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Abstract

In this paper we experimentally test two questions about bribery. The first question is whether there is more bribery in a situation with excessive regulation than in a situation with optimal regulation. The second question is whether the existence bribery leads to higher efficiency when there is excessive regulation and bribes can be used to restore efficiency. Our experimental results show that there are more bribes in *the bribery model with excessive taxes* than in *the bribery model with optimal taxes*. This difference decreases gradually over time. The experimental results also provide a non affirmative answer to the second question. In *the bribery model with excessive taxes* subjects use bribes not only to restore efficiency but also to free ride on others. As a consequence, the resulting efficiency levels are not only far from the social optimal that could be achieved, but also lower than the level that would be if there were no bribes.

Introduction

The bribery phenomenon has received considerable attention from economists. A wide range of issues is discussed in the literature. One of the issues discussed in both empirical and theoretical papers is the effect of corruption on the economy. A large number of empirical cross country works written by the IMF staff show the negative effect of corruption on health, education, tax revenue and public infrastructure. Mauro (1995) in his cross country study reveals a negative association between corruption and economic performance primarily through its negative effect on private investment. Theoretically, Shleifer and Vishny (1993) attribute corruption's negative effect to its secrecy. The authors argue that secrecy makes corruption more distortionary than taxation. In their model bureaucrats make socially inefficient decisions in order to increase bribes.

There are, however, authors in the literature who argue that bribery can be efficiency improving. Leff (1964) and Huntington (1968) list possible advantages of bribery. First, it is argued that bribes provide better incentives for bureaucrats. Second, bribes help circumvent cumbersome bureaucracies. Mauro (1995) tests the second argument empirically and reports that corruption reduces total investments and thus economic growth in countries with cumbersome bureaucracies as much as in countries without cumbersome bureaucracies. However, there is a reason that raises suspicion over this result. Surprisingly, in his test of this argument, Mauro (1995) does not control for other variables, like, for example, initial GDP, population growth rate, government expenditure, etc., that can affect the rates of investment in a country.

In this paper, we analyze theoretically and test experimentally two questions related to the second argument about the advantages of bribery. We, first, ask whether the existence of excessive regulation (or cumbersome bureaucracy) affects the incidence of bribery compared to a case with optimal regulation (or optimal bureaucracy). To our knowledge this question has not been studied in the literature. Second, we look at the question of whether bribery can improve efficiency when there is excessive regulation (or cumbersome bureaucracy).

The theoretical framework we consider is a social dilemma situation. Players report income and pay taxes from reported income. The taxes collected from all players are invested in a common project (public good). The amount collected in the common project is multiplied by a certain factor and then distributed equally among all players. We assume that the amount that is multiplied when invested in the common project is bounded from above. Anything in excess of this upper bound is lost when invested in the common project. This feature allows us to model excessive regulation. Bribes enter in the following way. Players can use bribes to report less income and thus evade taxes without being punished. We consider three different cases to answer the main questions of this paper. First, in *the bribery model with optimal taxes* the tax rate is set such that without tax evasion the total amount collected in the common project equals exactly to the upper bound and thus the socially optimal level. Second, in *the bribery model with excessive taxes* the tax rate is set such that without tax evasion the total amount collected in the common project is more than the upper bound. Third, in *the model with excessive taxes and no bribery* the tax rate is the same as in the second case but there are no bribes and thus no possibility of making sure that one is not punished for evading taxes.

We think our framework captures the most important aspects of bribery that are relevant to answering the main questions of this paper. *In the bribery model with optimal taxes,* bribes can be used to free ride on others and result in a lower efficiency from the social perspective. Paying bribes is good from the individual perspective but bad from the social perspective. On the other hand, *in the bribery model with excessive taxes* bribes can be used “wisely” to improve social efficiency. To see why, note that the tax rate is too high in this case. Players contribute more than the socially optimal level of resources to the common project. If bribes are used to certain extent only, the money collected in the common project will decrease towards its socially optimal level. However, using bribes too much lowers social efficiency because this time there is very little amount of resources collected in the common project.

To answer our first question from the game theoretical perspective we compare the amount of bribes *in the bribery model with optimal taxes* to that in *the bribery model with excessive taxes*. We consider cases where the tax rates are equal in both models. However, *in the bribery model with optimal taxes* this tax rate corresponds to the socially efficient rate, while in the *bribery model with excessive taxes* it is above the socially optimal rate. We achieve this by setting different upper bound in two models. Our game theoretical prediction states that with sufficiently cheap bribes the amounts of bribes are the same in both models. In both cases, players report zero income and contribute nothing to the common project. In the bribery model with optimal taxes bribes are paid to free ride on others. In the bribery model with excessive taxes bribes are paid both to free ride and evade inefficient taxes. Since in both models players report zero the amounts of bribes paid are equal in two models.

The discussion of the game theoretical predictions for *the bribery model with excessive taxes* in the previous paragraph shows why the answer to the second main question is likely to be non-affirmative. As mentioned in the literature bribery allows one to circumvent cumbersome regulation. However, at the same time the existence of bribery also creates an opportunity to free ride on society. The standard theoretical prediction is that people will utilize bribes not only to restore efficiency but also to free ride on others. Thus, the socially optimal solution is not obtained. Actually, to answer the second question one needs to compare the efficiency levels from *the bribery model with excessive taxes* to those from *the model with excessive taxes and no bribes*. In the first, case there is nothing in the common project and in the second case there are too many resources in the common project. Thus, which case is better depends on the parameter choice. For reasonable parameter values in our model the second case is better than the first. Also, we are interested more in situations like this because we want to see if people can intentionally limit the use of bribes to improve efficiency. If full free riding is better than paying excessive taxes then as along as people use bribes the resulting efficiency is higher relative to the case where nobody uses bribes. Hence, our theoretical prediction is that in *the bribery model with excessive taxes*, first, payers fail to coordinate around socially optimal level and second, the resulting efficiency level is lower than in *the model with excessive taxes and no bribery*.

There are, however, reasons for treating these standard game-theoretical results with suspicion. First of all, previous experimental results show that people are significantly more cooperative in social dilemma situations than is predicted by game theory. While *the bribery model with optimal taxes* is purely a social dilemma situation, *the bribery model with excessive taxes* involves the other consideration, excessive taxes, in addition to the social dilemma situation. Second, the experimental literature also reports that people care about fairness. It is documented that fairness considerations affect human behavior in strategic games. It might be relevant to our model because in *the bribery model with excessive taxes* there is some sort of unfairness towards agents while *the bribery model with optimal taxes* can be considered as fair. In other words, contributing socially optimal levels might be considered as fair and contributing above that level as unfair. We suspect that these motivations can result in different choices for each model. We are interested in how the excistence of excessive taxes affects the propensity to free-ride. Do people switch their attention from free riding to eliminating inefficiency when there are excessive taxes? Or are they going to free ride even more? As theoretical predictions are silent about these issues, we present experimental results to see the actual behavior by subjects.

To test the game theoretical prediction regarding the first question we compare the incidence of bribery in two different treatments. In one of our treatments called Treatment OptTax the actual tax rate is equal to the socially optimal rate. In the other treatment called Treatment ExcessiveTax the actual tax rate is the same as in the Treatment OptTax, however, higher than the socially optimal rate. We compare the amounts of bribes collected in both treatments. Our results show that there is significantly more bribery in Treatment ExcessiveTax than in Treatment OptTax. However, this difference shrinks as more rounds are played.

To test the prediction regarding the second question we compare the efficiency results from Treatment ExcessiveTax with those from a theoretical benchmark with exactly the same parameters as in Treatment ExcessiveTax but no possibility of bribing. We explain later why we do not run a separate treatment for the case with excessive taxes and no bribes but rather use a theoretical benchmark. Looking at efficiency results for Treatment ExcessiveTax, only, we see that subjects clearly fail to coordinate close to socially optimal level by using bribes. Moreover, comparing these efficiency levels with those from the theoretical benchmark shows that the existence of bribes actually lowers social efficiency. This result is in line with our theoretical prediction.

Our results can be extended to cumbersome bureaucracies as discussed in the literature. It is true that bribes allow one to circumvent cumbersome bureaucracy. However, nothing stops one from using bribes to circumvent "efficient" bureaucracy as well. Our results show that subjects use bribes not only to restore efficiency but also to free ride.

The remainder of the paper is organized as follows. In the next section we present our theoretical framework and solve for game-theoretical predictions. In Experiment section we describe the design and procedure for our experiment. Results section presents our experimental findings. We conclude in the last section.

Model

In this section we, first, present a theoretical framework to analyze the answers to the main questions of this paper. Then, we solve for game-theoretical predictions. Finally, we discuss why the theoretical predictions might possibly not hold in reality and it is necessary to test the model experimentally.

We construct a model that captures the most important aspects of the bribery phenomenon that are relevant to answering the main questions of the paper. Our framework is a simplified version of how bribes function in a society. The framework we consider is similar to public goods game with some differences. In our model, players report income and pay taxes from reported income. The taxes collected from all players are invested in a common project (public good). The amount collected in the common project is multiplied by a certain factor and then distributed equally among all players. We assume that the amount that is multiplied when invested in the common project is bounded from above. Anything in excess of this upper bound is lost when invested in the common project. This feature allows us to model excessive taxation. The decision on how much to report is voluntary, however, each player faces a certain probability that his actual income is monitored. If as a result of monitoring it is discovered that a player has not reported his full income, he is fined. Assuming that the probability of being monitored is high enough it is not optimal from the individual perspective to misreport income. Bribes enter the model in the following way. By paying a bribe in proportion to the amount of income one does not want to report it is possible to completely avoid being punished for misreporting. We think this framework captures very important aspects of the bribery problem. With optimal taxes bribery allows players to free-ride on society by contributing less than the socially optimal levels. It is beneficial from the individual perspective but detrimental to society. By slightly changing our model we can easily analyze the case where bribes can, possibly, if used to certain extent, improve social efficiency. We proceed with detailed description of the model and payoff functions step by step.

Consider the following $n \geq 2$ player game. In the beginning each player receives an income, y_i, drawn independently from a uniform distribution. There is, also, a common project. Any amount invested in the common project is multiplied by $r > 1$ and then divided equally among all n players. The following condition is satisfied; $0 < \frac{r}{n} < 1 < r$. Assume contributions to the common project are made via taxes. Players report whatever income they want and part of the income reported, tax, is added to the common project. The payoff function for player i is:

$$\pi_i = y_i - \tau y_i^{rep} + \frac{r}{n}\tau\sum_{j=1}^{n} y_j^{rep} \qquad (1)$$

where y_i^{rep} denotes the amount of income reported by agent i and τ denotes the tax rate . For the moment, let us take τ as given and discuss the theoretical predictions for the choice of y_i^{rep}. The dominant strategy from the individual perspective is to contribute nothing by reporting zero income. To see this, note that the derivative of (1) with respect to y_i^{rep} is always negative. This is insured by $\frac{r}{n} < 1$. On the other hand, for given τ, the sum of the payoffs of all players, $\sum_{i=1}^{n}\pi_i = \sum_{i=1}^{n} y_i - \tau\sum_{i=1}^{n} y_i^{rep} + r\tau\sum_{i=1}^{n} y_i^{rep}$, is maximized when all players report full income. This is insured by the assumption that r >1.

To answer the main questions of this paper we need a framework where we can model excessive regulation. In the model we have presented so far it is not possible to model excessive taxes. To be able to do this we modify our model while the main characteristics remain the same. Above we assumed that whatever amount is invested in the common project it is multiplied by r and that is why the socially optimal solution was to invest as much money as possible in the common project. We change this feature by assuming that only limited amount of money is increased when invested in the common project. Any excess amount is lost when invested in the common project. We call the maximum amount that will be multiplied by r when invested in the common project the upper bound. We assume that the upper bound is proportional to the sum of the initial incomes received by all players and denote it by $\theta\sum_{i=1}^{n} y_i$, where $0 < \theta < 1$. We call θ the upper bound coefficient. The assumption that the upper bound is proportional to the sum of initial incomes allows us, for given tax rate, to construct a model with either excessive taxes or optimal taxes by changing the upper bound coefficient only. The payoff function for a model with an upper bound looks like:

$$\pi_i = y_i - \tau y_i^{rep} + \frac{r}{n}\min(\tau\sum_{j=1}^{n} y_j^{rep}, \theta\sum_{j=1}^{n} y_j) \qquad (2)$$

Let us consider two cases. The first case is what we call *the model with optimal taxes* where $\theta = \tau$. The individually optimal strategy is to report zero income as the derivative of the payoff function with respect to y_i^{rep} is always negative. However, the sum of the payoffs is maximized if the sum of taxes paid is exactly equal to the upper bound. This is ensured by $r > 1$ and the upper bound. The socially optimal solution in this case can be achieved if all players report full income. In this case total taxes collected will equal to the upper bound. Incorporating bribes in this version of the model allows us to analyze the effect of bribes in a situation where a regulator intervenes optimally.

The second case is where $\theta < \tau$ and we call it *the model with excessive taxes*. We do not discuss why the tax rate is not set at the optimal level but rather take it as given. The individually optimal strategy is again to report zero income as the derivative of the payoff function is zero irrespective of what the other players do. However, in this case if all players report full income total taxes collected are higher than the upper bound and thus part of the amount collected in the common project is lost. To achieve the socially optimal solution the sum of the taxes from all players should equal to the upper bound as in *the model with optimal taxes*. This can, for example, be done if all players report $\frac{\theta}{\tau}$ part of their income and thus pay θ part of their income in taxes. This case shows how we model excessive regulation.

So far, in our models we assumed that agents can voluntarily choose what income to report. We, now, introduce additional feature into our model. Assume that each agent is free to report any amount but there is a probability p that an agent is monitored. If an agent is monitored and it is discovered that his actual and reported incomes are different, he pays a fine equal to this difference in addition to the tax paid from the reported income. If not monitored, an agent pays only a tax from the reported income.

The payoff function is:

$$E(\pi_i) = (1-p)\left[y_i - \tau y_i^{rep} - \frac{r}{n}\min\left[\tau y_i^{rep} + G_{-i}, \theta\sum_{i=1}^{n} y_i\right]\right] + p\left[y_i - (\tau y_i^{rep} + f_i) + \frac{r}{n}\min\left[(\tau y_i^{rep} + f_i) + G_{-i}, \theta\sum_{i=1}^{n} y_i\right]\right] \quad (3)$$

where $f_i = y_i - y_i^{rep}$ and $G_{-i} = \tau\sum_{j\neq i} y_j^{rep} + p\sum_{j\neq i}\left(f_j\right)$. f_i denotes a fine player i pays if he is monitored and G_{-i} stands for the taxes and fines paid by all the players except player i. The first part of the expression on the right hand side of equation (3) denotes the payoff to player i if he is not monitored multiplied by the probability of not being monitored and the second part denotes the payoff to player i if he is monitored multiplied by the probability of being monitored.

Irrespective of whether we are in *the model with optimal taxes* or *with excessive taxes*, to ensure that all players report full income in the equlibrium the condition $p > \tau$ should be satisfied. To see that in the unique equilibrium all players report full income, note that the derivative of the expected payoff function (4) with respect to y_i^{rep} is always positive when $p > \tau$, whatever other players do. We assume that $p > \tau$ holds.

Next, we incorporate bribes. In both *the model with optimal taxes* and *in the model with excessive taxes* the optimal thing to do from the individual perspective is to report full income when $p > \tau$. In the model with optimal taxes this leads to the socially optimal solution. In the model with excessive taxes, on the other hand, full income reporting leads to too much money collected in the common project. Now, assume that one can pay bribes and make sure that he can report any amount without being fined. Unlike fines collected bribes are not invested in the common project. We assume that bribes are proportional to the difference between the actual income and the reported income and denote a bribe paid by player i by b_i where $b_i = \lambda(y_i - y_i^{rep})$ and $0 < \lambda < 1$. Given that one wants to pay bribes the payoff function becomes:

$$\pi_i = y_i - \tau y_i^{rep} + \frac{r}{n}\min[\tau y_i^{rep} + G_{-i}^{b}, \theta(\sum_{i=1}^{n} y_i)] - \lambda(y_i - y_i^{rep}) \qquad (4)$$

where $G_{-i}^{b} = \tau E(\sum_{k\neq i} y_k^{rep}) + \tau E(\sum_{j\neq i} y_j^{rep}) + p(E(\sum_{j\neq i} y_j) - E(\sum_{j\neq i} y_j^{rep}))$ and stands for the taxes and fines paid by all players except player i. k is the number of players who pay bribes and j is the number of players who do not pay bribes. Obviously, $k + j = n - 1$. Taking the derivative with respect to y_i^{rep} gives either $\frac{\partial E(\pi_i)}{\partial y_i^{rep}} = -\tau + \frac{r}{n}\tau + \lambda$ or $\frac{\partial E(\pi_i)}{\partial y_i^{rep}} = -\tau + \lambda$ depending on the amount of taxes and fines collected from the other players. For sufficiently small λ, both of these expressions are negative. Hence, conditional on paying bribes, the optimal action from the individual perspective is to report zero income given that bribes are not too expensive. This is true for both the model with optimal taxes and the model with inefficient taxes. On the other hand, as mentioned above evading taxes without paying bribes does not pay off in the expectation as we have set $p > \tau$ in both models.

We call the model with optimal taxes and the possibility of bribing *the bribery model with optimal taxes*. The model with excessive (inefficient) taxes and the possibility of bribing is called *the bribery model with excessive taxes*.

Let us discuss our theoretical predictions in relation to the main questions of the paper. In relation to the first question of whether there are more bribes with excessive taxes than with optimal taxes the theoretical prediction is not affirmative. To see this assume that we have two bribery models with the same tax rate but different upper bound coefficients. Assume in one case the upper bound coefficient is equal to the tax rate and in the other case it is below it. We, also, assume that $p > \tau$ is satisfied in both cases. The first case corresponds to *the bribery model with optimal taxes* and the second case corresponds to *the bribery model with excessive taxes*. It is clear from our analysis above that in both cases the individually optimal strategy is to report zero income given that bribes are cheap enough. In the model with optimal taxes people pay bribes to free ride on others. In the second case they pay bribes to both to evade inefficient taxes and to free ride. Since in both models reporting zero income is the dominant strategy the amounts of bribes paid should be equal in two models. In other words, the answer to our first question is negative with standard preferences. Whether one pays bribes to free ride or to evade inefficient taxes does not matter from theoretical point of view. We state this prediction in proposition.

Proposition 1: *With standard preferences there is no difference between the amounts of bribes paid in the bribery model with optimal taxes and in the bribery model with excessive taxes.*

However, we know from previous research that people are significantly more cooperative in social dilemma situations than it is predicted by the game theory. *The bribery model with optimal taxes* is purely a social dilemma situation. This fact makes us treat the game theoretical prediction that players will use bribes to report zero income *in the bribery model with optimal taxes* with suspicion. We expect that although bribes will be used by players to free ride, the reported incomes will be higher than zero. On the other hand, the *bribery model with excessive taxes* is not a pure social dilemma situation. Using bribes to certain extent can actually be beneficial from the social perspective as there is excessive taxation. Using bribes too much, on the other hand, decreases social efficiency. We do not know of any previous studies on these kinds of situations and it is difficult to predict how players will behave in reality. We, briefly, speculate about different possibilities.

One possibility is that in *the bribery model with excessive taxes* players will use bribes to report incomes that lead to the socially optimal levels of public good. For this to happen, players should have strong preferences for the socially optimal levels of contributions. For example, assume that players consider optimal taxes as fair and paying more or less than the optimal taxes as unfair. If this fairness consideration is strong enough one might expect that players will use bribes "wisely" to eliminate excessive regulation only. Another possibility is that when faced with excessive taxes people evade taxes even more than *in the bribery model with optimal taxes*. This may happen if players are angry because they are excessively taxed.

There is one more reason that might affect the incidence of bribing *in the bribery model with excessive taxes*. We showed that in both models with bribes the individually optimal strategy is to report zero income. However, even from the theoretical perspective there is a difference if players report high incomes. Consider, for example, the incentive to pay bribes in both models if the contributions by all players are very high. In *the bribery model with optimal taxes* the higher income reporting (paying less bribes) by a player leads to a higher social efficiency but is not the individually dominant strategy. In the bribery model with excessive taxes, on the other hand, reporting higher income (paying less bribes) does not lead to a higher social efficiency and it is, also, not the individually optimal thing to do. Actually, if the other players report very high incomes *in the bribery model with excessive* taxes any increase in the reported income and thus taxes paid by a player is lost. On the other hand if all players report very low incomes the marginal incentives to report more income are identical in both models. In sum, we have reasons to treat our game theoretical predictions with suspicion. An experimental test of Proposition 1 should help clarify things more.

The theoretical analysis gives negative answer to our second question of whether bribes improve efficiency when there is excessive regulation. According to our theoretical predictions with $p > \tau$ and no bribes agents report full income and part of collected taxes is lost when invested in the common project. With $p > \tau$ and bribes agents pay bribes and report zero income. Which result is better from the social efficiency perspective depends on the choice of parameters. However, for reasonable choice of parameters reporting nothing is worse than reporting too much. Moreover, we are more interested in situations like this because we want to see if players can limit the use of bribes to increase social efficiency. We state the game theoretical prediction for the second question in the following proposition.

Proposition 2: *With standard preferences the existence of bribes in the bribery model with excessive taxes does not lead to a higher social efficiency than in the model with excessive taxes and no bribery.*

This conclusion is based on the game-theoretical prediction that players will use bribes not only to restore efficiency but also to free ride. In the discussion of theoretical predictions for the first question we speculated why this might or might not hold depending on the preferences of players. To see what happens in reality we conduct experimental tests.

Experiment

Design

The structure of our experimental game is similar to the theoretical framework presented in the previous section. There are four players. At the beginning of each period, each player receives an income drawn randomly and independently from a uniform distribution between 0 points and 100 points. Each player's income is his private information. Then, each player decides how much income to report and whether to make a private payment (pay bribes) or not. Taxes are deducted from the reported income at the announced tax rate. In addition, if a player is monitored he pays a fine that is equal to the difference between his actual income and reported income. If a player chooses to make a private payment (pay bribes), fixed proportion of the difference between actual income and reported income is deducted. By making a private payment a player makes sure that he is not monitored and thus not fined. Taxes and fines collected are invested in the common project. After all four players make decisions each player is provided with information in two parts. The general information part is same for all players and constitutes of information on total taxes and fines collected, the sum of initial incomes received by all players, the upper bound and the return from the common project to each player. The private information part for each player constitutes of information on tax, fine (if any), private payment (if any) paid by a player and his payoff. Each player's payoff is equal to the sum of income left after tax, fine (if any) and private payment (if any) are deducted and return from the common project.

We run two different treatments. In both treatments the tax rate is set to 60% of reported income, the probability of being monitored is 70% to ensure that it is not individually optimal to evade taxes without paying bribes and the bribing coefficient is set to 10%. The return to the common project is 100%. The only difference between the two treatments is in the upper bound coefficient. In one of the treatments labeled Treatment OptTax we set the upper bound coefficient equal to the tax rate of 60%. In the other treatment, called Treatment ExcessiveTax, we set the upper bound coefficient to 40%. In Treatment OptTax, if nobody evades taxes the total tax collected equals, exactly, to the upper bound and thus to the socially optimal level. In Treatment ExcessiveTax, if nobody evades taxes the total tax collected is more than the upper bound and thus one third of it is lost when invested in the common project. We compare the amounts of bribes in these treatments to answer our first question of whether excessive taxes generate more bribes.

To answer our second question of whether bribes can improve efficiency when there is excessive regulation we need an additional control treatment with the same parameters as in Treatment ExcessiveTax but no possibility of bribery. However, we decided not to run an additional treatment and use theoretical benchmark for the following reason. With excessive taxes and no possibility of bribing, if a player reports full income then he contributes 60% of his income to the common project via taxes. On the other hand, even if a player reports zero income, in expectation, he contributes 70% of his income to the common project via fines. Any other choice in between these two extremes leads, in expectation, to a contribution between 60% and 70% of one's income to the common project. Now, let's have a look at the efficiency levels for a group of four players. Let x be the sum of initial incomes of all players within a group. On the one hand, if all players report full income then one-third of the total tax collected is lost when invested in the common project. The overall efficiency is $(x-0.6x)+2*0.4x=1.2x$. This means that the sum of actual incomes is increased by 20%. Assume the other extreme with all players reporting zero income and facing a probability of 0.7 of being punished. In this case, in expectation, total fines constitute 70% of the sum of actual incomes. In this extreme, the expected value of overall efficiency is $(x-0.7x)+2*0.4x=1.1x$. Any other choice between these two extremes yields in expectation an efficiency that is between 110% and 120% of the sum of initial incomes. This means that although the choice set of each player includes a lot of different options, the resulting expected overall efficiency is within a narrow interval. As the efficiency interval is very small and we are interested in efficiency results for answering our second question we decided that there is no need for running additional treatment with excessive taxes and no bribes. We compare efficiency results from Treatment ExcessiveTax to the efficiency interval from the theoretical benchmark.

We, also, briefly, discuss the efficiency levels that can be attained in Treatment ExcessiveTax with the parameters we have chosen. If subjects play according to the game theoretical prediction then the overall efficiency level will be $(x-0.1x)+2*0=0.9x$. The expression in brackets shows the sum of incomes left after bribes are paid by all players. The money collected in the common project is zero and thus the return from the common project is zero. If no player pays a bribe the efficiency level is $1.2x$ as shown above. With bribes it is actually possible to achieve even higher levels of efficiency. Before showing this let us consider the efficiency level that could be achieved if the tax rate was set to its optimal value, the upper bound coefficient, and there were no bribes. The total tax collected equals $0.4x$ in this case. This is exactly equal to the upper bound and nothing is lost when invested in the common project. The overall efficiency is $(x-0.4x)+2*0.4x=1.4x$. In our model with excessive taxes, on the other hand, very close efficiency rates can be achieved. To see this, assume all players report 2/3 of their income and pay bribes to not to be fined. The efficiency level attained is $(x-0.6*0.67x)+2*0.4x-0.1*0.33x=1.367x$.[1] In other words, using bribes "wisely" it is possible to attain efficiency levels very close to the first best.

Procedure

Three experimental sessions were run at Tilburg University. Two sessions were run in Treatment ExcessiveTax and one session was run in Treatment ExcessiveTax. A total of 48 university students participated in the experiment. 28 subjects participated in Treatment ExcessiveTax and 20 subjects in Treatment ExcessiveTax. Each student participated in only one treatment. Students were recruited from Tilburg University via email announcement. The experiment was programmed and conducted with the software z-Tree (Fischbacher 2007).

At the beginning of the experiment subjects were seated randomly behind computers which were separated by partitions. Each subject was randomly and anonymously assigned to a group of four players. For each session the game was played for 20 periods. All subjects stayed in their groups until the end of the session. Subjects never knew the other members of their group.

After all subjects were seated and randomly assigned to a group, instructions were distributed and read aloud by the experimenter. Fifteen minutes were allocated to subjects to study instructions carefully and ask questions if necessary. We conducted a small quiz

[1] It is actually the highest level that can be attained in the bribery model with excessive taxes. Maximizing in *y* the expression for the sum of payoffs, *(x-0.6*yx)-2*min(0.4x,0.6yx)-0.1*(x-yx),* gives *y=0.67*, where y denotes the proportion of initial income that report.

to test the understanding of the instructions by subjects. One trial period was run. The earnings were between 8 and 13 Euros. The experiment lasted between 65 and 75 minutes.

Results

In this section we, first, compare the amounts of bribes in Treatment ExcessiveTax to those in Treatment OptTax to test the game theoretical prediction from Proposition 1. Next, efficiency results for Treatment ExcessiveTax are presented and discussed. We compare these efficiency results to those from our theoretical benchmark to answer our second question of whether the existence of bribes improves efficiency when there are excessive taxes. Finally, we discuss whether subjects who received higher initial income reported more compared to subjects who received lower income.

Figure 1 presents the amounts of bribes collected (in proportion to the sum of initial incomes received) in each of the 20 periods for both Treatment ExcessiveTax and Treatment OptTax. According to our theoretical predictions paying bribes and reporting zero income is the individually optimal strategy in both treatments. Since a bribe is 10% of the difference between actual and reported income, the amount of bribes collected should constitute 10% of the sum of initial incomes if players report zero income. However, it is seen from the Figure 1 that it is not what happens and actually in both treatments bribes are used to a lesser extent than predicted by game theory.

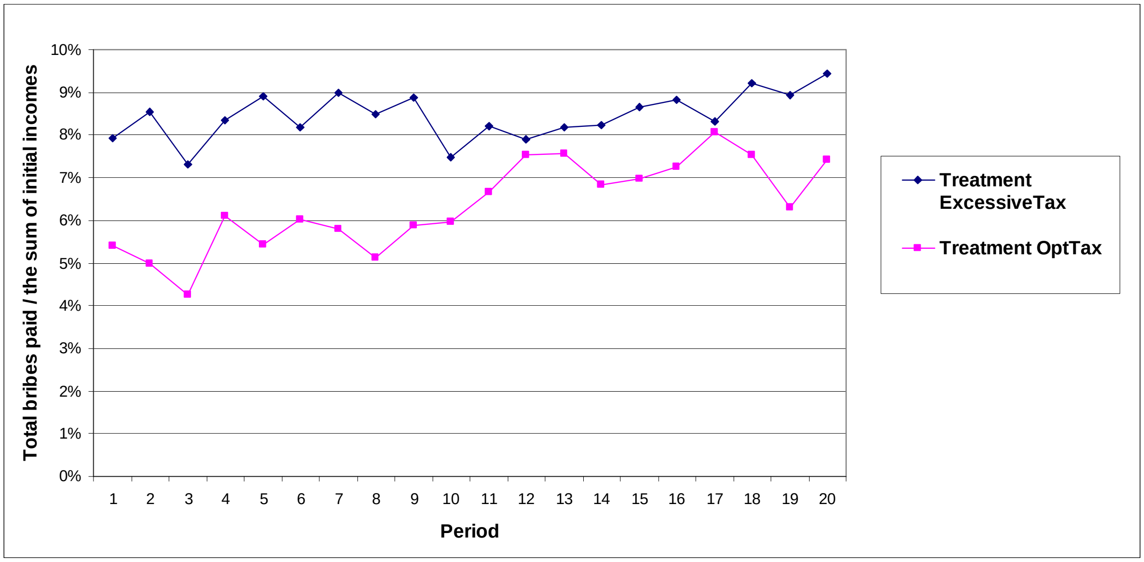
On the other hand, the socially optimal level of bribes is different in two treatments. For Treatment ExcessiveTax the socially optimal level is 3.33% of the sum of initial incomes and for Treatment OptTax it is 0%. Clearly, for both treatments actual amounts of bribes are much higher. We conclude that in both treatments bribes are used more than it is socially optimal and less than it is individually optimal.

Comparing the amounts of bribes in both treatments shows that in every period there are more bribes paid in Treatment ExcessiveTax than in Treatment OptTax. The difference in the amounts of bribes paid is larger in the first 10 periods than in the last 10 periods.

We test whether the amounts of bribes paid in two treatments are different over all 20 periods, first 10 periods and last 10 periods. The unit of observation is the amount of bribes paid (in proportion to the sum of initial incomes) in each group over the relevant number of periods. Since there are five groups in Treatment ExcessiveTax and seven groups in Treatment OptTax, we have five independent observations in one treatment and seven in the other. We marginally reject the null hypothesis that the amounts of bribes in two treatments are equal over 20 periods (Mann-Whitney test, $p = 0.07$, two tailed). Also, we reject the null hypothesis that the amounts of bribes are equal in two treatments over the first 10 periods (Mann-Whitney test, $p = 0.02$, two tailed). We cannot reject the null hypothesis that the amounts of bribes are equal in two treatments in the last 10 periods (Mann-Whitney test, $p = 0.27$, two tailed).

Looking carefully at the data we found out that in one of the groups from Treatment ExcessiveTax the amounts of bribes are significantly lower than in the other groups from the same treatment. We observed that this is driven by full income reporting in almost all periods by a single player. This kind of behavior is strange in Treatment ExcessiveTax. Actually, no other player in any of the two treatments behaved in this way. Since there are only four players in each group and the total number of groups is not too large, such a behavior by a single player can significantly affect our results. We exclude this group from the test and check if we still cannot reject the null hypothesis of no difference between two treatments in the last 10 periods. This time we marginally reject the null hypothesis of no difference between two treatments in the amounts of bribes in the last 10 periods (Mann-Whitney test, $p = 0.07$, two tailed).

Figure 1: The amounts of bribes (in proportion to the sum of initial incomes) in Treatment ExcessiveTax and in Treatment ExcessiveTax



Our experimental results are not in line with our theoretical predictions in answering our first main question at least for the beginning periods. It appears that subjects use bribes less than it is individually optimal but more than it is socially efficient in both cases. In sum, we conclude that the excessive taxes generate more bribes, although the difference decreases significantly over time.

Next, we move to discuss efficiency results from Treatment ExcessiveTax. From our discussion regarding the first question it is evident that the efficiency levels attained should be far from the socially optimal level in Treatment ExcessiveTax. To achieve the socially optimal level, the amount of bribes should be close to 3.33% of the sum of initial incomes. Obviously, subjects paid more bribes and reported less income than it would be socially optimal. In Table 1, below, we present the efficiency levels attainted (in proportion to the sum of initial incomes received) for each of the five groups from Treatment ExcessiveTax, separately. Average efficiency level over five groups is also reported in the table. The efficiency levels attained are far from the socially optimal level of 137%. Subjects fail to coordinate around socially optimal levels in each of the five groups.

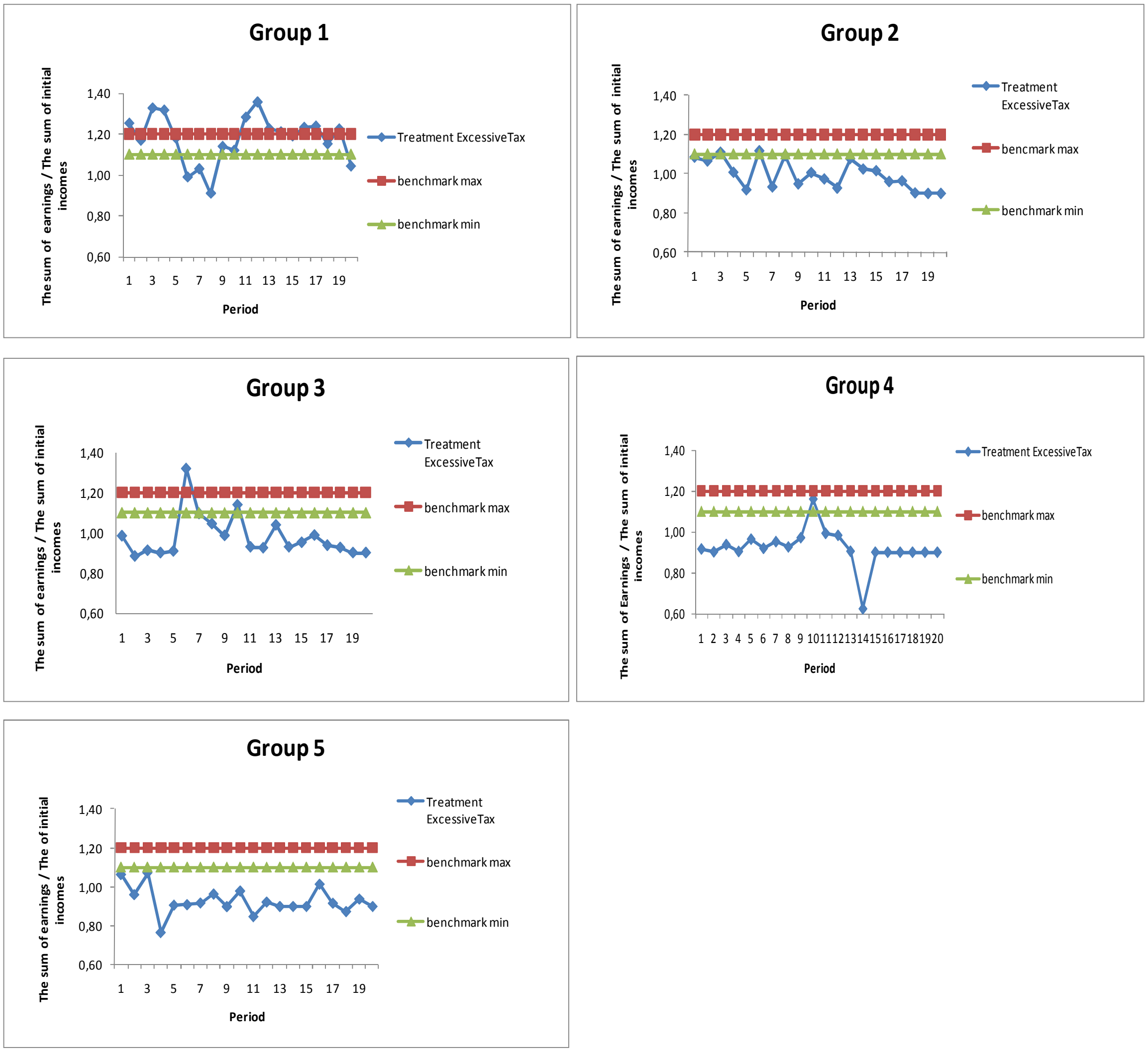
Table 1: Efficiency levels attained by groups in Treatment ExcessiveTax

Treatment ExcessiveTax			
	Total Earnings over 20 periods(X)	Total Initial Income Received over 20 periods(Y)	X/Y (%)
Group 1	4516	3845	117%
Group 2	3557	3676	97%
Group 3	3778	3835	99%
Group 4	3880	4131	94%
Group 5	3832	4032	95%
Average over all groups	3913	3904	100%

The efficiency level for Group 1 is much higher than those for the other groups. As discussed above the higher level of efficiency attained in Group 1 is driven by the behavior of a single member of this group. This member of the group reported full income in almost all periods. In other words, the higher efficiency rate attained is not a result of higher contributions by all members of Group 1 but only by a single member. Actually, the behavior of the remaining members of Group 1 is similar to that of the subjects from the other groups. As in our experiment the size of the groups is small this kind of behavior by a single person can change the results significantly.

The results from Table 1 show that subjects fail to coordinate around socially optimal level of income reporting using bribes. However, this is not enough to answer our second question. We need to compare the efficiency levels from Treatment ExcessiveTax to the efficiency interval from the theoretical benchmark. The efficiency interval is between 110 % and 120% in expectation. Clearly, the average efficiency level over all groups over all periods is below this interval. For all groups except Group 1 the efficiency level is well below the interval. For Group 1 the efficiency level is within the interval but not higher. We discussed above that the Group 1 results are driven by the behavior of a single individual. In sum for no group the efficiency level attained is higher than the theoretical benchmark with no bribes. Subjects not only fail to reach the social optimal using bribes but also perform worse relative to the case with excessive taxes and no bribes in terms of social efficiency.

Figure 2: Efficiency levels attained by groups in Treatment ExcessiveTax for each period



In Figure 2 we present efficiency results for each period to analyze the dynamics. No significant dynamic effects are observed. The behavior over periods is quite volatile. However, we do not observe any trends.

Finally, we briefly discuss one more issue. The tax scheme in our models has a redistributive feature. Actually, those players who receive lower incomes benefit more from cooperation around higher social efficiency levels. On the other hand, it is possible that a low income player cares less about how he plays because his decisions have little effect on his payoffs. In the figures below, we show average reported incomes (in proportion to actual incomes) for low incomes (less than 20 points) and high incomes (more than 20 points) in Treatment OptTax and Treatment ExcessiveTax. We observe that the dynamics of average reported incomes is very volatile for low incomes. Also, the average reported incomes for low incomes seem to be higher than those for high incomes. We analyzed data for low incomes closely and found out that in vast majority of cases there are two types of behavior for low incomes. Players with low income either report full income or report nothing. This, actually, explains the high volatily in average reported incomes for low incomes. We use Wilcoxon matched pair signed rank test to test for significant differences in both treatments separately. For Treatment ExcessiveTax, there are five groups and thus five pairs. The null hypothesis that the average reported incomes (in proportion to actual incomes) are equal for low and high incomes can not be rejected for this case (Wilcoxon signed rank test, p =0.15, one tailed). For Treatment OptTax, there are seven groups and thus seven pairs. The null hypothesis that there is no difference between average reported incomes (in proportion to actual incomes) by low and high incomes is rejected for this treatment (Wilcoxon signed rank test, $p \le 0.5$, one tailed).

Figure 3: Average reported income (in proportion to actual income) for each period in Treatment ExcessiveTax

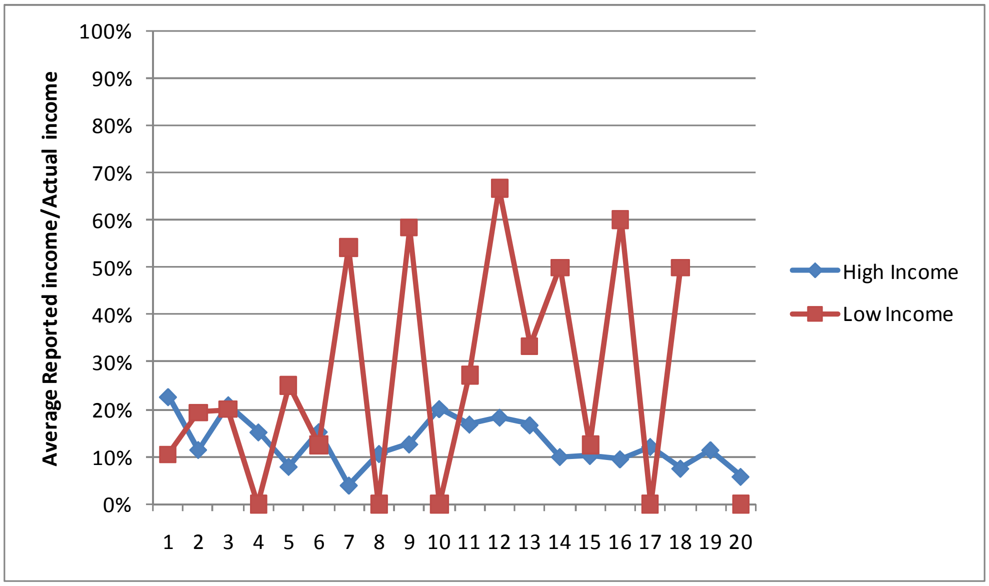
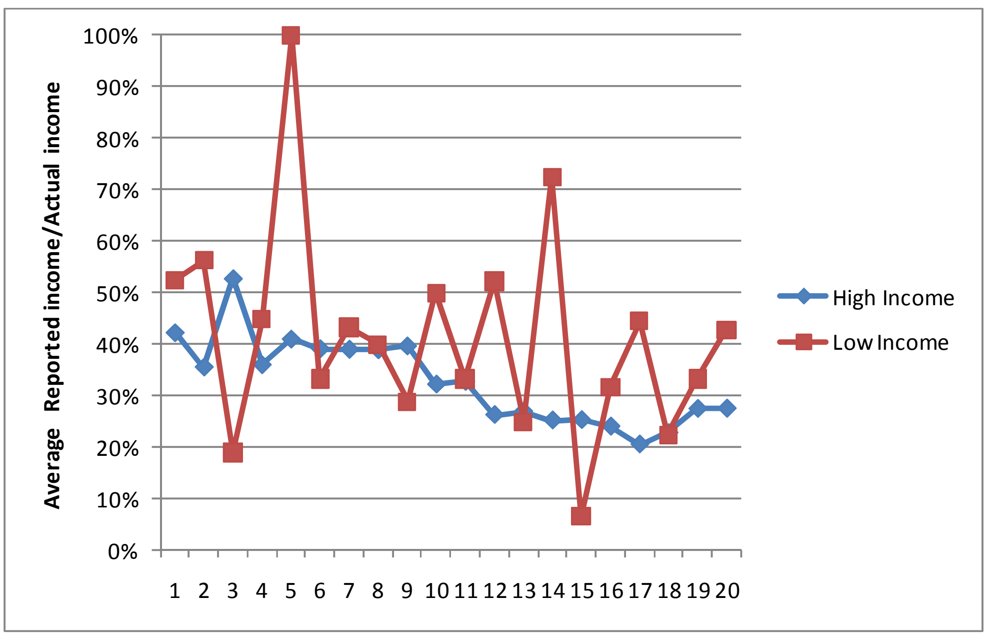


Figure 4: Average reported income (in proportion to actual income) for each period in Treatment OptTax



Conclusion

We analyze two questions about bribery. The first question is whether there are more bribes in a situation with excessive taxes than in a situation with optimal taxes. The second question is whether the existence of bribes improves efficiency when there is excessive regulation.

Our experimental results provide affirmative answer to the first question. We compare the amounts of bribes paid in two different treatments. Subjects pay more bribes in the treatment with excessive taxes than in the treatment with optimal taxes. However, the difference decreases significantly as more periods are played.

The experimental results regarding the second question are negative. We, first, show that subjects fail to use bribes to attain the social optimum. Second, the resulting efficiency levels in the treatment with excessive taxes and bribes are lower than in the theoretical benchmark with excessive taxes and no bribes. This result means that the existence of bribes when there is excessive regulation does not increase efficiency.

We have to mention that our second result also depends on the parameter choice. For example, it is possible to construct parametric examples in which there is so much excessive taxation that contributions close to free riding by paying bribes lead to higher efficiency levels than those achieved with no bribes and full compliance. In other words, no taxation can be better than over taxation. However, we intentionally construct an experiment where this is not the case. We wanted to see whether players can intentionally limit the use of bribes to improve social efficiency.

In sum, the results suggest that it might be better to have an inefficient system with no bribes than an inefficient system with bribes. Similar reasoning can be extended to cumbersome bureaucracies. While bribes allow one to circumvent excessive bureaucracy, they also create an opportunity to bypass "efficient" bureaucracy and free ride on others.

Appendix

Unfortunately, there was a programming error. Below, we first explain the error and then how it affected the behavior by subjects. We do not provide any formal tests but rather check if there was a significant change in the behavior of subjects who could have realized that there was an error.

After all subjects were taxed and fined, for several subjects the fined amount was not invested in the common project. These happened in 21 out of 1048 cases. Only in 13 out 21 cases subjects could have realized that there was a mistake. One case happened in the last period and can be ignored. Two cases happened in the trial period. They do not count towards earnings; however, they could have affected the way subjects played in later periods. In total 9 subjects could have realized the error. We next show how these subjects played after the error occurred. It is important to note that none of the nine subjects complained about the error.

Below, we present individual reported incomes as part of actual income for 9 subjects affected by the error and who could have possibly realized that there was an error. There were 4 subjects in the first treatment and 5 subjects in the second treatment.

Figure 1A: Reported incomes by subjects in Treatment ExcessiveTax who, possibly, realized the error in the program

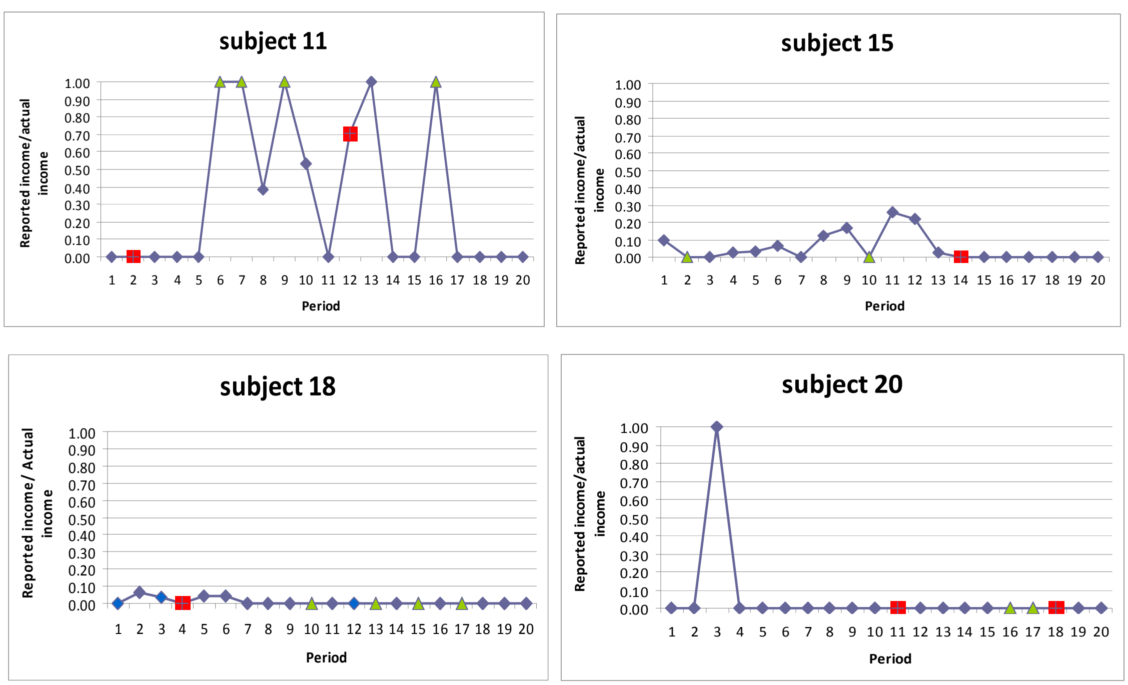
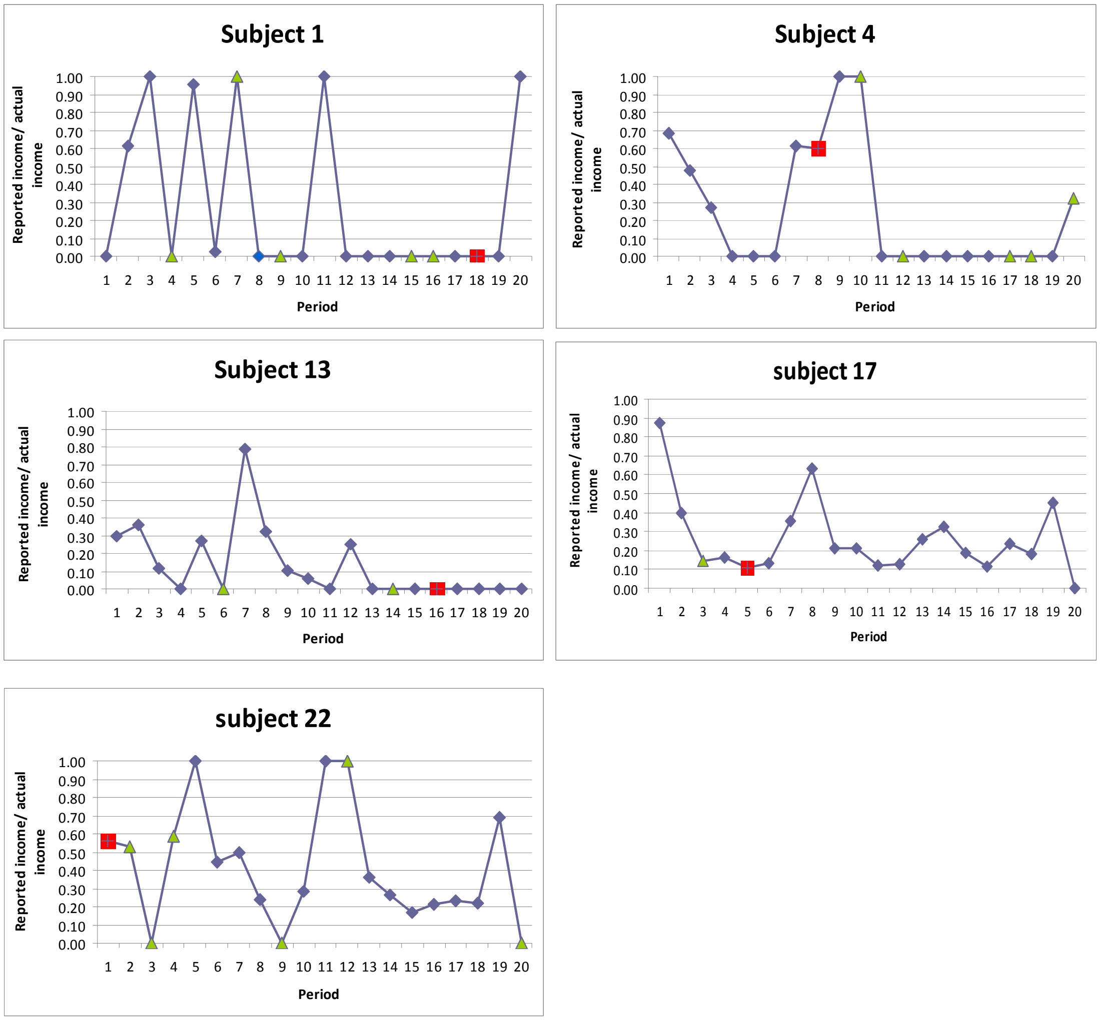


Figure 2A: Reported incomes by subjects in Treatment OptTax who, possibly, realized an error in the program



Red square data points denote when the error occurred for respective subject. Green triangular data points denote cases when actual incomes were below 20 points. Incorporating green data points is actually very important. Subjects received very small endowments and we suspect that their behavior can be different in these cases compared to those where they received larger endowments

For subject 18 in the first treatment and subject 22 in the second treatment it is impossible to tell anything. The error occurred in the trial period and we do not know what could have happened if there was no error. For other cases it seems that there was no significant change in the behavior of subjects after the error occurred. At least, we do not observe changes in how the game was played after the error occurred.

There could me a more subtle problem arising from the error. In fact subjects saw less money accumulated in the common project than it had to be. This could affect their behavior indirectly. For example, seeing that there is little money accumulated in a common project can make one contribute little money due to reciprocity. To see whether this was a problem we present the amounts not shown to subjects:

Table 1A: The sum of amounts not added to the common project due to the error vs. total amounts collected in the common project

Treatment ExcessiveTax						Treatment OptTax					
	Maximum amount that could be invested (X)	Total tax and fine collected shown to subjects (Y)	Amount not shown to subjects (Z)	Z/Y (%)	Z/X (%)		Maximum amount that could be invested (X)	Total tax and fine collected shown to subjects (Y)	Amount not shown to subjects	Z/Y (%)	Z/X (%)
Group 1	1538	918	2	0%	0%	Group 1	2371	472	115	24%	5%
Group 2	1470	281	0	0%	0%	Group 2	2371	970	12	1%	1%
Group 3	1534	291	35	12%	2%	Group 3	2365	1171	54	5%	2%
Group 4	1652	127	62	49%	4%	Group 4	2650	212	2	1%	0%
Group 5	1613	143	45	31%	3%	Group 5	2435	1331	81	6%	3%
						Group 6	2245	726	0	0%	0%
						Group 7	2276	739	0	0%	0%

From the table we can ignore Group 1 and Group 2 from Treatment ExcessiveTax and Group 2, Group 4, Group 6 and Group 7 from Treatment OptTax as the amounts not shown to subjects were very small. It leaves out three groups in each treatment that could be problematic. Below we analyze these cases more closely looking at the periods when the errors occurred and the dynamics of taxes and fines collected after the error occurred.

In the figures below blue data points show how much tax and fine were actually collected in each period for each of the problematic groups. The amounts collected are shown in proportion to the upper bound for that period. Red data points, on the other hand, indicate what these amounts had to be if there was no error in the program. From the Figures below we conclude that for 5 groups out of 6 the effect of the error is likely to be very small. On the other hand, for Group 4 in Treatment ExcessiveTax it is not clear. It might be that had the error not occurred the contributions would not go to zero so early. However, even if it is really the case, the taxes and fines collected in the earlier periods suggest that the contributions should not be too high had the error not occurred.

Figure 2A: Actual taxes and fines collected vs. what they had to be if there was no error (Treatment ExcessiveTax)

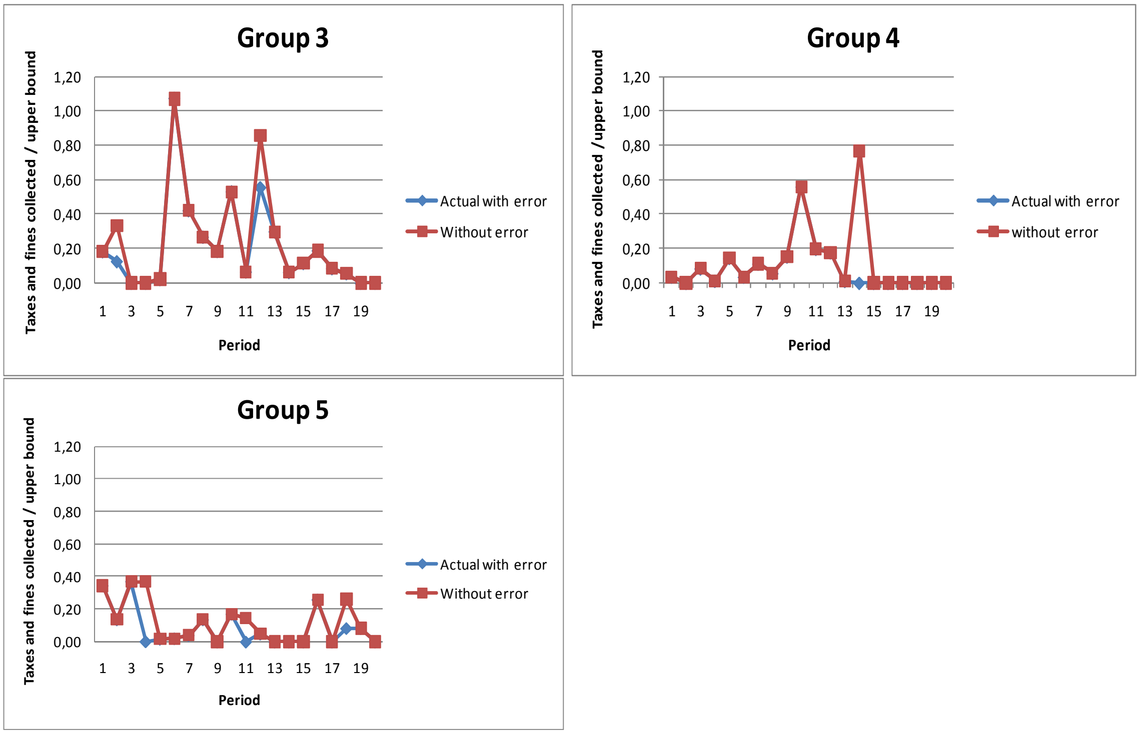
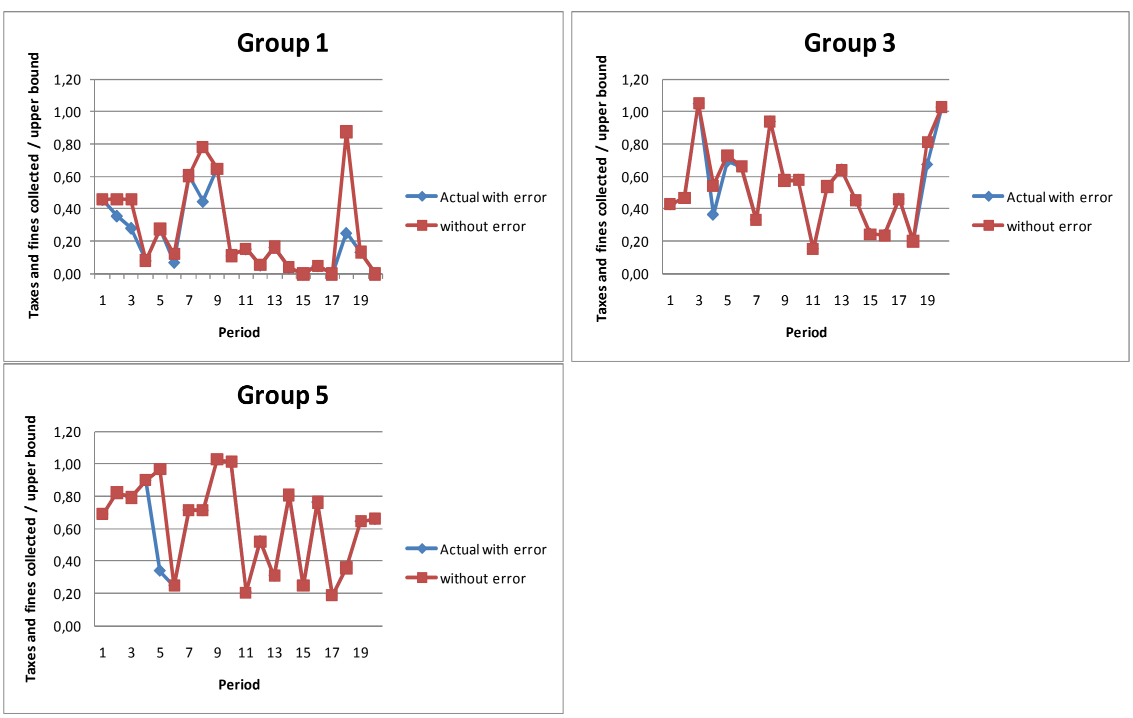


Figure 3A: Actual taxes and fines collected vs. what they had to be if there was no error (Treatment OptTax)



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