Univerzita Karlova v Praze
Fakulta sociálních věd

Institut ekonomických studií

Bachelor Thesis

Self-Regulation and Government Oversight: First Experimental Test

Author: Vojtěch Mravec

Supervisor: Prof. Andreas Ortmann, Ph.D.

Academic Year: 2008/2009

Affirmation

The author declares that he has produced the thesis by himself with the use of the listed sources only.

Prague, May 20, 2008 **Vojtěch Mravec**

Acknowledgement

I would like to thank Prof. Andreas Ortmann, Ph.D., for his exceptional guidance throughout the whole process of writing of this thesis. Furthermore, I would like to thank the CERGE-EI students interested in experimental economics for their useful comments during the experimental design and support with the experimental implementation. Finally, funding from the Boston Consulting Group, through their support of Professor Ortmann's professorship, is gratefully acknowledged.

Abstract

This paper provides empirical evidence on the Demarzo, Fishman and Hagerty (2004) Self-regulation and Government Oversight model through an economic experiment. The model predicts that, for some parameterisations of the model, self-regulation organisations on the securities market set higher regulation than needed in order to pre-empt governmental intervention. In order to experimentally test this theoretical outcome, I derive a game with 2 players and 2 actions from the model and run an experiment with 30 participants, which has confirmed the predictions of the model.

Moreover, I also test a side-hypothesis that experiment participants perform differently when choosing between column and row strategies. The experimental results do not support the side-hypothesis.

Abstrakt

Tato práce se snaží pomocí ekonomického experimentu poskytnout empirické důkazy modelu Samoregulace a vládního dohledu, který sestrojili Demarzo, Fishman a Hagerty (2004). Při jistých parametrizacích tohoto modelu samoregulační organizace na trhu cenných papírů vykonávají více regulace, než je třeba, s úmyslem odradit vládu od vstupu na tento trh s regulací. Pro tyto účely byl model transformován na hru se dvěma hráči a dvěma strategiemi, na jejichž základě byl vykonán ekonomický experiment s 30 účastníky, jenž potvrdil zmiňovaný závěr modelu.

Dále byla podrobena zkoumání hypotéza, že se účastníci experimentu chovají jinak, když volí své strategie mezi sloupci, a jinak, když je volí mezi řádky. Provedený experiment tuto hypotézu nepotvrdil.

1. Introduction ... - 1 -
1.1. The DFH Model ... - 2 -
1.2. Conclusions of DFH ... - 3 -
2. Experimental Design ... - 4 -
2.1. Players and Actions ... - 4 -
2.2. Parameterisation ... - 6 -
2.3. Outcome 1 ... - 7 -
2.4. Outcome 2 ... - 8 -
2.5. Outcome 3 ... - 8 -
2.6. Outcome 4 ... - 9 -
2.7. The Specific Game ... - 9 -
3. Experimental Implementation ... - 10 -
3.1. Experimental Environment ... - 10 -
3.2. The Games ... - 12 -
3.3. Experimental Characteristics ... - 14 -
4. Results ... - 15 -
4.1. The DFH Game Results ... - 16 -
4.2. Alternative Pay-off Game Results ... - 18 -
4.3. Alternative Parameterisation Game Results ... - 19 -
4.4. Prisoner's Dilemma Results ... - 21 -
4.5. Game of Chicken Results ... - 23 -
4.6. Battle of the Sexes Results ... - 23 -
4.7. Stag Hunt Results ... - 24 -
4.8. Discussion of the Results of DFH Non-related Games ... - 25 -
5. Conclusion ... - 26 -
6. Appendices ... - 27 -
6.1. Appendix 1 – Experimental Results and Statistical Test Results ... - 27 -
6.2. Appendix 2 – Experimental Instructions ... - 41 -
6.3. Appendix 3 – Experimental Sheet – Row Participants ... - 43 -
6.4. Appendix 4 – Experimental Sheet – Column Participants ... - 45 -
7. References ... - 47 -

1. Introduction

In an attempt to theoretically understand the issues of self-regulation and Government oversight, DeMarzo, Fishman and Hagerty (2004, hereinafter referred to as DFH) model the interactions among four different players on the securities market. They analyse the behaviour of agents (securities brokers), customers (investors), a self-regulatory organization (SRO) with some regulatory authority on the market representing the agents, and the Government, which defends the interests of customers by also regulating the market. An example of an SRO is the Financial Industry Regulatory Authority, which is the largest organisation of this kind in the US. The authors find that, when deciding how to regulate markets, under certain parameterisations of the model, the SRO will impose and enforce higher self-regulation than what the agent would prefer in order to pre-empt Government regulation of the market. In other words, the SRO tries to pre-empt Government action.

In this paper I select a parameterisation of the DFH model that implements a particular outcome of the model in line with the aforementioned prediction. I design and implement an experiment that focuses on the behaviour of the SRO and the Government. I test the hypothesis that under certain parameterisations the SRO will impose and enforce regulation to pre-empt the Government from high market regulation.

To the best of my knowledge, as of now neither an experimental test of the DFH model nor experiments studying the behaviour of an SRO attempting to stave off Government regulation have been conducted.

In the paper I also explore whether the behaviour of experimental participants differs when the play as columns or rows players.

This thesis is organized as follows: In Section 1 I introduce the topic and describe the DFH model. In Section 2 I explain the experimental design. In Section 3 I provide a description of the experimental implementation. Section 4 analyses the results of the experiment and Section 5 interprets them in a concluding discussion. Section 6 lists the appendices and Section 7 the references used for this paper.

1.1. The DFH Model

In the DFH model, customers hire agents to carry out financial transactions on the securities market for them. The outcome of the transaction is a binary random variable W with the support $\{w_1, w_2\}$, where $w_2 > w_1 \geq 0$. Let π_i denote the probability that $W = w_i$. When the agent observes the realized cash flow W, he faces the moral hazard of reporting the true realization or lying to the customer. The reported cash flow is denoted r and can take on the values $\{w_1, w_2\}$. The contract between the customer and agent is represented by a function z, where z(r) specifies the payment from the agent to the customer if the agent reports that the realized cash flow is r.

If the agent and the customer do not agree on a contract, the agent receives the pay-off 0 and the customer an alternative opportunity pay-off worth α. The model assumes heterogeneous customers, which means that their alternative pay-offs are not constant. Let α_i denote customer i's alternative pay-off and let $F(\alpha)$ represent the fraction of the customer population with opportunity cost below α.

The SRO can investigate the agent's reporting at a cost c. The investigation takes place with probability $p_s(r)$ and the SRO sets a transaction fee t_s to fund its investigation activities net of penalties, which is paid by the customer to participate in the market. The investigation always reveals the true realization of the cash flow. Based on the investigation result, the SRO may impose a monetary penalty on the agent x_s, where $x_s(w,r) \geq 0$. Anticipating the behaviour of the customers, agents and the Government, the SRO chooses its enforcement policy (p_s, x_s, t_s) to maximize the agent's expected utility. The agent's utility function u(y) is increasing, concave and $u(0) = 0$.

After the SRO sets its enforcement policy, the Government enters the model, with the possibility to set its own enforcement policy to maximize the customers' expected pay-off. The Government can set its own investigation probability $p_g(r)$, which adds up with $p_s(r)$ to create the final probability of the agent being investigated p(r) ($p = p_g + p_s$)[1]. The Government conducts an investigation with the cost c_g, where $c_g \geq c$[2]. Moreover, the Government can set a penalty x_g which overrides the penalty x_s and a transaction fee t_g to cover its costs net of

[1] This definition implies the following realization of the investigation. First the SRO investigates the fraction of the agents, according to the probability of investigation. Further on, the Government does the same thing, but excludes the agents investigated by the SRO. Therefore, the two probabilities can add up; no agent will be investigated twice.

[2] This assumption reflects the fact that SROs have more experience with investigation and are closer to the subjects.

penalties (neither the Government nor the SRO make any profit, they use the transaction fees only to cover their costs).

Finally, the customer has to pay a transaction fee t ($t = t_g + t_s$) to participate in the market. The agents face an investigation probability p(r) and the threat of a penalty x_g. The timing of the model is as follows:

1. The SRO chooses an enforcement policy and transaction fee (p_s, x_s, t_s).
2. Taking the SRO's enforcement policy and transaction fee (p_s, x_s, t_s), as given, the Government chooses its enforcement policy and transaction fee (p_g, x_g, t_g).
3. Taking the overall enforcement policy, ($p_s + p_g$, x_g, $t_s + t_g$), as given, the customer either takes the alternative pay-off α_i, in which case the agent's pay-off is 0, or the customer offers a contract z to the agent. If the customer offers a contract, then the problem continues.
4. If the agent rejects the contract, the agent receives 0 and the customer receives α_i. If the agent accepts the contract, the customer pays $t_s + t_g$ and the problem continues.
5. The agent privately observes the realization of the cash flow w, chooses a cash flow, r, to report and pays the customer z(r).
6. Given the report r, the agent is investigated with probability p(r). If the SRO investigates the agent, the SRO pays c. If the Government investigates the agent, the Government pays c_g. In either case, the agent pays the penalty $x_g(w,r)$ (subject to his/her resource constraint).

1.2. Conclusions of DFH

The most important result for the following experiment is that, under certain parameterisations, during the enforcement policy setting process the threat of Government enforcement leads to higher enforcement by the SRO than what agents would prefer, just enough to pre-empt any Government enforcement.

DFH also offer several other conclusions that are important for the experiment, namely:

- There is no cheating in equilibrium. This is secured by the agent's incentive compatibility constraint (AIC). If the AIC doesn't hold, then the customer doesn't offer the agent a contract. The AIC's formulation is:

$$u(w_2 - z(w_2)) \geq p(w_1)u(\max[w_2 - z(w_1) - x_g(w_2, w_1),0]) + (1 - p(w_1))u(w_2 - z(w_1))$$

- $p(w_2) = 0$, if the agent reports the high cash flow, then there is no need of investigation, the agent cannot be lying
- $x(w_1,w_1) = 0$, if the agent is not lying, then the penalty equals 0
- $t_s = \pi_1 p_s(w_1)c$, $t_g = \pi_1 p_g(w_1)c_g$, the transaction fee equals the cost of investigations multiplied by the probability of investigation and the probability of the state (both of the low cash flow)

2. Experimental Design

2.1. Players and Actions

In my experiment, I study the behaviour of two of the players featured in the DFH model, the SRO and the Government. In particular, I study how they set their enforcement policies. This interactive decision-making is modelled by a simultaneous game, where each player can choose from two actions – setting either a low or a high probability of investigation. After the subjects make their choice, the outcome is determined by adding up the investigation probabilities. Obviously, as Figure 1 shows, 4 outcomes may occur.

Figure 1: General Game Design

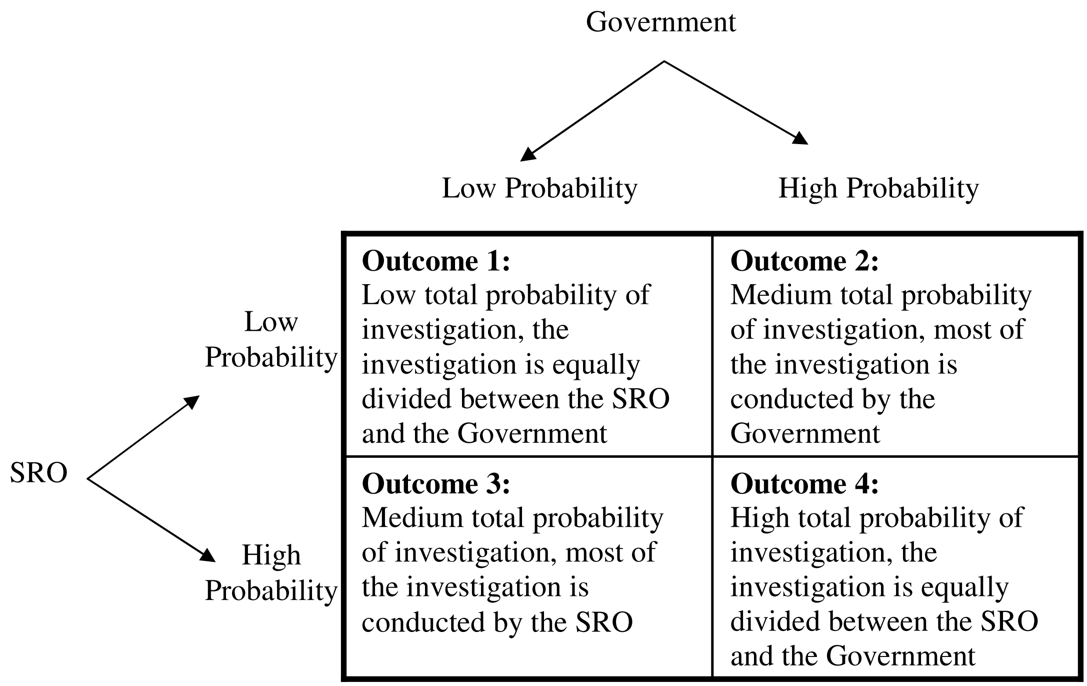


Figure 1 depicts the four possible outcomes of the designed game. Outcome 1 includes low, Outcomes 2 and 3 medium and Outcome 4 high total probability of investigation. It is also important to consider not only the final probability of investigation but also the subject, which conducts the investigation. This is crucial, because the Government and the SRO have different investigation costs, therefore their transaction fees differ, and therefore a different number of customers is attracted based on who is the investigator (this is a result of the heterogeneous customer model assumption in the DFH).

For the chosen parameterisation, the conclusion of the DFH model is that Outcome 3 will take place, i.e., the SRO will choose a high probability of investigation and the Government will choose a low probability of investigation, leaving most of the regulation to the SRO.

A simple game with 2 players that have 2 actions is a huge simplification of the real decision-making of the SRO and the Government. One can ask why should the players not have more, maybe even continuous options? This is essentially an experiment design choice. This simple 2-player, 2-action game is transparent plus experimental economists have traditionally argued that theories that do not survive experimental tests in simple experimental designs are likely to have problems in more complicated models.

The simultaneity of the designed game is another questionable assumption. However, in reality the two subjects make decisions at the same time and have to anticipate the next move of the other player, exactly as in the game I described above.

2.2. Parameterisation

To be able to experimentally tests the abovementioned game, concrete pay-offs have to be assigned for each player for every outcome. A parameterisation of the DFH model was used to calculate these values.

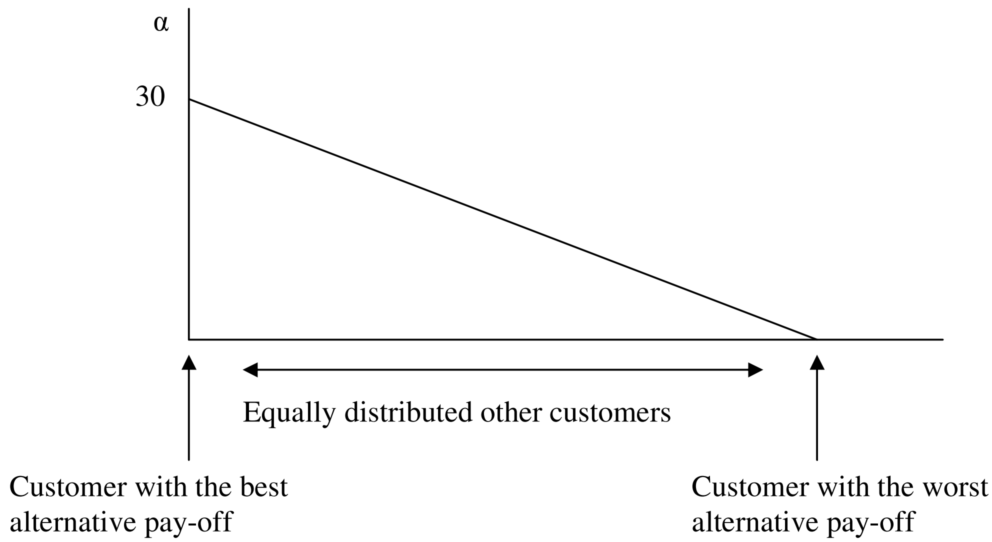
I set the high probability to 0.5 and the low probability to 0.2 (the high and low probability concern only the situation when the low cash flow is reported $p(w_1)$, if the high realization of cash flow is reported there is no need to investigate, as stated in the DFH model section). Furthermore, the cash flow realisation W takes on the values $w_1 = 40$ and $w_2 = 60$. The probabilities that either of these cash flows occur are equal, i.e., $\pi_1 = \pi_2 = 0.5$. Investigation costs are $c = 15$ and $c_g = 35$. The agents utility function is linear $u(y) = y$. The contract z gives the agents the pay-off of 20 in both cases, that is $z(w_1) = 20$ and $z(w_2) = 40$. Another assumption is that the Government always implements the highest possible penalty (with respect to the agent's budget constraint, which is very realistic, because there is no moral reason for the agent keeping a part of the cash flow when he cheats), that is $x(w_2,w_1) = w_2 - z(w_1) = 40$. All the parameters are summarized in Figure 2.

Figure 2: Parameters

Binary variables			
$p(w_1)$ – low	0.2	$p(w_1)$ - high	0.5
w_1	40	w_2	60
π_1	0.5	π_2	0.5
c	15	c_g	35
$z(w_1)$	20	$z(w_2)$	40
Other parameters			
$u(y) = y$			
$x(w_2,w_1) = w_2 - z(w_1) = 40$			
$\alpha = 15$			

Concerning the customers' alternative pay-offs, the customer with the best alternative pay-off will have the alternative pay-off equal to the expected pay-off of the contract (i.e., $\alpha_1 = \pi_1 z(w_1) + \pi_2 z(w)_2 = 30$) and the customer with the worst alternative pay-off will have the alternative pay-off 0. Other customers will be equally distributed between the two and their pay-offs will decline linearly as in Figure 3. Therefore, the average expected pay-off of a customer would equal the best pay-off plus the worst pay-off, all divided by 2, which is 15.

Figure 3: The Distribution of Customers



2.3. Outcome 1

I determine the pay-offs for each outcome based on the parameterisation. In the first outcome, both subjects use low regulation, that is $p_s(w_1) = p_g(w_1) = 0.2$ and $p(w_1) = 0.4$. As regards the AIC in this outcome, we get the inequality:

$$u(w_2 - z(w_2)) \geq p(w_1)u(\max[w_2 - z(w_1) - x(w_2, w_1), 0]) + (1 - p(w_1))u(w_2 - z(w_1))$$

$$u(60-40) \geq 0.4 * u(\max\left[60-20-40,0\right] + (1-0.4)u(60-20)$$
$$20 \geq 24$$

Since the AIC does not hold in the first outcome (the probability of investigation is too low for the customers to accept the contract – they are afraid of being cheated), the customers accept their alternative pay-off 15 and the agents receive 0 (In all four cases I will assume that SRO represents one agent and the Government one customer. Due to the structure of the model, the number of players in each group is irrelevant, as long as the number is the same for both groups, the pay-offs would change only proportionally.)

2.4. Outcome 2

In the second outcome, the SRO implements low regulation and the Government high regulation. Therefore the sum is $p(w_1) = 0.7$. In this case the AIC holds and therefore both parties receive pay-offs from trading with each other. The transaction fees are $t_s = \pi_1 c\ p_s(w_1) = 0.5 * 15 * 0.2 = 1.5$ and $t_g = \pi_1 c_g\ p_g(w_1) = 0.5 * 35 * 0.5 = 8.75$. The final Government pay-off (which is the pay-off of one customer) will be the expected income from the deal minus the sum of the transaction fees. Thus the Government pay-off in the second outcome is $GP_2 = \pi_1 z(w_1) + \pi_2 z(w_2) - t_g - t_s = 0.5*20 + 0.5 * 40 - 1.5 - 8.75 = 19.75$.

It is slightly more difficult to compute the SRO's pay-off. Once again, I assume one agent with his expected pay-off being the SRO's pay-off, but this time the value is multiplied by the fraction of the market that will participate $F(\alpha)$. The borderline pay-off α_b (customers with a higher alternative pay-off do not participate in the market) is the Government pay-off GP and the fraction F(GP) is equal to $F(GP) = GP / (\pi_1 z(w_1) + \pi_2 z(w_2))$. The last two assumptions ($\alpha_b = GP$ and $F(\alpha_b) = F(GP)$) are based on the distribution of customers depicted in Figure 3.

Under the conditions described in the paragraph above the SRO pay-off SP_2 is calculated as the expected pay-off from the contract multiplied by the fraction of the customers participating, i.e., $SP_2 = F(GP_2) * (\pi_1(w_1 - z(w_1)) + \pi_2(w_2 - z(w_2))) = (19.75/30)(0.5*20 + 0.5*20) = 13.2$.

2.5. Outcome 3

In the third outcome, which is the outcome that is theoretically supported by the DFH model, the SRO chooses the high probability of investigation and the Government chooses the low probability of investigation, adding up to the total of $p(w_1) = 0.7$. The AIC holds and therefore so far this outcome is identical with the second outcome. However, the difference between these two outcomes is that, since the majority of the investigation in the third outcome is done by the SRO, the investigation has lower costs, thus the transaction fees are lower as a result of which more customers are attracted and both parties receive higher pay-offs.

The Government pay-off is computed identically to Outcome 2: $GP_3 = \pi_1 z(w_1) + \pi_2 z(w_2) - t_g - t_s = 0.5 * 20 + 0.5 * 40 - 3.5 - 3.75 = 22.75$.

To compute the SRO pay-off SP_3, we use the same methodology as in Outcome 2: $SP_3 = F(GP_3)\ (\pi_1(w_1 - z(w_1)) + \pi_2(w_2 - z(w_2))) = (22.75/30)*(0.5*20 + 0.5*20) = 15.2$

2.6. Outcome 4

In the last outcome, both subjects choose to enforce high regulation, $p_s(w_1) = p_g(w_1) = 0.5$, therefore $p(w_1) = 1$. The AIC holds and the Government and SRO pay-offs are computed using the same steps as in Outcome 2 and 3:

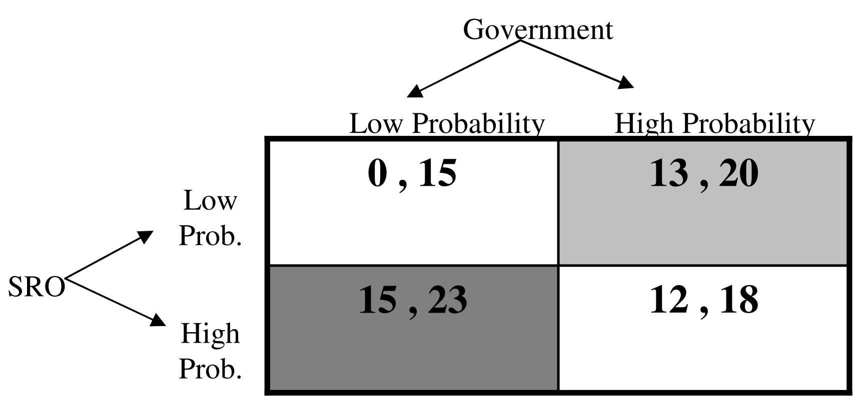
$$GP_4 = \pi_1 z(w_1) + \pi_2 z(w_2) - t_g - t_s = 0.5 * 20 + 0.5 * 40 - 8.75 - 3.75 = 17.5$$

$$SP_4 = F(GP_4)\ (\pi_1(w_1 - z(w_1)) + \pi_2(w_2 - z(w_2))) = (17.5/30)*(0.5*20 + 0.5*20) = 11.7$$

2.7. The Specific Game

Taking all the preceding computations into consideration and rounding off to whole numbers, the interactive decision-making situation to be tested experimentally is shown in Figure 4 (I will refer to this decision-making situation as the "DFH Game"; the numbers in the cells represent the pay-offs for both players if the given outcome is selected – the first number in each cell denotes the pay-off of the SRO and the second number denotes the pay-off of the Government):

Figure 4: DFH Game



The DFH Game is an asymmetric coordination game with two pure-strategy Nash equilibria (grey cells) and one mixed equilibrium. In the mixed equilibrium, the SRO plays Low probability (LP) with 0.5 probability and High probability (HP) with 0.5 probability. On the other hand, the Government plays LP with the probability of 0.0625 and HP with the probability of 0.9375. As concerns the Nash equilibria, the darker grey cell (Outcome 3) is a both risk and pay-off dominant equilibrium. This outcome is also proposed by the underlying parameterisation of the DFH model and therefore it is likely to be the outcome that results from the experiment.

There are several market forces in the DFH Game that drive the stated pay-offs for every outcome. First of all, customers require the probability of investigation to be high enough for the agents to be motivated not to cheat. This is represented by the AIC, which holds in Outcomes 2, 3 and 4 and does not hold in Outcome 1. Furthermore, both parties do not want excessive regulation. Excessive regulation increases transaction fees for customers, which lowers their net income leading to a smaller number of participants in the market which in turn results in lower net income of the agents. Finally, both groups also care about the composition of the provided regulation. Since investigation costs are higher for the Government than for the SRO, both agents and customers prefer if a larger portion of the investigation is done by the SRO. If more investigation is carried out by the SRO, customers profit, because the transaction fees are lower. Thanks to this, the agents profit, as more customers take part in the market.

3. Experimental Implementation

3.1. Experimental Environment

The behaviour of players in the DFH Game was experimentally tested in a non-computerized experiment with 30 participants recruited from students of economics[3]. The experiment took place in 2 sessions[4] with 16 participants in the first session and 14 participants in the second session. Upon the arrival of participants in each session, they were randomly seated and the instructions (See 6.2) were read aloud so that each participant knew that everyone had been given the same instructions. The instructions contained a comprehension question to make sure that each participant knew how to read the earnings

[3] CERGE-EI, VŠE and IES FSV UK students recruited through the web page www.experimenty.eu
[4] April 17, 2009; 16:00 and 19:00

tables. The comprehension question was checked by the experimenters and discussed with participants, if necessary. After the instructions were read, and all questions were answered, the participants were asked to mark their action choices in an experiment sheet (See 6.3 and 6.4).

In the experiment, the participants were asked to play 7 games so that they would get familiar with the action selection process in this particular setting (see Hertwig & Ortmann 2001[5]). For the purposes of the experiment I developed 6 additional games which are described bellow and some of which are related to the DFH model.

The DFH Game was one of the 7 games for which participants were asked to make action choices. In addition, they were asked to make action choices for each game both as the Row player and the Column player. Thus each participant made 14 action choices. In order not to tell the participants that they were playing each game twice (for example once as the SRO and once as the Government), the games were transformed in such a way that all 14 action choices of each participant appeared either as decisions between rows or all 14 choices appeared as decision between columns. I will refer to this transformation below as transposition[6]. This resulted in 14 decisions for each player, with half of the players called Row Participants (with their choices presented to them as choice between rows) and the other half called Column Participants (with their choices presented to them as choice between columns). Nevertheless, all participants took the same 14 action choices (7 games as both players), the only difference being the layout of the games (choices between columns vs. choices between rows).

[5]In this paper the authors argue that participants in an experiment experience a new environment when they enter the laboratory, which can affect their decision-making. Therefore, it is better to have them face several similar decision-making situations, which makes them adapt to the environment. This learning procedure is also supported by Weber (2000), whose experimental results suggest that learning takes place even during experiments with no feedback during a series of decisions. This is another reason for running more games than just one. If the key decisions are made after several other similar decisions, then the results should be more reliable.

[6] For the purposes of this paper, transposition is the following operation (players change positions in the game):

	Player 2	
Player 1	a,b	c,d
	e,f	g,h

=>

	Player 1	
Player 2	b,a	f,e
	d,c	h,g

3.2. The Games

Since every player played 7 different games in total, some of the other games were also designed to yield results directly related to the test of the DFH model. All 14 action choices are depicted in Figure 5.

Figure 5: Experimental Games

Basic Games:

Game 1
Prisoner‘s dilemma

10 , 10	3 , 14
17 , 2	6 , 7

Game 2
Game of Chicken

15 , 13	6 , 23
22 , 9	0 , 1

Game 3
The DFH Game with alternative pay-off

5 , 15	13 , 20
15 , 23	12 , 18

Game 4
Battle of the Sexes

14 , 11	5 , 4
2 , 3	12 , 15

Game 5
The DFH Game

0 , 15	13 , 20
15 , 23	12 , 18

Game 6
Stag Hunt

12 , 13	3 , 9
9 , 4	9 , 9

Game 7
The DFH Game with alternative parameterisation

15 , 28	12 , 22
14 , 25	11 , 20

Transposed Games:

Game 1‘
Prisoner‘s dilemma

10 , 10	2 , 17
14 , 3	7 , 6

Game 2‘
Game of Chicken

13 , 15	9 , 22
23 , 6	1 , 0

Game 3‘
The DFH Game with alternative pay-off

15 , 5	23 , 15
20 , 13	18 , 12

Game 4‘
Battle of the Sexes

11 , 14	3 , 2
4 , 5	15 , 12

Game 5‘
The DFH Game

15 , 0	23 , 15
20 , 13	18 , 12

Game 6‘
Stag Hunt

13 , 12	4 , 9
9 , 3	9 , 9

Game 7‘
The DFH Game with alternative parameterisation

28 , 15	25 , 14
22 , 12	20 , 11

All 14 action choices were taken in the same manner as the DFH Game described above. Each game had two participants - Row Participant and Column Participant. The Row Participant could choose either the first or the second row as his or her strategy (labelled strategy A and B) and the Column Participant could choose either the first or the second column as his or her strategy (labelled strategy C and D). Whatever outcome took place after the strategies had been chosen, the Row Participant received a pay-off equal to the first number in the relevant cell and the Column Participant received a pay-off equal to the second number in the relevant cell, in both cases multiplied by 10 CZK.

The first 7 games are the originally designed games. Games 1' – 7' are transpositions of games 1 – 7.

Games 3, 5 and 7 depicted in Figure 4 are related to the DFH model and thus are significant for evaluating the DFH model (Naturally, so are the transposed relevant games 3', 5' and 7'). Game 5 and 5' (The DFH game) has already been discussed. Game 3 and 3' changes the pay-off for Outcome 1, by adding 5 pay-off units for the Row Participant. This change can be intuitively justified with regard to the DFH model. In the DFH Game, Outcome 1 represents the situation when the players do not agree on a contract and therefore the customer receives an average alternative pay-off 15 whereas the agent doesn't receive anything. Thus, the customer can quite easily invest his money in a different deal, whereas the agent is established in his business, so he cannot shift easily to a different kind of business. Nevertheless, in Game 3 and 3', I set an alternative where the agent is also capable to shift his activities to a different sector and earn some money. Of course, this shift would be much more costly for the agent and therefore I set his alternative pay-off to one third of the customer's pay-off, which equals 5. Even though the game-theoretic characteristics of Game 3 stay the same as in Game 5, some participants in the experiment might consider this change and adjust their choices.

Game 7 and 7' represents an alternative parameterisation of the DFH model. For this game I changed one parameter of the model. In my first parameterisation, agents received 20 for any kind of deal realized. In this alternative parameterisation I set the reward of 10 in the case that low cash flow takes place and a reward of 25 if high cash flow takes place, which copies a somewhat motivating scheme for agents to reach better results. After this arrangement both the pay-offs and the characteristics of the game changed. The Nash equilibrium is now in Outcome 1 when the low probability of investigation is implemented by both the SRO and the Government. This parameterisation offers a different theoretical prediction than the DFH Game, although of course, it is still derived from the DFH model.

Having participants make decisions as Row and Column players allowed me to investigate across decisions whether being a Row player or a Column player makes a difference. Specifically, the 14 action choices were set up in such a way that both player types faced the same decision situation in the same order. For example, if Column participants played the Prisoner's Dilemma first, the Row participants would play the transposed Prisoner's Dilemma game, etc. Thus every player underwent the series of decisions in the same order. The only difference was the layout of the games. The Row Participants made choices between rows, whereas the Column Participants made choices between columns. Thanks to this set-up it was possible to study also whether the lay-out of the games had any effect on the decision making of the subjects.

In the experiment sheet the games were sequenced so that the games relevant for this thesis would not be played first, in order to let the participants to adjust to the experimental environment.

3.3. Experimental Characteristics

Following the conventions of experimental economics (e.g., Hertwig & Ortmann 2001), and to increase the external validity of the experiment, our participants were motivated by earnings based on their decision-making. Specifically, the amount that every experimental subject received was based on the results of one game only, which was selected randomly at the end of the experiment[7]. The selection of the pay-off relevant game was indeed random and performed in a manner that was transparent to the participant for the reasons mentioned in Ortmann & Hertwig (2002)[8].

The earning of each participant was the pay-off from a particular cell of the randomly selected game multiplied by CZK 10 (the matching scheme will be explained bellow). The subjects also earned CZK 100 as a show-up fee. The average earning per participant was about CZK 210. The earnings ranged from CZK 160 to CZK 330 and in total CZK 6850 was paid out.[9] Each experimental session took about 45 minutes, including the explanation of the instructions and paying out the earnings.

In order to pay the participants, a random matching scheme was used to match them, in other words, after the experiment session Row and Column Participants were randomly matched in couples. In these couples, the chosen strategies of the randomly selected game were compared and based on the outcome, the pay-offs were determined.

[7] At the end of both sessions, one game was drawn by one of the participants and all participants in the session received their pay-offs based on this particular game.
[8] In Ortmann & Hertwig (2002) the authors argue that leaving the subjects with a possible feeling of deception might cause both random as well as systematic error variance in the data.
[9] All values include the show-up fees

Nevertheless, this scheme was strictly used only to transparently motivate the experiment participants. The following method was used for the evaluation of the results:

For each game the frequency distribution of Row and Column choices was constructed. Furthermore, to obtain an average outcome occurrence rate for every outcome, the strategy frequency rates of the two strategies resulting in the given outcome were multiplied. The advantage of this method is that the results are not influenced by a matching scheme that might cause some kind of side effects (for example the random effect of a random matching scheme).

In the experiment, abstract instructions were implemented. This means that the SRO was labelled Row Participant and the Government was labelled Column Participant (The players were of course switched in the transposed games). SRO's low probability strategy was labelled Strategy A and high probability strategy as Strategy B. Government's low probability strategy was labelled Strategy C and high probability strategy as Strategy D[10]. Abstract instructions were implemented so as not to influence the experimental subjects by any factors other than utility maximization through their decisions. Had concrete labelling been used, subjects might assume that the Government should behave differently from the SROs, which is an undesirable factor for the results of the experiment.

4. Results

Looking at the experimental results, I do not study only the behaviour of the SROs and Government. Apart from the main hypothesis related to the DFH model I also study whether participants' choices differ when they play as Row and Column Participants. My conjecture was that subjects find it harder to make choices when choosing between columns than when choosing between rows.

For each game I analyse the outcome frequencies and chosen strategies based on the participant type. As mentioned above, I order the specific games so that both Column and Row Participants make the same decisions in the same order. Therefore, I can study whether there is an impact of the participant type (Participant Row or Participant Column) on the results. I will further on refer to this type of study as 'layout analysis'.

[10] For games not related to the DFH model, the players and their strategies were labelled in the same way, so the players couldn't recognize the DFH related games from the others.

4.1. The DFH Game Results

The DFH Game is the most important game for the examination of the DFH model. As mentioned in section 2.7, the DFH Game is a coordination game with two pure-strategy Nash equilibria and one mixed equilibrium. In the mixed equilibrium, SRO plays LP with 0.5 probability and HP with 0.5 as well. On the other hand, the Government plays LP with the probability of 0.0625 and HP with 0.9375. Regarding the Nash equilibria, Outcome 3 is a both risk and pay-off dominant equilibrium. This outcome is also proposed by the DFH model and therefore theoretically, it is likely to be the outcome that results from the experiment.

-- Figure 6 --

Figure 6 sums up the results of the experiment. In this table the game is depicted three times. The first part (labelled OVERALL) represents the results for all participants, the two following parts represent the result only for the Row and Column Participants, respectively. In each part, the pay-off matrix is reproduced (large, bold numbers) and the pure-strategy Nash equilibria are shaded horizontally. Furthermore, the figure shows the frequency of each strategy played by each player (on the left of the pay-off matrix for the SRO and above the pay-off matrix for the Government) and the average outcome frequency in the grey cells for each outcome. The outcome with the highest average outcome frequency is shaded vertically. Therefore, when the highest outcome takes place on a Nash equilibrium outcome, the cell is shaded in a somewhat squared pattern. This type of table will be also used for the analysis of the results of the following games.

In the overall results of the DFH Game, Outcome 3 was selected in 73% of cases. This is both in line with the game-theoretical prediction (Outcome 3 is the risk-dominant and pay-off dominant Nash equilibrium) and the DFH model prediction (The SRO should choose the high probability of investigation to pre-empt the entrance of the Government in the sector, and afterwards the Government will enter only with the low probability). It is interesting that none of the 30 participants chose the Low probability of investigation when playing the SRO. This can be justified by the fact that the incentive was not very high (a participant would have to assume that the Government would play the high probability, and in that case he would be 1 unit better-off when moving from 12 to 13). Also, the expected pay-off of Low is 7.5

whereas the expected pay-off of High is 13.5. Another factor influencing the participants is the fact that there is a possibility of earning nothing, when selecting the low strategy, which might have a strong psychological effect.

The action choice was not as straightforward for the Government decisions. In total, the participants played 73 % in favour of the predicted strategy (that is Low; expected pay-off of Low is 19). Nevertheless, a fair portion of participants played High (27 %; expected pay-off is 19 as well). High strategy was the more secure strategy, ensuring a pay-off of 18 whereas by choosing Low the participant faces the risk of obtaining only 15 (but of course the possibility to reach the highest pay-off 23). Despite the fact that the expected pay-offs were equal and the High strategy was the safer choice, the majority of participants chose the Low strategy. This can be explained by having a sample of risk-seeking participants, which is quite improbable. More likely, the participants managed to think about the choices of the other player and predicted that the SROs will be more willing to play the High strategy, which the SROs actually did in all cases.

When studying the results with regard to the player type, there is no change for the SRO strategy, since all participants played High, but we see some difference for the results of the Government choices. Participants played the predicted strategy (Low) more frequently when being the Row Participant (80%) than when being the Column Participant (67%). From these results we might assume that Participants Column had more problems reading the pay-off matrices as less of them chose the predicted strategy. An alternative explanation is that more risk-averse participants were in the group playing columns.

It is possible to use statistical tests on the frequency of action choices for the DFH Game based on the player type. Specifically, I perform three tests using the Statistica 8 software by Statsoft. The first test is the parametric T-test for two independent samples, testing the equality of mean values of the Row and Column samples[11]. I will also use the Kolmogorov-Smirnov test and Mann-Whitney test, both being non-parametric tests of equality of distribution. For all statistical tests I will use the common level of significance of 5%. In the T-test, the null hypothesis is the equality of mean values in the two samples. In the

[11] This test assumes equality of variances of the two samples. The Statistica software automatically tests this assumption and therefore there are 2 p-values in the result table. The first p-value is for the T-test itself and the second p-value is for the test of equality of variances to see whether the assumption is valid. If the second p-value is lower than the common level of significance 5%, we cannot use the results of the T-test because the assumption is not fulfilled.

other two tests, the null hypothesis is the equality of the distribution of the two samples. The same statistical analysis will be used for the other game results in the following sections.

The statistical test results are in Figure 7. There is nothing to test for the SRO, because all participants chose the same strategy. P-values of all tests for the Government are higher than 0.05, and so we can conclude that statistical analysis doesn't prove any significant differences in the choices based on the player type.

-- Figure 7 --

To conclude the analysis of the results of the DFH Game, the results support the prediction of the DFH model for an important parameterisation. Specifically, as predicted for this parameterisation, based on the experimental results, the SRO will attempt to pre-empt regulatory action.

4.2. Alternative Pay-off Game Results

The Alternative Pay-off Game has similar characteristics as the DFH Game, because it only introduces an alternative pay-off of 5 for the SRO in Outcome 1. The Alternative Pay-off Game is a coordination game with two Nash equilibria and one mixed equilibrium. In the mixed equilibrium, SRO plays LP with 0.5 probability and HP with 0.5 as well. On the other hand, Government plays LP with the probability of 0.09 and HP with 0.91. Regarding the Nash equilibria, Outcome 3 is a both risk and pay-off dominant equilibrium.

Analysing the results of the Alternative Pay-off Game is interesting with regard to the DFH model because the game only changes one small assumption in the model. This assumption in the DFH model is that agents cannot earn an alternative profit when the deal with the customers does not take place. In reality, when we look at this problem from a more long-term point of view, the security brokers can also get established elsewhere when deals do not come. Therefore, it is justified to introduce an alternative pay-off for the agents when the deal does not take place. This alternative establishment of the agent is more costly and takes a longer time, therefore I introduced the alternative pay-off equal to one third of the alternative pay-offs of customers.

-- Figure 8 --

Figure 8 depicts the results of the experiment for this game. The results are similar to those from the DFH Game with no alternative pay-off for the agent. Once again, Outcome 3 takes place in most of the places (64%), so that even after the introduction of the alternative pay-off the DFH model statement is still true.

On the other hand, interestingly after introducing 5 instead of 0 as the SRO pay-off in Outcome 1, there has been one participant who found this difference so relevant, that he or she switched to the Low strategy when playing the SRO.

When looking at the results based on the participant type, the trend is the same as in the DFH Game. Participants tend to choose the predicted strategies more when they play as Row Participants (Outcome 3 takes place in 68% of cases) rather than Column Participants (60%).

-- Figure 9 --

The results of the statistical tests are in Figure 9. All p-values are higher than 0.05, therefore we do not reject the null hypothesis of equivalence of mean values (distributions).

4.3. Alternative Parameterisation Game Results

The Alternative Parameterisation Game is a game with 1 Nash-equilibrium. Low probability of investigation is the dominant strategy for both players and therefore theoretically Outcome 1 should dominate in the results. The expected pay-offs for the SROs are 13.5 for Low and 12.5 for High and for the Government 27.5 for Low and 21 for High.

When looking carefully at the pay-offs of the Alternative Parameterisation Game, there is not much difference in Outcomes 2, 3 and 4 compared to the DFH Game (the differences in the pay-offs of the Alternative Parameterisation Game and the DFH Game are stated in Table 1).

On the other hand, since the alternative parameterisation allows deals between agents and customers when the low probability is set by both the SRO and the Government, there is a large difference in Outcome 1, which becomes the only Nash equilibrium of the game.

Table 1: Differences in the pay-offs of the Alternative Parameterisation Game and the DFH Game

15 , 13	-1 , -2
-1 , 2	-1 , 2

The results of the Alternative Parameterisation Game are stated in Figure 10. The alternative parameterisation changes considerably both the game theoretical prediction and the experimental results. The predicted result – Outcome 1 – takes place in 90 % of the cases. Outcomes 2, 3 and 4 take place in 6 %, 3 % and 0 % respectively.

-- Figure 10 --

As in the previous 2 games, participants chose the theoretical results in more cases when playing rows (93 %) than when playing columns (87 %).

The result of 90 % occurrence of Outcome 1 is a meaningful fact for the assessment of the DFH model. This game predicts different results of the SRO - Government bargaining and most participants followed these incentives and chose Outcome 1. Therefore, I conclude that the SRO - Government bargaining depends on the model parameterisation. Especially, on the fact whether or not trading takes place in Outcome 1, therefore, the key factor influencing the outcomes of the games is whether the parameterisation allows the Agent Incentive Constraint (AIC) to be valid in Outcome 1.

$$\text{(AIC)} \quad u(w_2 - z(w_2)) \geq p(w_1)u(\max[w_2 - z(w_1) - x(w_2, w_1),0]) + (1 - p(w_1))u(w_2 - z(w_1))$$

The AIC is valid when it is better for the agent to report truthfully than lie. If it doesn't hold, then the customers do not accept contracts with agents. In the DFH Game, the AIC did not hold in Outcome 1 and the participants shifted to the Outcome 3 of high self-regulation performed by the SRO. In all my parameterisations I assume that when agents cheat they face the highest possible penalty with regard to their budget constraint:

$$x(w_2,w_1) = w_2 - z(w_1) = 40$$

Therefore I can rewrite the AIC as follows:

$$\text{(AIC)*} \qquad u(w_2 - z(w_2)) \geq (1 - p(w_1))u(w_2 - z(w_1))$$

Moreover, I took the assumption of u being a simple linear function u(y) = y and obtained the following result:

$$\text{(AIC)**} \qquad p(w_1) \geq \frac{z(w_2) - z(w_1)}{w_2 - z(w_1)}$$

Therefore, in my model transformation the AIC depends on the parameterisation of the cash flow w, contract function z(w) and the probability of investigation if the low outcome is reported $p(w_1)$.

Once again, I continue with the statistical analysis of the player type performance for the Alternative Parameterisation Game. The result of the statistical analysis is in Figure 11. P-values of all tests are higher than 0.05 and therefore we do not reject the null hypothesis of equality for any test.

-- Figure 11 --

4.4. Prisoner's Dilemma Results

In the following section I will analyse the results of other games put into the experiment. These games are not related to the DFH model and were used mainly to make experiment participants familiar with the experimental environment. Nevertheless, we can take advantage of the collected data to support the layout analysis. Therefore in the following analysis I focus especially on the difference in actions based on the participant type. Also, I no longer call the players 'SRO' and 'Government' but 'Player 1' and 'Player 2'. The strategies are no longer called ‘Low Probability’ and ‘High Probability’ but ‘Strategy 1’ and ‘Strategy 2’.

As every economic textbook says, the Prisoner’s Dilemma Game has only one Nash equilibrium, occurring when both players ‘give away’ each other (Strategy 2 in my depiction of the game). Therefore, game theory predicts the highest occurrence of Outcome 4.

-- Figure 12 --

Experimental results are provided in Figure 12. In 78 % of cases, the predicted Outcome 4 takes place. An interesting result is that in this case, when dividing the choices based on the participant type, Column Participants were closer to the theoretical prediction with 93 % of choices taking place in this outcome. The difference of the average occurrence for the two player types is quite high. Row Participants chose Outcome 4 only in 64 % of the cases, therefore the difference of Outcome 4 occurrence for the two player types is nearly 30 %.

An interesting fact is the ‘good’ performance (in the sense of game theory prediction) of Column Participants when playing Player 2. In this situation all 15 of them chose to play Strategy 2 – ‘Not cooperating with the other prisoner’.

-- Figure 13 --

The statistical results are in Figure 13. Even though all of the p-values are higher than 0.05, sometimes they are very close to the level of significance. For Player 1 this occurs in the test of equality of variance, where the p-value reaches the value of about 0.088. We do not reject the null hypothesis of equality of variance but it is close. Nevertheless, in this case we can move to the other two tests that do not reject the null hypothesis of equality of distribution of choices.

Furthermore, for Player 2 choices the p-value for the T-test is about 0.07. Once again, I do not reject the null hypothesis for these tests, however, the result is not so straigtforward. Looking carefully on the Player 2 results of the experiment, we see that the Column

Participants did a better job than the Row Participants as regards the game-theoretical prediction. Therefore, based on this fact, even if there were a statistical significance in the differences of choices, it would not be in favour of our above-mentioned hypothesis saying that it is easier for the Row Participants to handle the pay-off matrices than for the Column Participants.

4.5. Game of Chicken Results

The Game of Chicken represents the situation of American bored youth playing a game, during which two of them drove cars towards each other and the one who 'chickened out' and avoided the crash first lost. Strategy 1 represents chickening out and driving off the road and Strategy 2 represents driving straight. When both players choose Strategy 2, the cars crash. The game has two Nash equilibria in Outcomes 2 and 3.

-- Figure 14 --

The results of the experiment are in Figure 14. The Nash equilibrium in Outcome 2 is the most frequent with 32 % of occurrence in all three cases (overall, Row, Column). On the other hand, Outcome 3 is the least frequent with 19 %, once again in all three cases. Small differences of outcome percentage (with respect to participant type) occur only between Outcome 1 and 4.

-- Figure 15 --

The small differences in player type performance are supported by the results of the statistical analysis (Figure 15) as well, where some of the p-values, especially for the Mann-Whitney test, are very high.

4.6. Battle of the Sexes Results

The Battle of the Sexes Game is a coordination game with two Nash equilibria in Outcomes 1 and 4. The difference between the pay-offs in the Nash equilibria and the two other outcomes is very high (the sum of pay-offs of the Nash equilibria outcomes is 52 and the sum of pay-offs of the two other outcomes is 14), so the participants should be very motivated to achieve the coordination equilibria. As shown in the results (Figure 16), they succeed only partially as 35 % led to Outcome 4 and 35 % led to Outcome 2.

-- Figure 16 --

Statistical tests on the differences in the player type performance are summarized in Figure 17. All p-values are higher than 0.05 and therefore there is no statistical difference based on the player type.

-- Figure 17 --

4.7. Stag Hunt Results

The Stag Hunt Game is a coordination game with 2 Nash equilibria in Outcome 1 and 4. The results of the game are in Figure 18. The results of this game have the most dispersed results of all 7 games in the experiment. The overall numbers put the highest frequency to two outcomes equally: Outcome 3 and Outcome 4 with an average occurrence frequency of 27 %. For Column Participants, Outcome 3 is the most frequent with 36 % of occurrence frequency and surprisingly, for Row Participants it is Outcome 2 with 32 %. This means that when regarding the decisions separately, the participants did not manage to reach the Nash equilibria with better pay-offs with the highest occurrence. A Nash equilibrium was only reached when determining the outcome frequencies for all players together and yet the first place occurrence was shared with another 'non-Nash' outcome.

-- Figure 18 --

As we see both from the statistical results (Once again, the p-values of the test are not below 0.05, but they are quite low for Player 1, reaching about 0.15 in the T-test. See Figure

19) and from the experimental results, the disparity of the outcome frequencies is caused especially by the performance of Player 1. Player 1 played Strategy 1 and Strategy 2 with the ratio 60:40 as Row Participant and 33:67 as Column Participant.

-- Figure 19 --

4.8. Discussion of the Results of DFH Non-related Games

Since in all four DFH non-related games (Prisoner's Dilemma, Game of Chicken, Battle of the Sexes and Stag Hunt) are games where coordination is a key element of the players' behaviour, we cannot conduct a detailed analysis as only one shot games with no communication among players were allowed.

Nevertheless, an interesting result is the 'good' performance of the participants when playing the Prisoner's Dilemma, as 78 % of outcomes took place in the non-cooperative Nash equilibrium. This might be caused by the fact that experiment participants were economic students, and all of them probably covered the theory of this very famous game.

The results from the Prisoner's Dilemma game can be compared with the results in Chen & Hogg (2006) where the authors conduct 860 one-shot games with the results of only about 45 % of played games ending in the non-cooperative equilibrium.

Authors of a different paper (Battalio, Samuelson, Van Huyck, (2001)) conducted an experiment to analyse the behaviour in the Stag Hunt game. Even though this experiment did not implement a one-shot game (75 rounds of the game were played), after the first round, 39 % of outcomes took place in the outcome, which I label Outcome 1 and which took place in 23 % of cases in my experiment.

All together, it is not easy to compare the results of the DFH non-related games in my experiment, as other authors use different implementation details, and even though the results from this experiment differ from the results of different papers, I cannot come to any specific conclusions.

5. Conclusion

In this paper I place the DFH model to an experimental test when transforming the model to a simple 2-player, 2-strategy coordination game. The results indeed support the hypothesis that for certain parameterisations SROs set higher regulation to lower the entrance of the Government on the market (supported by the results of the DFH Game and the DFH game with alternative parameterisation).

On the other hand, for certain parameterisations of the model both players prefer to choose low regulation of the securities market (supported by the results of the Alternative Parameterisation Game).

The vital element determining the outcome of the DFH parameterisation is the Agent Incentive Constraint, which for my model transformation depends on the parameterisation of the cash flow w, contract function z(r) and probability of investigation of the agent if the low cash flow is reported $p(w_1)$.

Therefore, I conclude that the SRO – Government bargaining is a very difficult process, involving a lot of factors. Market forces of coordination and anticipation of the other player's performance influence this process, and particularly, the SROs might set higher regulation than what is favoured by the agents in order to pre-empt the Government to set its regulation.

As to whether the player performance depends on the player type, at first glance, the results might seem to support the fact that Row Participants followed more the theoretical prediction as all three DFH related games results prove. Nevertheless, this is not valid for the Prisoner's Dilemma where the Column Participants performed 'better' according to game theory. Most importantly, statistical tests used for the player performance based on the player type do not find any significant differences between the two groups.

Therefore, based on the experimental results I cannot confirm the hypothesis that Column Participants find it more difficult to read the earnings table than Row Participants.

6. Appendices

6.1. Appendix 1 – Experimental Results and Statistical Test Results

Figure 6: DFH Game Results

OVERALL			Government	
			Frequency of Low probability	Frequency of High probability
			73%	27%
SRO	Frequency of Low probability	0%	**0 , 15**	**13 , 20**
			0%	0%
	Frequency of High probability	100%	**15 , 23**	**12 , 18**
			73%	27%

ROW PARTICIPANTS			Government	
			Frequency of Low probability	Frequency of High probability
			80%	20%
SRO	Frequency of Low probability	0%	**0 , 15**	**13 , 20**
			0%	0%
	Frequency of High probability	100%	**15 , 23**	**12 , 18**
			80%	20%

COLUMN PARTICIPANTS			Government	
			Frequency of Low probability	Frequency of High probability
			67%	33%
SRO	Frequency of Low probability	0%	**0 , 15**	**13 , 20**
			0%	0%
	Frequency of High probability	100%	**15 , 23**	**12 , 18**
			67%	33%

Nash equilibria
Most frequent outcome
Average outcome frequency (Product of frequency of the 2 particular strategy resulting in the given outcome
Large numbers in the table represent the pay-off matrix of the game

Figure 7: DFH Game - Statistical Test Results

The DFH Game

Player 1

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - Row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	1.000000	1.000000	0.00000	**0.000000**	15	15	0.0000	0.0000	0.0000	0.0000

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	0.000000	0.00	**p > .10**

Mann-Whitney Test	Sum of ranks Row	Sum of Ranks Column	P-value
	233	233	**1.000000**

Player 2

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.200000	0.333333	-0.806947	**0.426499**	15	15	0.414039	0.487950	1.388889	0.546919

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	-0.133333	0.00	**p > .10**

Mann-Whitney Test	Sum of ranks - Row	Sum of Ranks Column	Úroven p
	217.5	247.5	**0.533830**

Note: For all the tests, the following transformation takes place: Strategy 1 = 0 and Strategy 2 = 1

Figure 8: Alternative Pay-off Game Results

OVERALL			**Government** Frequency of Low probability	**Government** Frequency of High probability
			67%	33%
SRO	Frequency of Low probability	3%	**5 , 15**	**13 , 20**
			2%	1%
	Frequency of High probability	97%	**15 , 23**	**12 , 18**
			64%	32%

ROW PARTICIPANTS			**Government** Frequency of Low probability	**Government** Frequency of High probability
			73%	27%
SRO	Frequency of Low probability	7%	**5 , 15**	**13 , 20**
			5%	2%
	Frequency of High probability	93%	**15 , 23**	**12 , 18**
			68%	25%

COLUMN PARTICIPANTS			**Government** Frequency of Low probability	**Government** Frequency of High probability
			60%	40%
SRO	Frequency of Low probability	0%	**5 , 15**	**13 , 20**
			0%	0%
	Frequency of High probability	100%	**15 , 23**	**12 , 18**
			60%	40%

Nash equilibria
Most frequent outcome
Average outcome frequency (Product of frequency of the 2 particular strategy resulting in the given outcome
Large numbers in the table represent the pay-off matrix of the game

Figure 9: Alternative Pay-off Game - Statistical Test Results

Alternative Pay-off Game

Player 1

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - Row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.933333	1.000000	-1.00000	**0.325875**	15	15	0.2582	0.0000	0.0000	1.0000

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value	Mann-Whitney Test	Sum of ranks Row	Sum of Ranks Column	P-value
	-0.066667	0.00	**p > .10**		225	240	**0.755736**

Player 2

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.266667	0.400000	-0.755929	**0.456005**	15	15	0.457738	0.507093	1.227273	0.706889

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value	Mann-Whitney Test	Sum of ranks - Row	Sum of Ranks Column	Úroven p
	-0.133333	0.00	**p > .10**		217.5	247.5	**0.533830**

Note: For all the tests, the following transformation takes place: Strategy 1 = 0 and Strategy 2 = 1

Figure 10: Alternative Parameterisation Game

OVERALL			Government	
			Frequency of Low probability	Frequency of High probability
			93%	7%
SRO	Frequency of Low probability	97%	**15 , 28**	**12 , 22**
			90%	6%
	Frequency of High probability	3%	**14 , 25**	**11 , 20**
			3%	0%

ROW PARTICIPANTS			Government	
			Frequency of Low probability	Frequency of High probability
			100%	0%
SRO	Frequency of Low probability	93%	**15 , 28**	**12 , 22**
			93%	0%
	Frequency of High probability	7%	**14 , 25**	**11 , 20**
			7%	0%

COLUMN PARTICIPANTS			Government	
			Frequency of Low probability	Frequency of High probability
			87%	13%
SRO	Frequency of Low probability	100%	**15 , 28**	**12 , 22**
			87%	13%
	Frequency of High probability	0%	**14 , 25**	**11 , 20**
			0%	0%

Nash equilibria
Most frequent outcome
Average outcome frequency (Product of frequency of the 2 particular strategy resulting in the given outcome
Large numbers in the table represent the pay-off matrix of the game

Figure 11: Alternative Parameterisation Game - Statistical Test Results

The Alternative Parameterisation Game

Player 1

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - Row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.066667	0.000000	1.00000	**0.325875**	15	15	0.2582	0.0000	0.0000	1.0000

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	0.000000	0.07	**p > .10**

Mann-Whitney Test	Sum of ranks Row	Sum of Ranks Column	P-value
	240	225	**0.755736**

Player 2

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.000000	0.133333	-1.467599	**0.153357**	15	15	0.000000	0.351866	0.000000	1.000000

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	-0.133333	0.00	**p > .10**

Mann-Whitney Test	Sum of ranks - Row	Sum of Ranks Column	Úroven p
	217.5	247.5	**0.533830**

Note: For all the tests, the following transformation takes place: Strategy 1 = 0 and Strategy 2 = 1

Figure 12: Prisoner's Dilemma Results

OVERALL			Player 2	
			Frequency of Strategy 1	Frequency of Strategy 2
			10%	90%
Player 1	Frequency of Strategy 1	13%	**10 , 10**	**3 , 14**
			1%	12%
	Frequency of Strategy 2	87%	**17 , 2**	**6 , 7**
			9%	78%

ROW PARTICIPANTS			Player 2	
			Frequency of Strategy 1	Frequency of Strategy 2
			20%	80%
Player 1	Frequency of Strategy 1	20%	**10 , 10**	**3 , 14**
			4%	16%
	Frequency of Strategy 2	80%	**17 , 2**	**6 , 7**
			16%	64%

COLUMN PARTICIPANTS			Player 2	
			Frequency of Strategy 1	Frequency of Strategy 2
			0%	100%
Player 1	Frequency of Strategy 1	7%	**10 , 10**	**3 , 14**
			0%	7%
	Frequency of Strategy 2	93%	**17 , 2**	**6 , 7**
			0%	93%

Nash equilibria
Most frequent outcome
Average outcome frequency (Product of frequency of the 2 particular strategy resulting in the given outcome
Large numbers in the table represent the pay-off matrix of the game

Figure 13: Prisoner's Dilemma - Statistical Test Results

Prisonner's Dilemma

Player 1

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - Row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.8	0.933333333	-1.0583	**0.298963**	15	15	0.414039336	0.258199	2.571429	0.08809871

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	-0.133333333	0	**p > .10**

Mann-Whitney Test	Sum of ranks Row	Sum of Ranks Column	P-value
	217.5	247.5	**0.53383**

Player 2

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.8	1	-1.87083	**0.071854**	15	15	0.414039336	0	0	1

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	-0.2	0	**p > .10**

Mann-Whitney Test	Sum of ranks - Row	Sum of Ranks Column	Úroven p
	210	255	**0.350688**

Note: For all the tests, the following transformation takes place: Strategy 1 = 0 and Strategy 2 = 1

Figure 14: Game of Chicken Results

Game of Chicken			**Player 2**	
			Strategy 1	Strategy 2
			43%	57%
Player 1	Strategy 1	57%	**15 , 13**	**6 , 23**
			25%	32%
	Strategy 2	43%	**22 , 9**	**0 , 1**
			19%	25%

Row			**Government**	
			Frequency of Low probability	Frequency of High probability
			40%	60%
SRO	Frequency of Low probability	53%	**15 , 13**	**6 , 23**
			21%	32%
	Frequency of High probability	47%	**22 , 9**	**0 , 1**
			19%	28%

Column			**Government**	
			Frequency of Low probability	Frequency of High probability
			47%	53%
SRO	Frequency of Low probability	60%	**15 , 13**	**6 , 23**
			28%	32%
	Frequency of High probability	40%	**22 , 9**	**0 , 1**
			19%	21%

Nash equilibria
Most frequent outcome
Average outcome frequency (Product of frequency of the 2 particular strategy resulting in the given outcome
Large numbers in the table represent the pay-off matrix of the game

Figure 15: Game of Chicken – Statistical Test Results

Game of Chicken

Player 1

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - Row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.466666667	0.4	0.356753	**0.723951**	15	15	0.516397779	0.507093	1.037037	0.946714935

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	0	0.066666667	**p > .10**

Mann-Whitney Test	Sum of ranks Row	Sum of Ranks Column	P-value
	240	225	**0.755736**

Player 2

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.6	0.533333333	0.356753	**0.723951**	15	15	0.507092553	0.516398	1.037037	0.946714935

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	0	0.066666667	**p > .10**

Mann-Whitney Test	Sum of ranks - Row	Sum of Ranks Column	Úroven p
	240	225	**0.755736**

Note: For all the tests, the following transformation takes place: Strategy 1 = 0 and Strategy 2 = 1

Figure 16: Battle of the Sexes Results

OVERALL			Player 2	
			Frequency of Strategy 1	Frequency of Strategy 2
			30%	70%
Player 1	Frequency of Strategy 1	50%	14 , 11	5 , 4
			15%	35%
	Frequency of Strategy 2	50%	2 , 3	12, 15
			15%	35%

ROW PARTICIPANTS			Player 2	
			Frequency of Strategy 1	Frequency of Strategy 2
			40%	60%
Player 1	Frequency of Strategy 1	40%	14 , 11	5 , 4
			16%	24%
	Frequency of Strategy 2	60%	2 , 3	12, 15
			24%	36%

COLUMN PARTICIPANTS			Player 2	
			Frequency of Strategy 1	Frequency of Strategy 2
			20%	80%
Player 1	Frequency of Strategy 1	60%	14 , 11	5 , 4
			12%	48%
	Frequency of Strategy 2	40%	2 , 3	12, 15
			8%	32%

Nash equilibria
Most frequent outcome
Average outcome frequency (Product of frequency of the 2 particular strategy resulting in the given outcome
Large numbers in the table represent the pay-off matrix of the game

Figure 17: Battle of the Sexes – Statistical Test Results

Battle of the Sexes

Player 1

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - Row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.600000	0.400000	1.08012	**0.289304**	15	15	0.5071	0.5071	1.0000	1.0000

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	0.000000	0.20	**p > .10**

Mann-Whitney Test	Sum of ranks Row	Sum of Ranks Column	P-value
	255	210	**0.350688**

Player 2

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.600000	0.800000	-1.183216	**0.246673**	15	15	0.507093	0.414039	1.500000	0.457688

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	-0.200000	0.00	**p > .10**

Mann-Whitney Test	Sum of ranks - Row	Sum of Ranks Column	Úroven p
	210.0	255.0	**0.350688**

Note: For all the tests, the following transformation takes place: Strategy 1 = 0 and Strategy 2 = 1

Figure 18: Stag Hunt Results

OVERALL			Player 2	
			Frequency of Strategy 1	Frequency of Strategy 2
			50%	50%
Player 1	Frequency of Strategy 1	47%	12 , 13	3 , 9
			23%	23%
	Frequency of Strategy 2	53%	9 , 4	9 , 9
			27%	27%

ROW PARTICIPANTS			Player 2	
			Frequency of Strategy 1	Frequency of Strategy 2
			47%	53%
Player 1	Frequency of Strategy 1	60%	12 , 13	3 , 9
			28%	32%
	Frequency of Strategy 2	40%	9 , 4	9 , 9
			19%	21%

COLUMN PARTICIPANTS			Player 2	
			Frequency of Strategy 1	Frequency of Strategy 2
			53%	47%
Player 1	Frequency of Strategy 1	33%	12 , 13	3 , 9
			18%	16%
	Frequency of Strategy 2	67%	9 , 4	9 , 9
			36%	31%

Nash equilibria
Most frequent outcome
Average outcome frequency (Product of frequency of the 2 particular strategy resulting in the given outcome
Large numbers in the table represent the pay-off matrix of the game

Figure 19: Stag Hunt – Statistical Test Results

Stag Hunt

Player 1

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - Row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.400000	0.666667	-1.46760	**0.153357**	15	15	0.5071	0.4880	1.0800	0.8875

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	-0.266667	0.00	**p > .10**

Mann-Whitney Test	Sum of ranks Row	Sum of Ranks Column	P-value
	203	263	**0.213375**

Player 2

T-test for independent samples	Average Row Participants	Average Column Participants	T - statistic	P-value	Number of row participants	Number of Column Participants	Standard deviation - row	Standard deviation Column	F-ratio Variances	P-value for the equivalnce of variances
	0.533333	0.466667	0.353553	**0.726322**	15	15	0.516398	0.516398	1.000000	1.000000

Kolmogorov-Smirnov Test	Maximal negative difference	Maximal positive difference	P-value
	0.000000	0.07	**p > .10**

Mann-Whitney Test	Sum of ranks - Row	Sum of Ranks Column	Úroven p
	240.0	225.0	**0.755736**

Note: For all the tests, the following transformation takes place: Strategy 1 = 0 and Strategy 2 = 1

6.2. Appendix 2 – Experimental Instructions

Instructions

Welcome, and thank you for participating in our experiment on interactive decision making. In the experiment you will earn money depending on your behaviour and that of other participants you will be matched with. The earned money will be paid to you, in cash, right after the experiment. Please do not talk during the experiment. If you have a question, please raise your hand and wait for an experimenter to come and answer your question.

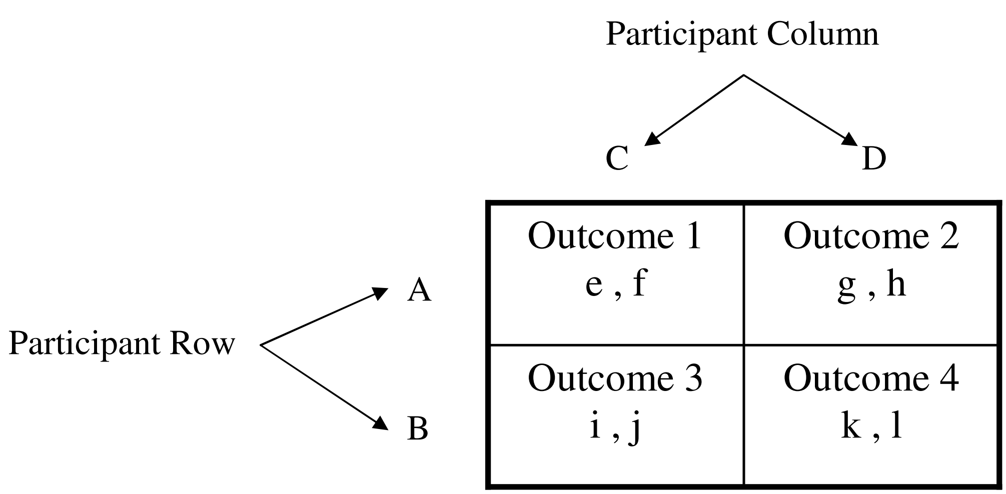
You will participate in a series of interactive decision situations (“scenarios”), Each such scenario will involve you and another participant. Each of you will have two options to choose from. If you are Participant “Row”, you choose between actions (“rows”) A and B. If you are Participant “Column”, you choose between actions (“columns”) C and D.

You, like every other participant in this experiment, will be randomly assigned to be a “Row” or “Column” participant. You will participate in 14 interactive scenarios of the kind described above.

Your earnings depend on which outcome is selected. Each outcome is represented by a cell in the tables of outcomes shown in the Illustration below: If, for example participant Row chooses A and participant Column chooses D, outcome 2 is selected.

In each cell, under the label “Outcome …”, there are two numbers separated by comma. These two numbers represent the earnings of the Row participant (always the first number) and of the Column participant (always the second number), respectively. If, for example, Outcome 2 were to be selected, then participant Row would earn ‘g’ and participant Column would earn ‘h’, as in the Illustration.

Illustration



Your earnings from this experiment will be based on the results of only one scenario, which will be determined randomly at the end of the experiment by one of you. You will be randomly matched to a participant from the other group and the outcome of the scenario will be selected. The earnings from the thus determined scenario will be multiplied by 10 and you will obtain the particular amount in Czech crowns. In addition, each of you will obtain a show-up fee of 100 Czech crowns.

Before we start the actual experiment, let us go through a Sample Scenario to make sure that everyone understands how to read the earnings tables. Assume that each participant were to try to maximize **their** earnings, what should they choose? Please circle the actions in the Sample Scenario for both players (i.e. A or B for participant Row and C or D for participant Column). When done, raise your hand and wait for an instructor to check your result.

Sample Scenario

		Participant Column	
		C	D
Participant Row	A	8 , 4	12 , 2
	B	4 , 3	7 , 2

Any questions?

6.3. Appendix 3 – Experimental Sheet – Row Participants

You are participant Row. Please circle your actions in the 14 following scenarios.

1

A	10 , 10	3 , 14
B	17 , 2	6 , 7

2

A	15 , 13	6 , 23
B	22 , 9	0 , 1

3

A	5 , 15	13 , 20
B	15 , 23	12 , 18

4

A	14 , 11	5 , 4
B	2 , 3	12 , 15

Name:____________

5

A	0 , 15	13 , 20
B	15 , 23	12 , 18

6

A	12 , 13	3 , 9
B	9 , 4	9 , 9

7

A	15 , 28	12 , 22
B	14 , 25	11 , 20

8

A	10 , 10	2 , 17
B	14 , 3	7 , 6

9

A	13 , 15	9 , 22
B	23 , 6	1 , 0

10

A	15 , 5	23 , 15
B	20 , 13	18 , 12

11

A	11 , 14	3 , 2
B	4 , 5	15 , 12

12

A	15 , 0	23 , 15
B	20 , 13	18 , 12

13

A	13 , 12	4 , 9
B	9 , 3	9 , 9

14

A	28 , 15	25 , 14
B	22 , 12	20 , 11

6.4. Appendix 4 – Experimental Sheet – Column Participants

You are participant Column. Please circle your actions in the 14 following scenarios.

1

C	D
10 , 10	2 , 17
14 , 3	7 , 6

2

C	D
13 , 15	9 , 22
23 , 6	1 , 0

3

C	D
15 , 5	23 , 15
20 , 13	18 , 12

4

C	D
11 , 14	3 , 2
4 , 5	15 , 12

Name:____________

5

C	D
15 , 0	23 , 15
20 , 13	18 , 12

6

C	D
13 , 12	4 , 9
9 , 3	9 , 9

7

C	D
28 , 15	25 , 14
22 , 12	20 , 11

8

C	D
10 , 10	3 , 14
17 , 2	6 , 7

9

	C	D
	15 , 13	6 , 23
	22 , 9	0 , 1

10

	C	D
	5 , 15	13 , 20
	15 , 23	12 , 18

11

	C	D
	14 , 11	5 , 4
	2 , 3	12 , 15

12

	C	D
	0 , 15	13 , 20
	15 , 23	12 , 18

13

	C	D
	12 , 13	3 , 9
	9 , 4	9 , 9

14

	C	D
	15 , 28	12 , 22
	14 , 25	11 , 20

7. References

BATTALIO, B., SAMUELSON, L. and VAN HUYCK, J. B.: Optimization Incentives and Coordination Failure in Laboratory Stag Hunt Games, Econometrica (2001) 69, 749-764

CHEN K. Y. and HOGG T.: How Well Do People Play a Quantum Prisoner's Dilemma? [on-line], 2006, last revision May 17, 2009, <www.hpl.hp.com/research/idl/papers/qpdilemma/dpddilemma.pdf>

COOPER, D. J. and VAN HUYCK, J. B.: Evidence on the equivalence of the strategic and extensive form representation of games, Journal of Economic Theory 110 (2003), 290-308

DEMARZO, P. M., FISHMAN, M. J. and HAGERTY, K. M.: Self-Regulation and Government Oversight, Review of Economic Studies (2005) 72, 687-706

DEVETAG G and ORTMANN, A.: When and Why? A Critical Survey on Coordination Failure in the Laboratory, Working Paper Series 302 (ISSN 122-3298), CERGE-EI, Prague 2006

GILLETTE, A. B., NOE, T. H. and REBELLO, M. J.: Corporate Board Composition, Protocols, and Voting Behavior: Experimental Evidence, The Journal of Finance (2003) 53, 1997- 031

HAUSKEN, K. and ORTMANN, A.: A First Experimental Test of Multilevel Game Theory: The PD Case, Applied Economics Letters, 15.4 (2008), 261 – 264

HERTWIG, R. and ORTMANN, A.: Experimental practices in economics: A methodological challenge for psychologists? Behavioral and Brain Sciences 24 (2001), 383-451

HUCK, S., MÜLLER, W. and VRIEND, N. J.: The East End, The West End, and King's Cross: On Clustering in the Four-player Hotelling Game, Economic Inquiry (2002) 40, 231-240

KAMECKE, U.: Rotations: Matching Schemes that Efficiently Preserve the Best Reply Structure of a One Shot Game, International Journal of Game Theory (1997) 26, 409-417

KRAJČOVÁ, J.: Experimental Testing of Leniency Programs: The Impact of Change in Parameterization, Working Paper, CERGE-EI, [on-line], 2008, last revision May 21, 2009, <http://www.cerge-ei.cz/pdf/wp/Wp372.pdf>

KRAJČOVÁ, J. and ORTMANN, A.: Experimental Testing of Leniency Programs: The Impact of Instructions Framing, Working Paper, CERGE-EI, [on-line], 2008, last revision May 21, 2009, <http://www.cerge-ei.cz/pdf/wp/Wp370.pdf >

NUNEZ, J.: Can self regulation work?: A story of corruption, impunity and cover-up, Journal of Regulatory Economics (2007) 31, 209–233

ORTMANN, A., HERTWIG, R.: The Costs of Deception: Evidence from Psychology, Experimental Economics 5 (2002) 111-131

ORTMANN, A., HERTWIG, R.: The Costs of Deception: Evidence from Psychology, Experimental Economics 5 (2002), 111-131

RYDVAL, O.: Statistical Tests for Experimental Economics, manuscript (Appendix to A. Ortmann, Behavioral and Experimental Economics, manuscript)

SCHMIDT, D., SHUPP, R., Walker, J. M., OSTROM, E. O.: Playing safe in coordination games: The roles of risk dominance, payoff dominance, and history of play, Games and Economic Behavior 42 (2003) 281-299

TUROCY, T. L. and VON STENGEL B.: Game Theory, CDAM Research Report LSE-CDAM-2001-09.

WEBER, R. A.: 'Learning' with no feedback in a competitive guessing game, Games and Economic Behavior 44 (2003) 134-144