Appendix), i.e. there was a significant and stable increase during the performance of the task and the HR went back

<sup>19</sup> With some subjects we could not find the signal from the chest belt at the beginning of a session and with some other subjects the signal kept being lost during the session, which I found out about during the data analysis. In the end, there are 677 reliable observations.

<sup>20</sup> further on HR

<sup>21</sup> HR measured in a “steady” state when no activity is performed; the interval after completion of a questionnaire and before collecting the money.

<sup>22</sup> To illustrate it, the maximum HR of a physically demanding activity is normally computed as 220-age and the higher threshold HR for optimal training of a physical activity like medium-distance jogging is then 80% of the maximum HR; that is by 22 year old subject about 160. Here we got 150, which is equivalent to running (Horčić and Formánek, 2003)

to normal levels between the tasks; but some of them were more or less random and similar to white noise (see Figure 3 in the Appendix). Interestingly, some subjects had a steep peak when they decided to guess the number instead of performing the task (took only a short time of thinking), but others did not. Many subjects also had a short peak just before a task started and then the normal hump-shape followed, which is a sign of a reaction to the introduction screen of each task. Overall, the HR during task was significantly different to the base rate, which proves the first part of the Hypothesis 5 on 1% level.

Hypothesis 5 also stated that there should be a positive correlation between the objectively measured stress and subjectively stated levels of stress, in our case between variables *SubjectiveStress* and *ObjectiveStress*. In Table 12 you can see that indeed there is a significant positive relationship between the *ObjectiveStress* and subjective stress, but the level is rather smaller than we would expect. However, much more interesting is the negative relationship between *ObjectiveStress* and the *InfoUsed*, which suggests that the more a person is in an aroused state (which may be a sign of stress, concentration or activity in general) the less willing she is to use the public information. Unfortunately, without another measure of stress it cannot be distinguished, what the reason for the increase of the HR was<sup>23</sup>.

		<i>ObjectiveStress</i>
<i>SubjectiveStress</i>	Pearson Correlation	<b>.105(*)</b>
	Sig. (2-tailed)	0.013
	N	559
<i>SelfConfidence</i>	Pearson Correlation	<b>.152(**)</b>
	Sig. (2-tailed)	0.000
	N	677
<i>InfoShown</i>	Pearson Correlation	<b>-0.070</b>
	Sig. (2-tailed)	0.180
	N	367
<i>InfoUsed</i>	Pearson Correlation	<b>-.225(**)</b>
	Sig. (2-tailed)	0.001
	N	205

**Table 12: Pearson correlations. Note: (\*) and (\*\*) indicate significance on 5% and 1% level respectively.**

An important part of analysis is comparison of the levels of both subjective and physiological stress with respect to the risk attitudes. Table 13 shows that the means of *ObjectiveStress* and *SubjectiveStress* are however insignificantly different from each other for the risk-averse and risk-loving subjects and thus we can reject second part of Hypothesis 3.

<sup>23</sup> Another measure of stress was by the time of conducting the experiment financially not affordable.

		<i>ObjectiveStress</i>	<i>SubjectiveStress</i>
Risk loving	Mean	<b>15.91</b>	<b>5.50</b>
	SE	0.611	0.201
	Std. Deviation	8.955	2.917
	N	215	211
Weakly Risk Averse	Mean	<b>16.73</b>	<b>5.85</b>
	SE	0.474	0.096
	Std. Deviation	10.192	2.245
	N	462	549

Table 13: Comparison of levels of stress wrt Risk attitude. F-test for the equality of means does not reject the null for both *ObjectiveStress* and *SubjectiveStress* on 10% level of significance.

## 5. Model evaluation

### 5.1. Explaining probability to view public information - *InfoShown*

Summarized in Table 14, the most important attributes playing a role in explaining the variation in the probability of viewing the publicly available information are the risk preferences and individual confidence. Both of these variables were expected to be significant and they also influence in the expected direction. Apart from these, the important variables were from the area of personality traits, namely Conscientiousness, Agreeableness and Neuroticism, which with the exception of conscientiousness also conform to our expectations. The positive relationship between Conscientiousness, the dimension that can be characterized mostly as being achievement-striving, and *InfoShown* suggests the following: the subjects high in this dimension do want to be successful but what's more, they also want to see the relative position of their estimate in comparison to others.

*RiskAversion* and *CE* are both significant on a 1% level and negative as we expected. This fact tells us that the more people are risk-averse, the less willing they were to view the public information. As discussed earlier, the subjects probably perceived the involvement with the public information as a certain kind of a lottery: it was costly and with an uncertain outcome. The second most stable, significant and important variable is the individual confidence represented by variable *SelfConfidence*. Its scale was decreasing: one is for the most self-confident and five for the least self-confident subject. In this point of view its coefficient gives an intuitive finding that the less confident a subject was, the higher the probability to view the public information.

The variable *TimeLeft* is sensitive to the addition of observations and its significance is not stable. The increasing level of time pressure (specified only as a set of dummies

*TP\_Medium* and *TP\_High*) did not have any significant influence on the propensity to view the public information, in any case. Lack of a relationship suggests that the subjects took the task as fixed and either they managed to complete it or they did not; and the level of time pressure did not play any role as suggests the behavior of *TimeLeft*. Being marginally significant, the variable *TimeLeft* reveals a positive relationship between the time subjects had left on the screen when entering their original estimate and the probability that they looked at the public information.

The subjective measure of stress *SubjectiveStress* appears to be steadily insignificant, but the objective measure *ObjectiveStress* reveals on one percent level of significance a stable negative relationship. The relationship of *ObjectiveStress* to *InfoShown* implies that the higher the level of physical arousal (we may say “stress”) the body was in during the task, the lower the probability of viewing the public information. I expected the opposite sign, so this requires more consideration of the underlying reasons: if a subject was in a highly stressful moment, or at least she was exhibiting considerable effort, there may have been a higher chance of being correct than in the opposite case. Apart from that, if this variable indicated effort rather than stress, the negative sign of the coefficient indicates that those subjects who tried hard to get a reliable estimate were sure enough about its precision and had no need to get more information about others. This finding generally agrees with the claim of Rieskamp and Hoffrage (2008) that the more people feel under stress, the more selective their strategy becomes: they search for less information, but only for the relevant information. If they perceived their own skill to be more reliable than the public information, this mechanism may be the explanation of this behavior.

**Explained dependent variable: InfoShown**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Full model	ObjectiveStress excl.	Personality traits excl.	TP excluded	Risk Preferences excl.	Only information	Only personality
<i>Reputation</i>	0.258 [0.262]	0.257 [0.212]	0.277 [0.237]	0.252 [0.262]	0.237 [0.259]	0.351*	
<i>TimeLeft</i>	0.011** [0.005]	0.006 [0.004]	0.008* [0.005]	0.011** [0.005]	0.012** [0.005]	0.004 [0.004]	
<i>TP_Medium</i>	-0.202 [0.295]	-0.362 [0.257]	-0.255 [0.287]		-0.161 [0.296]	-0.338 [0.239]	
<i>TP_High</i>	0.008 [0.337]	-0.239 [0.295]	-0.102 [0.325]		0.078 [0.332]	-0.209 [0.263]	
<i>O</i>	-0.022 [0.027]	-0.023 [0.021]		-0.023 [0.027]	-0.015 [0.026]		-0.016 [0.026]
<i>C</i>	0.063** [0.024]	0.072*** [0.021]		0.062** [0.024]	0.062*** [0.023]		0.063*** [0.023]
<i>E</i>	-0.001 [0.025]	-0.001 [0.020]		-0.001 [0.025]	0.003 [0.024]		-0.017 [0.024]
<i>A</i>	0.094*** [0.032]	0.059** [0.028]		0.094*** [0.031]	0.091*** [0.028]		0.068** [0.028]
<i>N</i>	0.083*** [0.030]	0.068*** [0.024]		0.082*** [0.029]	0.091*** [0.028]		0.069** [0.029]
<i>SubjectiveStress</i>	0.053 [0.053]	0.036 [0.045]	0.034 [0.048]	0.055 [0.052]	0.048 [0.053]		0.028 [0.048]
<i>Female</i>	-0.094 [0.289]	-0.091 [0.244]	0.141 [0.264]	-0.097 [0.289]	0.203 [0.256]	0.624*** [0.195]	
<i>CE</i>	-0.169*** [0.055]	-0.173*** [0.048]	-0.147*** [0.049]	-0.169*** [0.054]			-0.158*** [0.046]
<i>RiskAverse</i>	-1.341*** [0.410]	-1.512*** [0.344]	-1.475*** [0.389]	-1.340*** [0.404]			-1.423*** [0.375]
<i>SelfConfidence</i>	0.662*** [0.122]	0.452*** [0.087]	0.522*** [0.109]	0.661*** [0.122]	0.582*** [0.115]		0.667*** [0.119]
<i>lnTotProf</i>	0.019 [0.057]	0.027 [0.048]	0.010 [0.056]	0.022 [0.056]	0.030 [0.054]	0.002 [0.045]	
<i>ObjectiveStress</i>	-0.047*** [0.016]		-0.032** [0.013]	-0.047*** [0.016]	-0.043*** [0.014]		-0.047*** [0.015]
<i>Constant</i>	1.471 [1.343]	2.140* [1.155]	1.757 [1.206]	1.392 [1.260]	-2.187*** [0.846]	-0.123 [0.420]	2.146** [1.025]
Observations	365	493	365	365	365	493	365
Pseudo R <sup>2</sup>	0.137	0.125	0.0969	0.136	0.113	0.0260	0.119
Log-L	-216.3	-293.2	-226.4	-216.7	-222.4	-326.3	-220.8
Chi <sup>2</sup>	51.08	62.33	43.79	49.80	45.92	17.72	46.90

**Table 14: Logistic model of InfoShown. Note: Robust standard errors in parentheses. \*, \*\* and \*\*\* indicate significance on 10%, 5% and 1% level, respectively.**

## 5.2. Explaining the probability to use public information - *InfoUsed*

Both variables indicating the information seen on the screen (*ScreenInfo* and *GuessSimilar*), dummy indicating the fact that in general it was possible to view also the past performance of the subjects (*Reputation*), the time subjects spent on the screen with the public information (*TimeDeciding*), personality traits extraversion and neuroticism (variables *E* and *N*), and finally the log of total profit earned up to that time (*lnTotProf*) were significant. I expected that variables *TimeLeft* and *Female* would not be important, but apart from them, the insignificant variables were also the dummies indicating the level of time pressure *TP\_Medium* and *TP\_High*, *ObjectiveStress*, both variables indicating subjects' risk attitudes, and the reported level of confidence (remember, the scale is reversed). The insignificance of both time pressure dummies *TP\_Medium* and *TP\_High* then rejects Hypothesis 1 as the probability to use public information was not significantly different in either of the levels of time pressure. However, there may have been an indirect effect of the level of time pressure through other variables, such as the public information provided on the screen could have been perceived as less valuable or the time to make the decision could have been perceived as too precious.

	Time Pressure			
	No Pressure	Low	Medium	High
	Mean	Mean	Mean	Mean
Score of similarity of others' values among themselves	0	8,42	9,08	6,19
Score of similarity of zeros to the others' values	0	3,47	3,52	2,82

**Table 15: Real quality of information with respect to the level of time pressure.**

The variables that generally indicated the time dimension of the task reaped mixed results. Both dummies indicating the level of time pressure are not significant as well as the time the subjects had to make a decision, but the time they spent on the screen with the public information is the most important variable with a positive relationship to the explained variable. The logic may thus be this: the subjects did have a look at the others' results, decided quickly whether they needed to change the coefficient or not, and then either left or started to think of the new value they should switch to, which was time consuming. Therefore, the causality may not be in the way that the longer time a subject stays, the more probable it is that she switches her estimate; but rather the opposite: if a subject wants to switch from her value, it will take her some time.

Both variables indicating information contained in the public screen, *ScreenInfo* and *GuessSimilar*, turn out to be steadily significant and thus it proves that the subjects behaved rationally in the sense that the additional information provided to them in this form influenced their decisions in the correct way. The positive sign of the coefficient of the *ScreenInfo* means that the more similar the coefficients of others, the more informative the screen was and thus the higher the probability of using the information. On the other hand, the negative sign of the *GuessSimilar* means that the more similar the subject's estimate to the estimates of the others' was, the lower the reason she had to change it.

Overall, predictions made about the behavior of explanatory variables were mostly correct, but some of them turned out to have an opposite sign than assumed, such as the significant personality traits or the indicator of the availability of information about the reputation of subjects who made them. The most important variable was identified to be the time subjects spent on the screen with the publicly available information, but the causality is in this case probably reversed. Both variables capturing the information contained in the others' estimates are significant, behave as expected and have a considerable predictive power. Another important predictor is the transformed total profit the subjects had acquired. This variable behaved again as expected. A fundamental result is the insignificance of variables indicating the level of time pressure as well as the level of physical arousal subjects perceived themselves to be in, however as noted earlier, the indirect effect of the time pressure is visible in the variable *TimeDeciding* but it may be hidden also in the perception of value of the public information.



Explained dependent variable: <i>InfoUsed</i>							
VARIABLES	(1) Full model	(2) ObjectiveStres s excluded	(3) Personalit y traits excluded	(4) TP excluded	(5) Risk preference s excluded	(6) Only informatio n	(7) Only personalit y
<i>ScreenInfo</i>	0.068** [0.032]	0.064** [0.026]	0.089*** [0.034]	0.048 [0.030]	0.069** [0.032]	0.068*** [0.025]	
<i>GuessSimilar</i>	0.506*** [0.187]	-0.531*** [0.136]	-0.475*** [0.170]	0.502*** [0.190]	-0.526*** [0.177]	-0.492*** [0.114]	
<i>Reputation</i>	1.878*** [0.631]	-1.656*** [0.443]	-1.321** [0.531]	1.638*** [0.521]	-1.830*** [0.650]	-1.306*** [0.394]	
<i>Time-Deciding</i>	0.301*** [0.093]	0.237*** [0.056]	0.261*** [0.079]	0.315*** [0.098]	0.290*** [0.088]	0.216*** [0.052]	
<i>TimeLeft</i>	0.007 [0.015]	0.009 [0.011]	0.016 [0.017]	-0.005 [0.009]	0.008 [0.016]	0.014 [0.010]	
<i>TP_Medium</i>	-0.160 [0.710]	0.277 [0.449]	0.002 [0.638]		-0.189 [0.686]	0.376 [0.418]	
<i>TP_High</i>	0.899 [0.757]	0.972 [0.610]	1.245 [0.773]		0.978 [0.763]	1.056* [0.554]	
<i>O</i>	0.038 [0.047]	0.058 [0.038]		0.046 [0.048]	0.035 [0.049]		0.046 [0.038]
<i>C</i>	-0.070 [0.052]	-0.049 [0.037]		-0.062 [0.047]	-0.071 [0.052]		-0.034 [0.038]
<i>E</i>	0.151*** [0.055]	-0.128*** [0.038]		0.164*** [0.055]	-0.152*** [0.055]		-0.051** [0.032]
<i>A</i>	-0.021 [0.060]	0.040 [0.047]		-0.042 [0.059]	0.001 [0.058]		0.034 [0.037]
<i>N</i>	-0.115** [0.057]	-0.080** [0.037]		-0.124** [0.058]	-0.122** [0.056]		-0.013 [0.042]
<i>Subjective-Stress</i>	-0.184* [0.107]	-0.155** [0.077]	-0.223** [0.110]	-0.166 [0.105]	-0.180* [0.103]		-0.196** [0.072]
<i>Female</i>	0.253 [0.541]	0.009 [0.419]	0.026 [0.451]	0.313 [0.511]	0.037 [0.528]	-0.178 [0.302]	
<i>CE</i>	0.099 [0.095]	-0.038 [0.062]	0.105 [0.077]	0.124 [0.091]			0.098 [0.073]
<i>RiskAverse</i>	0.317 [0.617]	-0.736 [0.521]	0.342 [0.613]	0.478 [0.622]			0.636 [0.478]
<i>Self-Confidence</i>	0.037 [0.239]	0.274* [0.147]	-0.045 [0.219]	0.036 [0.232]	0.048 [0.227]		0.005 [0.164]
<i>lnTotProf</i>	0.669*** [0.218]	0.536*** [0.122]	0.597*** [0.179]	0.637*** [0.185]	0.658*** [0.220]	0.481*** [0.126]	
<i>ObjectiveStress</i>	-0.024 [0.032]		-0.022 [0.029]	-0.014 [0.035]	-0.021 [0.032]		-0.066** [0.024]
Constant	-6.643** [3.079]	-4.283** [2.093]	-6.521** [2.960]	-6.415** [2.664]	-4.915* [2.772]	-4.880*** [1.361]	-0.901 [1.433]
Observations	201	285	201	201	201	285	201
Pseudo R <sup>2</sup>	0.463	0.409	0.415	0.455	0.459	0.340	0.127
Log-L	-72.49	-114.6	-78.99	-73.68	-73.07	-128.0	-118.0
Chi <sup>2</sup>	59.03	87.21	56.05	51.13	59.11	60.98	18.87

**Table 16: Logistic model of InfoUsed. Note: Robust standard errors in parentheses. \*, \*\* and \*\*\* indicate significance on 10%, 5% and 1% level, respectively.**

### **5.3. Hypothesis evaluation**

#### **Hypothesis 1 – Herding and time pressure**

Both dummies indicating the time pressure are not significantly different from zero, and this result is fairly stable across various specifications, so we can conclude that there is no general relationship between the level of time-pressure and probability to herd. On the other hand, the time dimension played an important role in both models – in the first model it was the time subjects had left when setting the original estimate and in the second model the time they spent looking at the public information – and both must have been implicitly influenced by the total available time that varied with the level of time pressure.

#### **Hypothesis 2 – Personality traits**

Indeed, the big five dimensions of personality proved to be significant as a group in both examined models, but of course only alone did not play the most important part in the explanation of the dependent variables. Even though some of them were significant, they did not behave in the expected way in all cases. The underlying psychological mechanism may thus be much more complicated and I recommend it to be subject of a further interdisciplinary research of economists and psychologists.

#### **Hypothesis 3 – risk-averse subjects and stress**

Risk preferences indeed play a significant role in the model of explaining the propensity to look at the public information, as you can see in Table 14, but the direction is the opposite to that expected: the propensity to look at the public information is negatively influenced by the risk-aversion. Concerning the levels of risk-averseness, you can see that the means of both reported and physiological levels of stress were the almost the same for both risk-averse and risk-loving subjects so we have to reject the second part of Hypothesis 3.

#### **Hypothesis 4 – endorsement effect**

In Table 16 I showed that the effect is significant and this variable indeed plays an important role, but the effect is negative. On the other hand, the overall performance of subjects was indeed higher in the case of the fourth treatment, where the only difference to the third treatment was the displayed reputation of others, which speaks in favor of hypothesis 8. The underlying explanation may be that the rate of switching was lower due to greater selectivity of provided information – switching only in the important cases.

#### **Hypothesis 5 – stress and heart rate**

The result is that the average difference of the heart rate during the task to the base level was 16.47 so the variable *ObjectiveStress* looks like a good measure of the induced

stress. Of course, the heart rate of some subjects was overall not different to white noise, but the majority had very clearly identifiable periods of performance in comparison to the base level with some subjects reaching as high as 150 beats per minute. I expected this variable to be correlated to the subjectively reported level of stress in each period, but as it is shown in the Table 12, this correlation was significant on a 5% level but rather small – only 0.1. This shows a discrepancy between the reported and revealed/directly measure of stress.

### **Robustness check**

Before the estimation I performed a robustness check in that I compared the stability of coefficients in both specifications by using robust logit, probit, standard OLS in two versions – due to lack of data for *ObjectiveStress* I ran the set of regressions<sup>24</sup> for specification with *ObjectiveStress* included and excluded. I also checked for the multicollinearity problem by using the common indicators variance inflation factor (VIF) tolerance and eigenvalues. All indicators of possible problems give negative results<sup>25</sup>. To identify the influential observations, I plot the Pearson residuals vs. leverage from both of the separate model specifications to find and exclude four outliers from the analysis.

After I had checked for the presence of multicollinearity as well as for the normality of residuals I ran the main estimation of the two above specified equations. In Table 14 and Table 16 the stability check of both models performed by exclusion of a group of variables of interest is shown. It is visible that coefficients are fairly stable. If we focus on the personality traits, their exclusion causes a sharp significant decrease in log-likelihood function<sup>26</sup> and this indicates their importance in both of the regressions, confirming the view of Borghans et al. (2008) that an individual personality profile can well predict the possessor's behavior.

---

<sup>24</sup> Not reported in this paper.

<sup>25</sup> The VIF is not greater than 3, the tolerance factors are all above 0, and the highest eigenvalue is 13.4.

<sup>26</sup> In case of robust standard errors such test is not possible, so I run normal logistic regression, which gives the same results as when the SEs are robust, and from these I run LR test. The Chi2 statistic is 21.21 and p-value=0.000.

## **6. Conclusion**

The main purpose of this paper was to explain the individual propensity to herd with a special concern to the effect of time pressure. To do this, I designed and carried out a laboratory experiment. I tracked not only the information directly revealed during the task, but also the individual attributes such as risk attitude, task-specific confidence, personality traits and subjective as well as objective levels of stress. The most important results of this experiment are that time pressure indicated by a set of three 0/1 indicator variables played no significant role in either of the models of herding. Nevertheless, the time dimension, as revealed by the time spent on the screen with public information or time left when entering the first estimate, was significant and important in both cases and thus the time pressure needs to be further examined by using finer resolution. The indirect effects induced by the time pressure on the quality of public information also need to be considered. Information cascades did not arise in a perfect form, implying their fragility and dependence on the specific setting of the task. However, herding was relatively common and only in two out of 33 cases nobody used the public information. Personality traits contribute considerably to the explanation of both models, but the relationship is not straightforward and may need further research. Subjectively perceived stress was correlated to the objectively measured indicator but the correlation was very weak which suggests that the heart-rate may have indicated not only stress but physical arousal in general. The endorsement effect played an important and positive role in determination of the performance of subjects and it was also important in the prediction of the probability of switching, but this time the effect was unexpectedly negative. Subjects mostly used the information in a logical and rational way. Generally speaking, even though the results from this experiment have to be treated with care due to the specific nature of the given task and to the non-representative sample of subjects, this experiment has provided an insight into the state of the analysis of behavior under time pressure, especially in connection to the propensity to herd. Apart from that, it has also given rise to many important new questions, such as the relationship of the propensity to herd and personality traits or the relationship of the subjectively reported and objectively measured levels of stress.

## 7. References

- BADDELEY, M., BURKE, C., SCHULTZ, W. & TOBLER, T. 2010. Impacts of Personality on Herding in Financial Decision-Making. Faculty of Economics, University of Cambridge.
- BADDELEY, M. C., PILLAS, D., CHRISTOPOULOS, Y., SCHULTZ, W. & TOBLER, P. 2007. Herding And Social Pressure In Trading Tasks: A Behavioural Analysis. Faculty of Economics, University of Cambridge.
- BANERJEE, A. V. 1992. A SIMPLE-MODEL OF HERD BEHAVIOR. *Quarterly Journal of Economics*, 107, 797-817.
- BIKHCHANDANI, S., HIRSHLEIFER, D. & WELCH, I. 1992. A THEORY OF FADS, FASHION, CUSTOM, AND CULTURAL-CHANGE AS INFORMATIONAL CASCADES. *Journal of Political Economy*, 100, 992-1026.
- BORGHANS, L., DUCKWORTH, A. L., HECKMAN, J. J. & WEEL, B. T. 2008. The Economics and Psychology of Personality Traits. *Journal of Human Resources*, 43.
- CADSBY, C. B., SONG, F. & TAPON, F. 2009. The Impact of Risk Aversion and Stress on the Incentive Effect of Performance Pay. University of Guelph, Department of Economics.
- CAO, H. H. & HIRSHLEIFER, D. A. 2000. Conversation, Observational Learning, and Informational Cascades. *SSRN eLibrary*.
- COSTA, J. P. T. & MCCRAE, R. R. 1992. Normal Personality Assessment in Clinical Practice: The NEO Personality Inventory. *Psychological Assessment*, 4, 5-13.
- DOHMEN, T., FALK, A., HUFFMAN, D., SUNDE, U., SCHUPP, J. & WAGNER, G. G. 2009. Individual Risk Attitudes: Measurement, Determinants and Behavioral Consequences. Maastricht : METEOR, Maastricht Research School of Economics of Technology and Organization.
- FALK, A., HUFFMAN, D. & MIERENDORFF, K. 2006a. Incentive Effects and Political Acceptability of Workfare: Evidence from Real Effort Experiments. Deutsche Forschungsgemeinschaft.
- FALK, A., MENRATH, KUPIO & SIEGRIST 2006b. Unfair pay and Stress. *Discussion paper*. Bonn: University of Bonn.
- FISCHBACHER, U. 2007. z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, 10, 171-178.
- FOX, C. R. & TVERSKY, A. 1995. Ambiguity Aversion and Comparative Ignorance. *The Quarterly Journal of Economics*, 110, 585-603.
- GILBERT, T. & KOGAN, S. 2005. Learning From The Skills Of Others: Experimental Evidence. Carnegie Mellon University, Tepper School of Business.
- GOLDBERG, L. R. 2010. *International Personality Item Pool: A Scientific Collaboratory for the Development of Advanced Measures of Personality Traits and Other Individual Differences* [Online]. Available: <http://ipip.ori.org/> [Accessed].
- HIRSHLEIFER, D. & TEOH, S. H. 2003. Herd Behaviour and Cascading in Capital Markets: a Review and Synthesis. *European Financial Management*, 9, 25-66.
- HOGAN, R. & HOGAN, J. 2007. *Hogan Personality Inventory Manual, Third Edition*, Tulsa, OK, Hogan Assessment Systems.
- KEMENY, M. E. 2003. The Psychobiology of Stress. *Current Directions in Psychological Science*, 12, 124-129.
- KIRSCHBAUM, C., PIRKE, K. M. & HELLHAMMER, D. H. 1993. The 'Trier Social Stress Test' – A Tool for Investigating Psychobiological Stress Responses in a Laboratory Setting. *Neuropsychobiology*, 28, 76-81.
- KOCHER, M. G. & SUTTER, M. 2006. Time is money--Time pressure, incentives, and the quality of decision-making. *Journal of Economic Behavior & Organization*, 61, 375-392.
- LO, A. W. & REPIN, D. V. 2001. The Psychophysiology of Real-Time Financial Risk Processing. National Bureau of Economic Research, Inc.
- LUNDBERG, U. (ed.) 1993. *On the Psychobiology of Stress and Health*, New York: Springer.
- MAULE, J. A. & EDLAND, A. C. 2000. The Effects of time pressure on human judgment and decision making. In: RANYARD, R., CROZIER, W. R. & SVENSON, O. (eds.) *Decision making: cognitive models and explanations*. London: Routledge.
- PAYNE, J. W., BETTMAN, J. R. & LUCE, M. F. 1996. *When time is money : Decision behavior under opportunity-cost time pressure*, Kidlington, ROYAUME-UNI, Elsevier.
- PORCELLI, A. J. & DELGADO, M. R. 2009. Acute Stress Modulates Risk Taking in Financial Decision Making. *Psychological Science*, 20, 278-283.
- RAAFAT, R. M., CHATER, N. & FRITH, C. 2009. Herding in humans. *Trends in cognitive sciences*, 13, 420-428.
- RIESKAMP, J. & HOFFRAGE, U. 2008. Inferences under time pressure: How opportunity costs affect strategy selection. *Acta Psychologica*, 258-276.
- SHARMA, S. & BIKHCHANDANI, S. 2000. Herd Behavior in Financial Markets - A Review. International Monetary Fund.
- SCHARFSTEIN, D. & STEIN, J. 1990. Herd Behavior and Investment. *American Economic Review*, 80, 465-79.
- SVENSON, O. & BENSON, L. (eds.) 1993. *On Experimental Instructions and the Inducement of Time Pressure Behavior*, New York: Springer.
- VAN DEN BOS, R., HARTEVELD, M. & STOOP, H. 2009. Stress and decision-making in humans: Performance is related to cortisol reactivity, albeit differently in men and women. *Psychoneuroendocrinology*, 34, 1449-1458.
- WELCH, I. 1992. Sequential Sales, Learning and Cascades. *Journal of Finance*, 47, 695-732.

## 8. Appendix

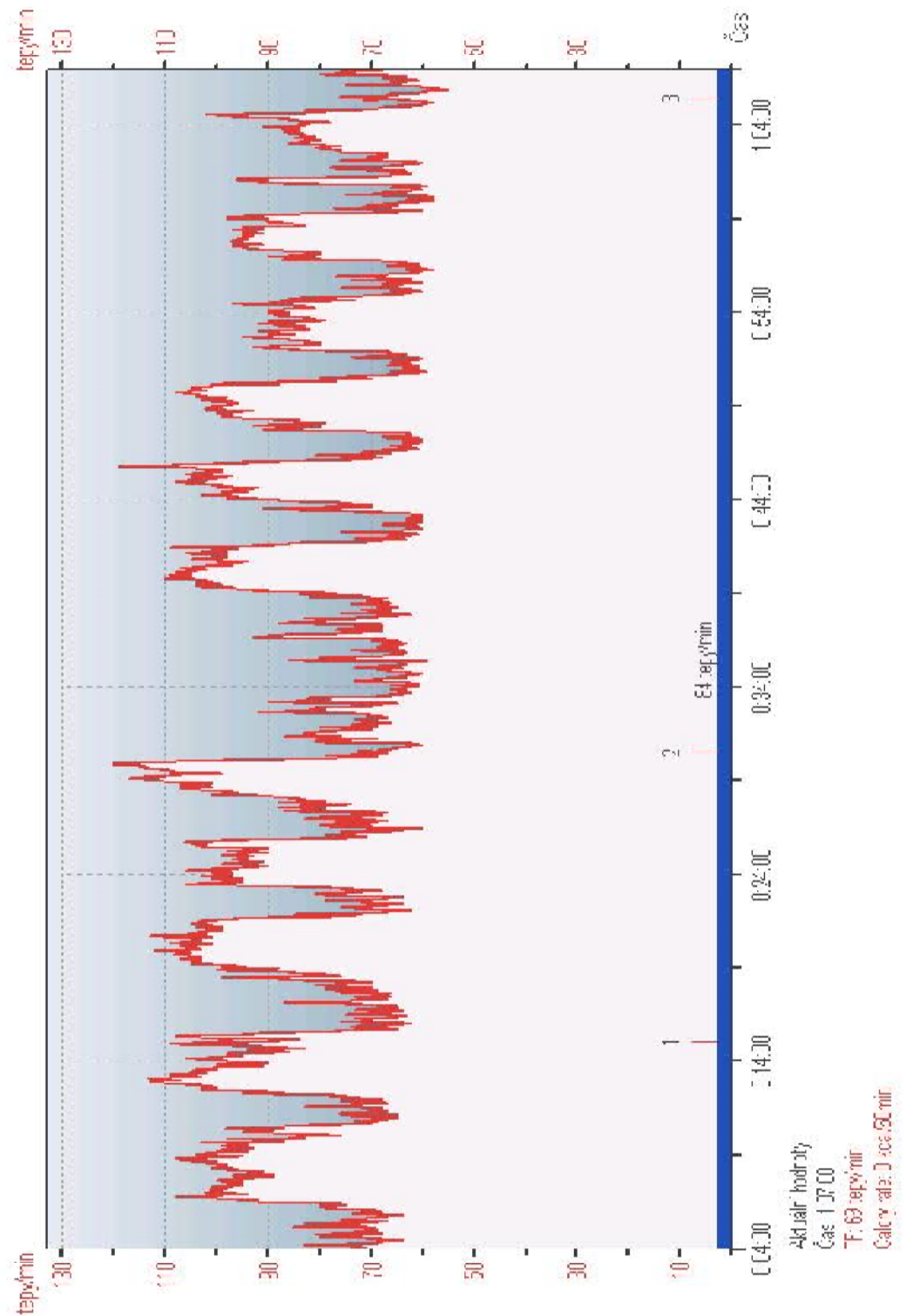
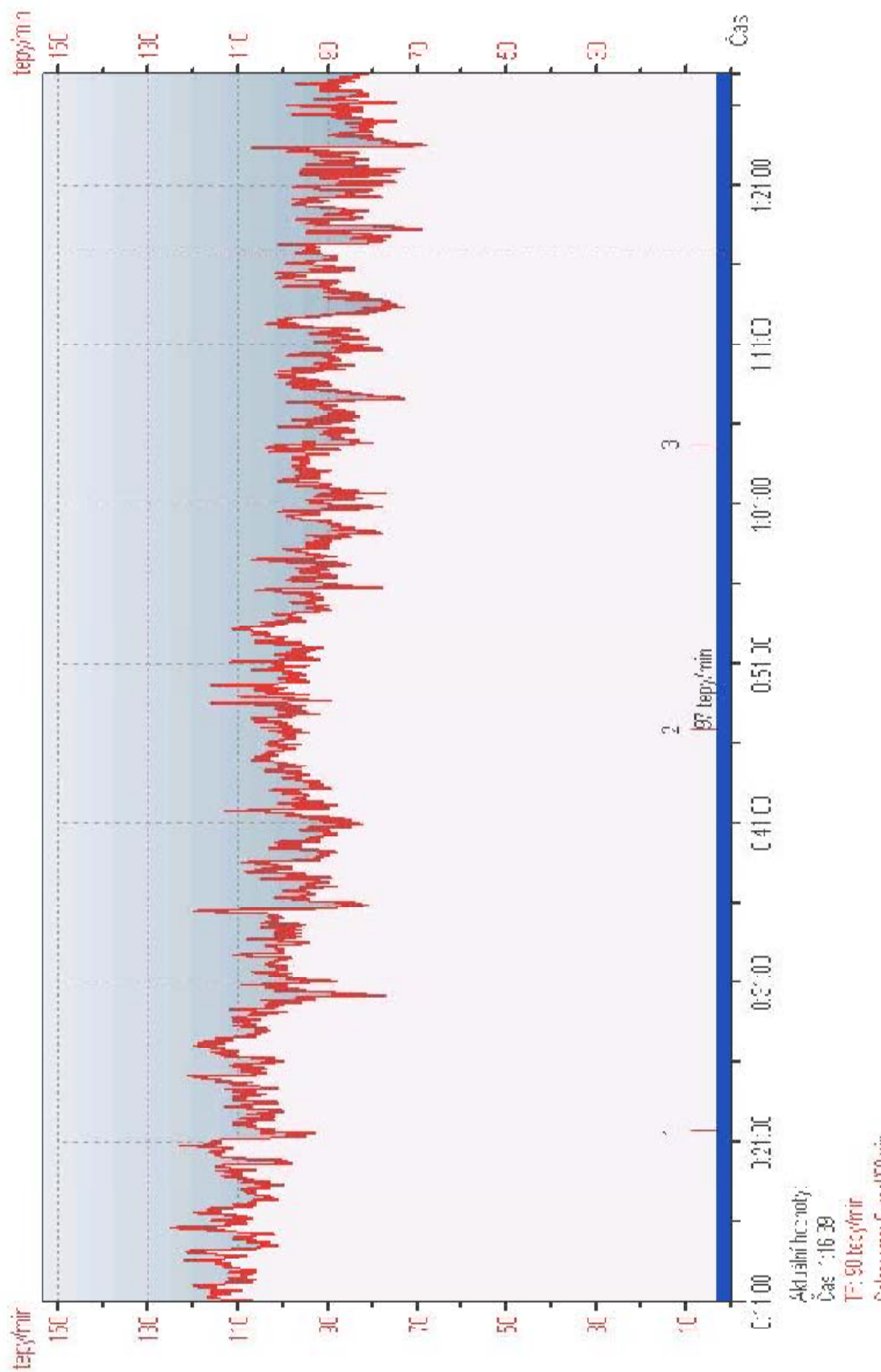


Figure 2: Curve of Heart rate from the HR-monitors. Example of a legible curve suggesting that the subject was in the state of a physical arousal during each of the task.



**Figure 3: Curve of Heart Rate from the HR monitor. Example of a curve of a subject who was not physically responding to the tasks.**

Time left: 88																			
0	1	1	0	1	0	1	1	0	0	1	0	1	0	1	1	1	0	1	0
0	0	0	0	1	1	1	0	1	0	1	1	0	0	0	1	1	0	0	0
1	0	1	0	1	1	0	1	0	0	0	0	0	0	1	0	0	1	0	0
1	0	1	0	1	1	1	0	0	0	1	0	1	0	0	0	1	1	0	0
1	0	0	1	0	0	1	1	1	0	0	1	0	0	1	1	1	1	0	1
1	1	0	1	0	1	1	0	0	0	1	1	1	1	1	1	1	1	0	0
1	1	0	1	1	0	1	1	0	1	1	0	1	1	1	0	0	0	1	1
0	0	1	0	0	0	1	1	1	0	1	0	0	0	1	1	1	1	1	0
0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	0	1	0	1	1
0	0	1	1	1	0	1	1	0	1	1	0	0	1	0	1	1	0	0	0
1	1	0	1	1	1	1	0	1	0	0	0	1	0	0	0	1	0	1	0
0	0	1	1	0	1	0	1	0	1	1	0	0	0	0	1	0	1	1	1
0	0	1	0	1	0	1	0	0	0	1	1	1	0	0	1	1	0	1	1
1	1	0	1	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	1
0	1	0	1	1	0	0	1	0	0	0	0	1	1	1	0	1	0	1	1
1	1	0	0	0	1	1	1	0	0	0	1	0	0	1	0	1	0	1	1
1	1	1	1	0	0	1	0	0	1	0	0	1	0	1	0	0	0	1	1
0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	0	0	0
0	0	1	1	0	0	1	0	0	1	1	0	1	1	1	0	1	1	1	0
1	0	1	0	0	0	1	0	1	0	1	1	0	1	1	1	0	1	0	0

**OVERVIEW**

You are **Participant 1**

Degree of time constraint: **High**

Time left: **88**

Bonus for being fast: **540**

---

Show information about others' estimates?

Figure 4: Decision task



**What alternative would you prefer: an amount of cash or a lottery?**

1	<input type="radio"/> 0 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
2	<input type="radio"/> 20 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
3	<input type="radio"/> 40 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
4	<input type="radio"/> 60 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
5	<input type="radio"/> 80 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
6	<input type="radio"/> 100 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
7	<input type="radio"/> 120 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
8	<input type="radio"/> 140 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
9	<input type="radio"/> 160 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
10	<input type="radio"/> 180 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
11	<input type="radio"/> 200 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
12	<input type="radio"/> 220 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
13	<input type="radio"/> 240 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
14	<input type="radio"/> 260 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
15	<input type="radio"/> 280 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
16	<input type="radio"/> 300 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
17	<input type="radio"/> 320 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
18	<input type="radio"/> 340 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
19	<input type="radio"/> 360 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%
20	<input type="radio"/> 380 ECU for sure	<input type="radio"/> or lottery where you can win 600 ECUs with a chance of 50% or win 0 with chance of 50%

Figure 5: Lottery task - protocol on assessment of risk preferences.

## 9. Instructions of the experiment

### ECONOMIC EXPERIMENT: INSTRUCTIONS (A)

#### Introduction

Today you are participating in an experiment with focus on behavior under time restrictions. These instructions describe how the experiment will be conducted and the decision task you will undertake. You will see the important part of instructions before each part of the experiment again on the screen. Your payoffs in this whole experiment will depend only on the choices made by you, and will not depend on choices made by other participants. You will be given 100 CZK for coming on time and completing a questionnaire in the end. This 100 CZK and any money that you earn during the experiment will be paid to you, in cash, at the end of the experiment. It is impossible to lose money in this experiment. You should feel free to make as much money as possible. Money for this experiment has been provided by the J&T Bank a.s..

#### Experimental Currency

All experimental payoffs are denominated in experimental currency units (ECUs). Your ECU earnings will be converted to CZK at the end of the experiment at a conversion rate of 10 ECUs equal to 1 CZK. You will be paid at the end of the experiment privately, and no other player will be told what you earned for the experiment. If you have any questions while these instructions are being read, please raise your hand and we will attempt to answer your questions.

Please do not talk to the other participants during the experiment, or else your participation in the experiment will be terminated without any payment.

#### Task

The decision task constitutes of several periods. Your task should substitute the real routine concentration effort you normally make in a real life. In each period, your task will be to **count zeros** from a table shown on the screen on the left and type in your **estimate** of this number. All parts of the experiment are based on this task and differ only in some additional features. In any given period, the task is identical across all participants.

In all parts of the experiment, you will be paid for the **accuracy** of your estimate:

If you estimate the number exactly, you get 100 ECU.

If you miss by one, you get 80 ECU.

If you miss by two, you get 50 ECU.

If you miss by more than two, you get 0 ECU.

The table with the zeros and ones has 20 rows and 20 columns and the numbers are generated randomly. Figure 1 (or later Figure 4) provides an example.

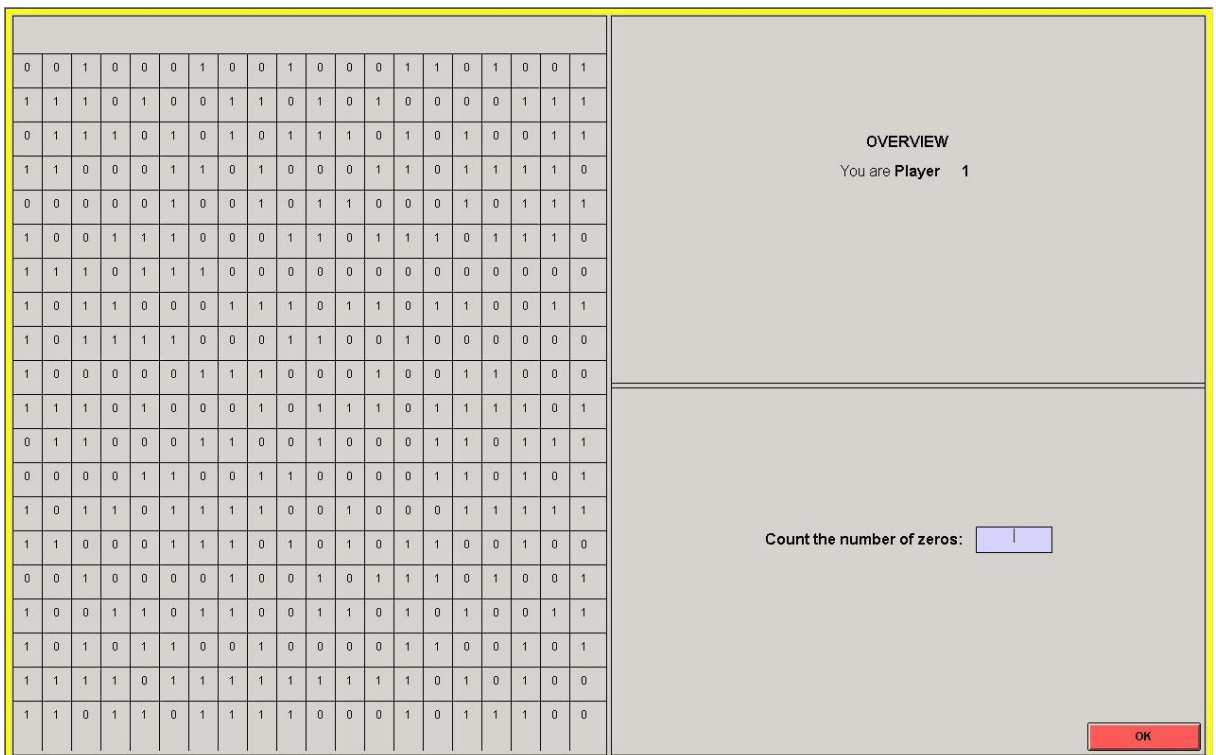


FIGURE 1

After each period, you will see the summary with the following information: your estimate, the true number of zeros, and your payoff (Figure 2). To begin with the next period, you will have to wait for others to complete the task. Please, always click “Continue” so that the experiment can continue.

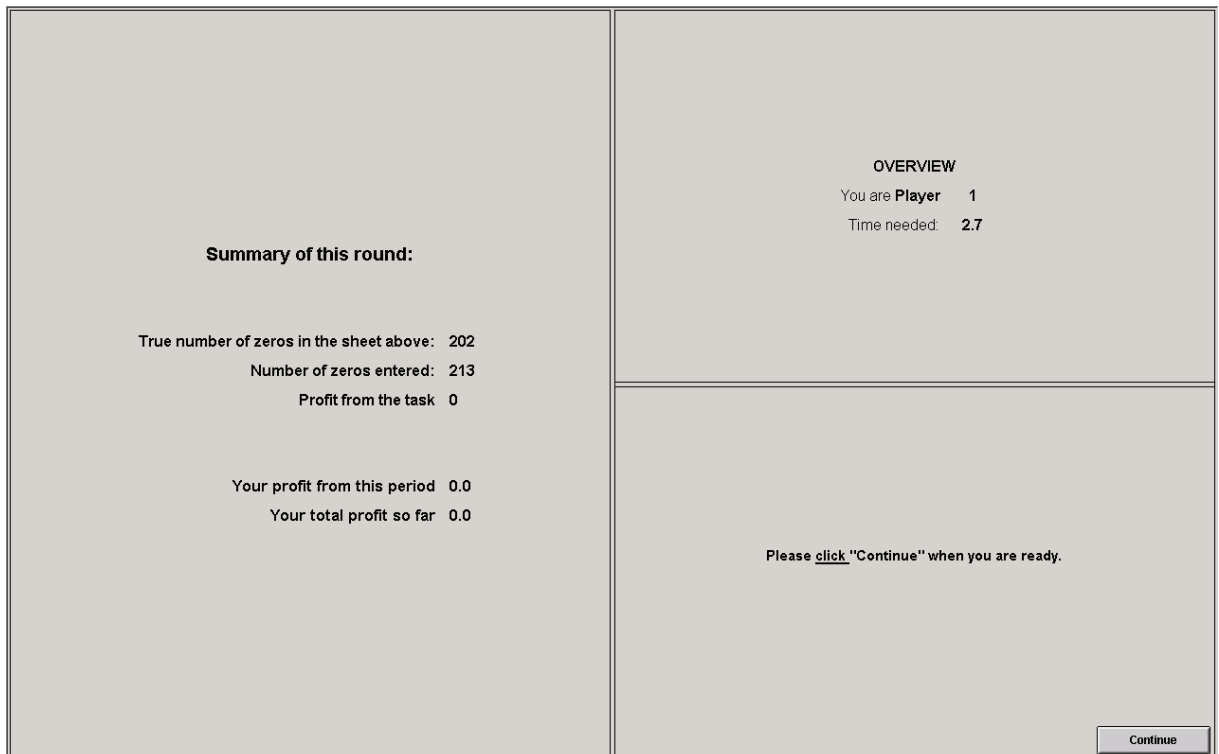


FIGURE 2

### **The parts of the experiment (treatments)**

**The first part** of the experiment is intended for you to practice the task. There will be two periods without any time restrictions.

**The second part** of the experiment will proceed under **time constraint** and will last for 3 periods.

There will be three levels of time constraint - "Low", "Medium" and "High", out of which one gets randomly selected. For completing the task, you will have 150 seconds in the "Low" time constraint, 130 seconds in the "Medium" and 100 seconds in the "High" level of time constraint.

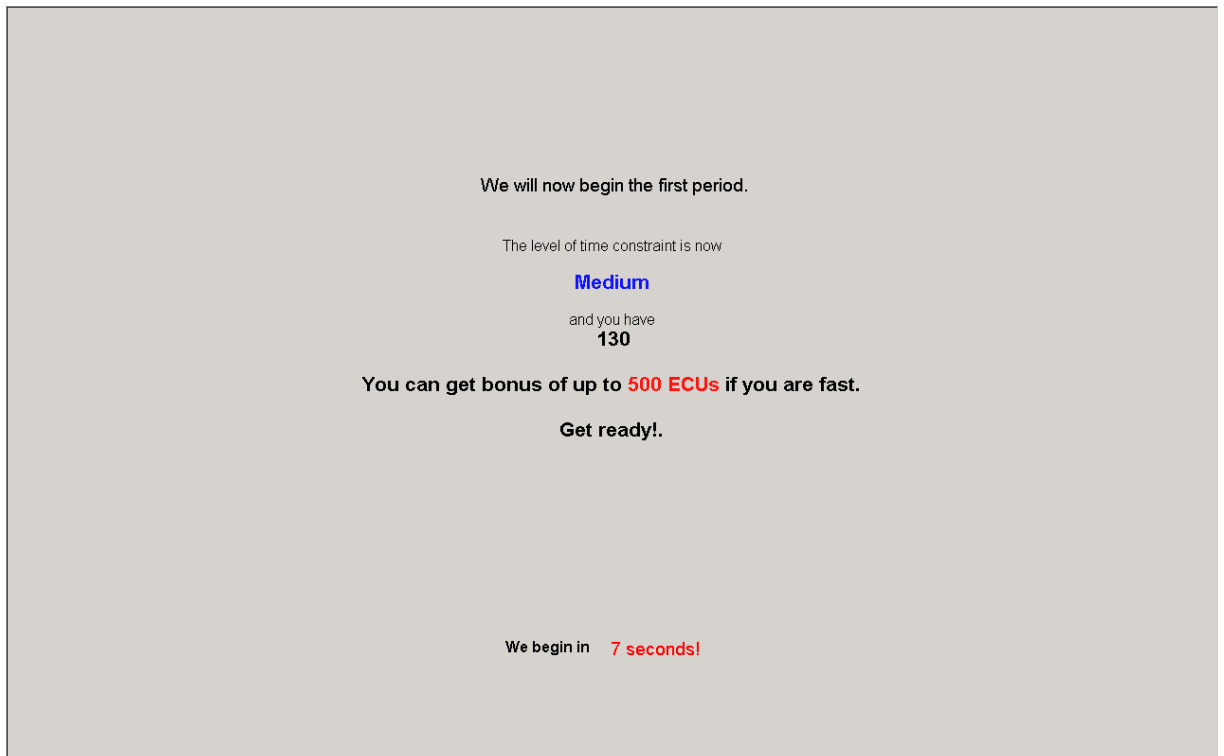


FIGURE 3

You will get a **bonus** for being fast. The bonus will **decrease with time**. In “Low” time constraint, the bonus starts at 400 ECUs at the beginning of a period and decreases by 3 ECUs with each second; in “Medium” time constraint, the bonus starts at 500 ECUs and decreases by 4 ECUS with each second; in “High” time constraint, the bonus starts at 600 ECUs and decreases by 5 ECUs with each second. You will get the bonus **only** if you do not miss it by more than 2. Otherwise your bonus will be 0.

Information about the level of time constraint for the period, time for the task and the bonus will appear on the **welcome screen (Figure3)** before you start a period.

Time left: 116																			
0	0	0	0	1	1	0	1	1	1	1	0	1	1	0	0	0	0	1	0
1	0	0	1	1	0	0	1	0	0	1	1	0	0	1	0	0	1	1	0
1	0	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1	1	1
1	1	1	0	0	0	0	0	0	0	1	1	1	0	0	1	1	1	0	0
1	0	0	1	0	1	1	1	1	0	1	1	0	1	1	1	1	0	0	1
1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	1	1	0
1	0	0	1	0	1	1	0	1	1	0	1	1	1	0	1	1	0	0	0
0	1	0	0	1	1	1	1	0	1	0	1	1	1	1	0	0	0	0	1
0	0	1	1	0	1	1	1	1	1	0	0	1	1	0	0	1	1	1	0
0	0	0	1	1	0	0	1	0	0	0	1	1	1	1	0	0	1	0	1
0	0	1	0	0	1	0	0	1	1	0	1	1	0	1	1	0	0	0	0
0	1	0	0	1	1	1	1	1	0	1	0	1	1	0	1	0	1	0	0
0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	0	0	1	1
0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	1	0	0	1	0
1	1	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1	1	1
1	1	1	1	0	1	1	0	1	0	1	0	0	0	1	1	1	0	0	1
0	1	1	1	1	0	1	1	1	1	0	0	1	1	0	1	1	0	0	0
1	1	1	1	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0
0	0	0	1	0	1	0	1	1	1	0	1	1	1	0	1	0	0	1	1
1	1	1	1	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0

**OVERVIEW**

You are **Participant** 1

Degree of time constraint: **Medium**

Time left: **116**

Bonus for being fast: **444.0**

---

Count the number of zeros:

**OK**

FIGURE 4

After you enter your estimate, the summary screen (Figure5) appears. There is one question in the bottom left corner on the level of pressure you subjectively felt during the task that you have to answer.

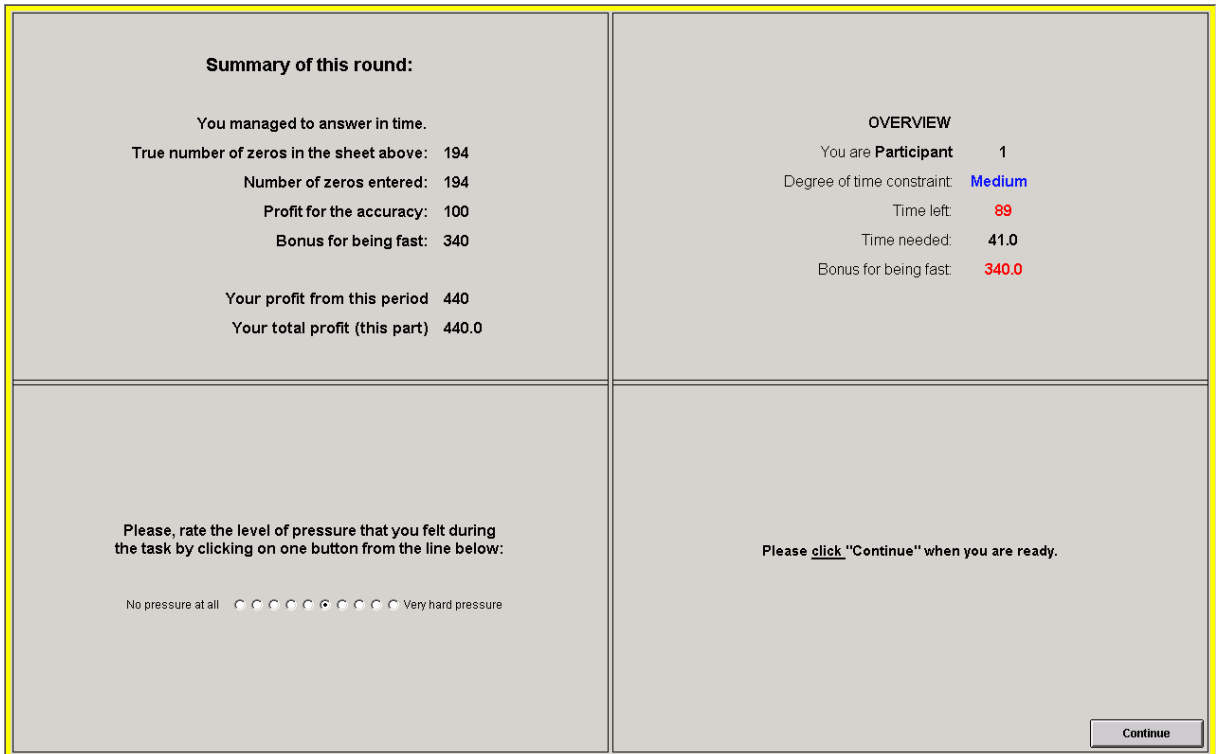


FIGURE 5

### The third part

This part will last for 6 periods and you will have the option to **see the estimates of the other participants** made in the current period and change your mind according to new information. To see it, you have to first type in your guess, click “OK” and then you can click "YES" or "NO” as to whether to see estimates of other participants.

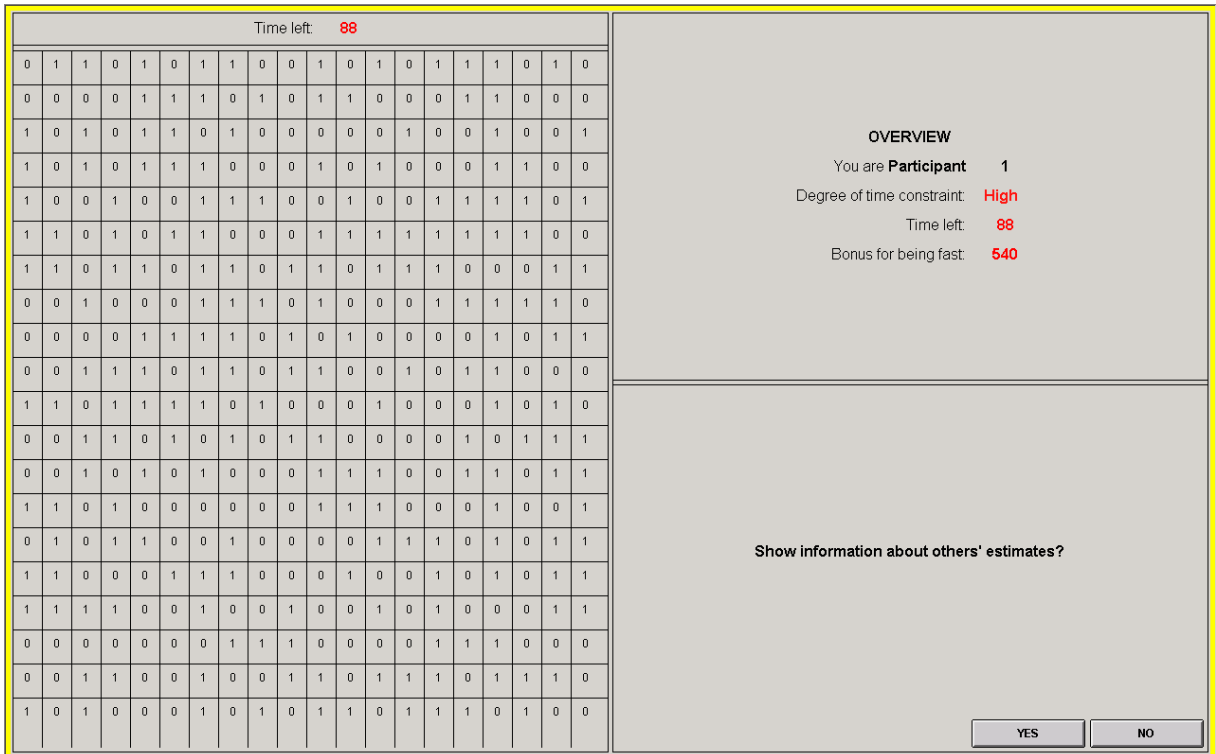


FIGURE 6

If you click “NO”, the experiment will proceed as in the previous parts– the estimate will be set and you will see the summary of the period.

If you click “YES”, you will see a table with the **original** estimates typed in by the other participants that entered them **before** you clicked on "YES". The estimates will be arranged in a table with a fixed order of participants, including you. You will see your own Participant number in the "Overview" part of the screen. While examining these estimates, your **time** will still be **running** out, so be careful.

In the screen with the estimates of the others (Figure 7), you will have a chance to enter a **new estimate**. If you want to use your own first estimate, click on “NO (Keep my original estimate)”. If you want to enter a new estimate, click on “OK (enter a new estimate)”. There is no penalty for changing your estimate.



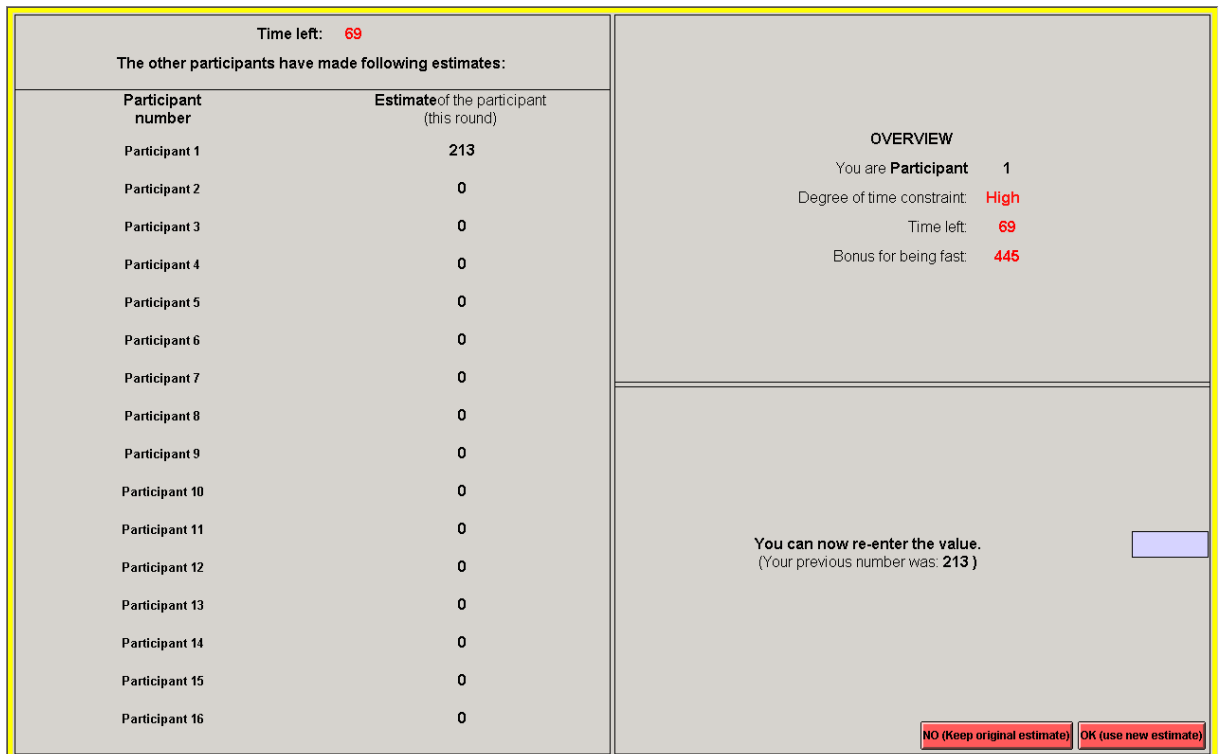


FIGURE 7

## Questionnaire

After concluding the decision tasks, you will fill out questionnaire asking you about:  
your preferences about **fairness** of division of 1000 CZK between you and an anonymous partner

your **personality profile**

your important **demographic characteristics** such as gender, field of work/study, etc.

Answers to these questions will be kept strictly confidential and will be used exclusively for research purposes.

There will also be a space for your feedback – please provide comments, suggestions, describe your strategy of solving the task, or comment on how you felt during the experiment. You can get extra bonus if we find the feedback outstanding.

Apart from these, on your table there is a **sheet of paper** with an additional task – choosing between a risky **lottery** and an amount of **cash** received for certain. Each line requires one choice. After you fill this piece of paper out, then me or my assistant will come, throw a dice and will write you the result on the paper. You will get signal when is the time to fill it out.

## Summary

The experiment will consist of three parts, each with several periods and different conditions, followed by a questionnaire at the end. You will be paid in cash at the end of the experiment. All information about your choices and payoffs in this experiment will be kept strictly confidential.

Please do not talk to the other subjects at any point during the experiment, even to ask questions about the instructions. If we hear you talking at any point during the experiment other than talking with me or one of my assistants, your participation in the experiment will be terminated without any payment. If you have any questions about any part of the instructions, please raise your hand now. We want everyone to understand the instructions before we begin the experiment.

# IES Working Paper Series

2011

1. Roman Horváth, Jakub Matějů : How Are Inflation Targets Set?
2. Jana Procházková, Lenka Šťastná : Efficiency of Hospitals in the Czech Republic
3. Terezie Výprachtická : *The Golden Rule of Public Finance and the Productivity of Public Capital*
4. Martina Mysíková : *Income Inequalities within Couples in the Czech Republic and European Countries*
5. Veronika Holá, Petr Jakubík : *Dopady změn parametrů pojištění vkladů v roce 2008*
6. Vladimír Benáček, Eva Michalíková : *The Factors of Growth of Small Family Businesses:  
A Robust Estimation of the Behavioral Consistency in the Panel Data Models*
7. Aleš Maršál : *The Term Structure of Interest Rates in Small Open Economy DSGE Model*
8. Robert Flasza, Milan Rippel, Jan Šolc : *Modelling Long-Term Electricity Contracts at EEX*
9. Jan Hlaváč : *Financial performance of the Czech private pension scheme: Its current position and the comparison with other CEE countries*
10. Tomáš Havránek, Zuzana Iršová, Karel Janda : *Demand for Gasoline Is More Price-Inelastic than Commonly Thought*
11. Martina Mysíková : *Personal Earnings Inequality in the Czech Republic*
12. Ondřej Lopusník : *Reflections on the reconciliation problem*
13. Martin Gregor, Lenka Šťastná : *The Decentralization Tradeoff for Complementary Spillovers*
14. Lenka Šťastná, Martin Gregor : *Local Government Efficiency: Evidence from the Czech Municipalities*
15. Andrea Klimešová, Tomáš Václavík : *Pricing of Gas Swing Options using Monte Carlo Methods*
16. António Afonso, Jaromír Baxa, Michal Slavík : *Fiscal developments and financial stress: a threshold VAR analysis*
17. Karel Báťa : *Equity Home Bias Among Czech Investors: Experimental Approach*
18. Karel Janda : *Credit Guarantees and Subsidies when Lender has a Market Power*
19. Roman Horváth : *Research & Development and Long-Term Economic Growth: A Bayesian Model Averaging Analysis*
20. Petr Jakubík : *Household Balance Sheets and Economic Crisis*
21. Jan Babecký, Tomáš Havránek, Jakub Matějů, Marek Rusnák, Kateřina Šmídková, Bořek Vašíček : *Early Warning Indicators of Crisis Incidence: Evidence from a Panel of 40 Developed Countries*

22. Josef Brechler, Adam Geršl : *Political Legislation Cycle in the Czech Republic*
23. Jozef Baruník, Lukáš Vácha, Ladislav Krištoufek : *Comovement of Central European stock markets using wavelet coherence: Evidence from high-frequency data*
24. Michal Skořepa : *A convergence-sensitive optimum-currency-area index*
25. Marek Rusnák, Tomáš Havránek, Roman Horváth : *How to Solve the Price Puzzle? A Meta-Analysis*
26. Marián Dinga, Vilma Dingová : *Currency Union and Investment Flows: Estimating the Euro Effect on FDI*
27. Krenar Avdulaj : *The Extreme Value Theory as a Tool to Measure Market Risk*
28. Ivo Jánický, Milan Rippel : *Value at Risk forecasting with the ARMA-GARCH family of models in times of increased volatility*
29. Pavel Ryska, Jan Průša : *Efficiency Wages in Heterogenous Labour Markets*
30. Peter Kukuk, Adam Geršl : *Political Pressure on the National Bank of Slovakia*
31. Jiří Schwarz : *Impact of Institutions on Cross-Border Price Dispersion*
32. Pavel Doležel : *Volební systémy pro volby do Poslanecké sněmovny Parlamentu ČR založené na matematickém programování*
33. Martin Gregor: *Corporate lobbying: A review of the recent literature*
34. Karel Janda, Ladislav Kristoufek, David Zilberman : *Modeling the Environmental and Socio-Economic Impacts of Biofuels*
35. Tomáš Havránek, Zuzana Iršová : *How to Stir Up FDI Spillovers: Evidence from a Large Meta-Analysis*
36. Jiří Witzany : *Estimating Correlated Jumps and Stochastic Volatilities*
37. Roman Horváth, Kateřina Šmídková, Jan Zápál : *Central Banks' Voting Records and Future Policy*
38. Petra Luňáčková : *The Unnoticed Difference between Antitrust and Competition Policy*

## 2012

1. Lubomír Cingl : *Does herd behavior arise more easily under time pressure? Experimental approach.*

All papers can be downloaded at: <http://ies.fsv.cuni.cz>

