A Behavioral Laffer Curve: Emergence of a Social Norm of Fairness in a Real Effort Experiment

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Abstract

This paper demonstrates, through a controlled experiment, that the "Laffer curve" phenomenon does not always reflect a conventional income - leisure trade-off. Whether out of reason or out of emotion, taxpayers may also be willing to punish intentionally unfair tax setters by working less than they would under the same exogenous circumstances. We conduct a real effort experiment in which a player A (the "tax receiver") is matched with a player B (the "worker") to elicit the conditions under which tax revenues will increase under a certain threshold and decrease thereafter. We ran four different treatments by manipulating work opportunities and the power to tax. Consistent with the history of tax revolts, the working partner overreacts to the perceived unfairness of taxation when the tax rate exceeds 50%, most strongly so in the high effort treatment. With two types of players, selfish and empathic, our model predicts the emergence of a social norm of fairness under asymmetric information, and elicits the optimal and emotional patterns of punishments and rewards consistent with the norm's enforcement. The social norm allows players to coordinate tacitly on a "focal equilibrium", which offers a solution to the indeterminacy raised by the Folk theorem for infinitely-repeated games and a behavioral justification for the tit-for-tat strategy. The social norm of fairness enhances productive efficiency in the long run.

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1. Introduction

The quest for American independence grew as issues like taxation without representation in the British government angered the local population of the former British colonies. When the British decided to tax the colonists to pay a share of their expensive war against the French and Indians, the colonists were angry and rallied behind the phrase, "No Taxation without Representation". The British were then forced to remove (1764-1767) most of the unfair taxes (tax on sugar, Stamp Act, Townsend Act) that they had been trying to enforce unilaterally. Two centuries later, the same scenario repeated in California as property taxes went out of control. Taxpayers were losing their home because they could not pay their property taxes, yet the government maintained the burden. California taxpayers stood up and passed Proposition 13 (1978) that reduced property taxes by about 57%. The tax revolt that swept the country had a worldwide impact.

Since then, tax revolts have been closely associated with the name of Arthur Laffer who forcefully defended as a simple rule of public finance that there is a unique optimal tax rate which maximizes revenue collection. If the tax level is set below this level, raising taxes (more specifically, marginal tax rates) will increase tax revenue. However, if the tax level is set above this level, then raising taxes will decrease tax revenue. This proposition, now called the "Laffer curve", had considerable influence on fiscal doctrine, and fuelled the "supply side economics" argument that a tax cut would actually increase tax revenue if the government is operating on the *right* side of the curve. [1]

The Laffer curve was based on conventional economic analysis: tax revenues are obviously zero if the tax rate is zero, and are still zero if the tax rate is equal to one, as rational agents would withdraw from the market to evade tax or consume untaxed leisure.[2] However, our paper demonstrates that the Laffer curve phenomenon does not always

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reflect a conventional income - leisure trade-off. Consistent with the history of tax revolts, we demonstrate the existence of a "behavioral Laffer curve" that will arise as a reaction to the perceived unfairness of taxation by a Leviathan government. Whether out of reason or out of emotion, taxpayers are willing to "punish" tax setters who *intentionally* violated the social norm of fair taxation by working less than they would under the same exogenous circumstances. We further point out that the behavioral Laffer curve peaks at a substantially lower tax rate than the conventional Laffer curve.

Natural experiments have been widely used for assessing the impact of a tax policy change on taxable income (e.g. Lindsey 1987, Feldstein 1995, Goldsbee 1999, Sillamaa and Veal 2000, Gruber and Saez 2002).[3] However, it is not possible to confirm, by means of a natural experiment, the role played by intentional over taxation of productive workers in tax revolts because intentions are unobservable. Laboratory experimentation in real effort is a more appropriate tool for eliciting the behavioral Laffer curve. Earlier experiments by Swenson (1988), Sillamaa (1999a) and Sutter and Weck Hannemann (2003) studied the effect of tax rates on work effort. In Swenson's experiment, subjects were confronted with discrete tax rates chosen by the computer and were asked to perform a number of real tasks. Swenson (1988) found a negative substitution effect with subjects decreasing their effort when the tax rate increases. Sillamaa (1999a) replicated Swenson's results. Sutter and Weck-Hannemann (2003) considered the effect of an endogenous variation of the tax rate on labor supply and brought evidence of a Laffer curve with tax revenues peaking at tax rates between 50% and 65%.

In our experiment, participants are paired. In each pair, one randomly selected participant is asked to choose and exert a *real* effort, and the resulting output is taxed to the benefit of her partner. The working subjects are confronted with a set of four different flat tax rates (12%, 28%, 50% or 79%) and are asked to choose and perform a discrete number of real

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tasks conditional on the tax rate imposed on them. We ran four different treatments depending on work opportunities (a ceiling of 26 or 52 tasks allowed to the worker) and on the power to tax effectively given to the worker's partner. In the *exogenous treatment*, the computer randomly selects the tax rate and the non-working partner merely receives the revenue from taxes. In the *endogenous treatment*, the non-working partner chooses a tax rate among the set of possibilities and receives the revenue generated by the worker's effort response to this tax rate.

Our study brings several important innovations to previous experiments. First, it provides a comparison of the endogenous and exogenous treatments that allows capturing the potential emotional reaction to unfair taxation.[4] Second, we introduce two treatments for work opportunities, which allows us to show that workers' response to unfair taxation critically depends upon work opportunities and the intensity of emotional arousal (Bosman and Van Winden 2002).[5] Finally, by repeating the experiment among partners for an indefinite number of periods, we come closer to historical conditions and we can observe the emergence of a social norm of fair taxation enforced by effective punishment of violators. Although indefinite repetition of the game leads to a multiplicity of potential Nash equilibria, we propose a novel theory of pre-play intentions of players, which generates a social norm of fair taxation under asymmetric information with heterogeneous players. The social norm allows players to coordinate tacitly on a "focal equilibrium", which offers a solution to the indeterminacy raised by the Folk theorem for infinitely-repeated games.

To anticipate the results, we do not report the existence of a Laffer curve phenomenon in the observed range of tax rates when the latter are randomly imposed on a working taxpayer. However, we observe it unambiguously in a Leviathan state condition (endogenous treatment) in which an experimental tax setter in flesh and blood is given the

power to maximize tax revenues to his own benefit. Tax revenues are then maximized at a 50% tax rate beyond which they decline, notably so for treatments with high work opportunities.

The remainder of the paper is organized as follows. Our experimental design is presented in more detail in section 2. Theoretical predictions concerning the experiment are presented in section 3. The experimental evidence on the behavioral Laffer curve is examined in section 4. Existence of a behavioral Laffer curve raises the question of the efficiency of discretionary taxation by a government. This question is discussed in section 5. Finally, we draw the implications of our analysis for fiscal policy in section 6.

2. Experimental Design

At the beginning of the experiment, the participants are paired and the role played by each subject as a tax receiver (subject A) or as a taxpayer (subject B) is randomly chosen. The same roles and matching are maintained during all the experiment. The experiment consists of 18 periods. In each period, subjects B produce an effort by performing a computerized work task, which consists of decoding a number from a grid of letters that appears on the computer screen. There was a different grid of letters and a different decoding number for each period.

In the *endogenous* treatment, subject A, the tax receiver, first chooses the tax rate that she wants to impose on the number of tasks completed by B among a set of four possibilities: 12, 28, 50 and 79%.[6] Then, B responds to the tax rate by choosing the number of tasks that she wants to complete. Once a tax rate has been chosen, it applies to three consecutive work periods, but B-players may vary the number of tasks they wish to solve in every single period. We adopted this procedure from previous studies for two reasons. First,

keeping the same tax rate during three periods reduces errors, according to Swenson (1988). Second, since emotional responses to tax rates are expected to be higher in the first than in the two remaining periods, observing a persistence of emotional reactions provides a robust test of emotional reactions to tax rates. Once B has decided how many tasks she wishes to perform, a first number appears, and B fills in the letter that ought to correspond to this number. Correct answers only are remunerated and taxed. The first period is completed when the last task from the number chosen by B is achieved.[7] The *exogenous* treatment is identical to the *endogenous* treatment except that the tax receiver A has no power to set the tax rate, which is randomly chosen by the computer among the same set of four possibilities that was used in the endogenous treatment.[8] While B is working, A is supplied with magazines and computer games to keep her waiting until the end of the session. B is aware that a randomly determined share of her own earnings will be transferred to a passive partner and she must decide how many tasks she wants to perform.[9] In the exogenous treatment, there is no room for either non-strategic behavior (intentions) or strategic behavior of players, while both types of behavior may be present in the endogenous treatment.[10]

For both the endogenous and exogenous conditions, we design two additional treatments, which differ by the work ceilings of subjects B, i.e. the maximum number of tasks that they are allowed to perform in each period. Work opportunities are limited to 26 tasks in the "low effort treatment", and to 52 tasks in the "high effort treatment". We have reasons to believe that the intensity of workers' reaction to tax rates depends on work opportunities. Increasing possibilities for work and degrees of freedom (e.g., self-employed workers), will offer greater opportunities to vary the work effort in response to changes in tax rates. Moreover, the emotional answer to a change in tax rate is likely to be higher when work effort increases.

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The monetary gains of both A and B are proportional to the number of correct tasks performed by Bs, with A capturing the wage tax and B getting the after-tax income. The marginal return for a correct task takes the constant value of 100 ECU (experimental currency units). In Table 1, we summarize the four treatments of the experiment:

[Table 1: about here]

Each experimental session is constituted of 18 periods of the game. To allow Bs to trade-off work and leisure, subjects were not told how many repetitions of the game they would have to play. Since the length of each period varies according to the number of tasks chosen by B, all pairs of players did not necessarily end the experiment at the same time.

The experimental sessions were run at the Lub3CE-CIRANO laboratory in Montreal. In the lab, curtains isolated participants in their respective computer booth. The experiment was computerized using the REGATE program developed by Zeiliger.[11] Two hundred and eight participants were recruited for this experiment. Most subjects were students. No subject had participated to previous experiments of a similar type. Once the 18 periods of play were over for a pair of players, both participants were able to leave the lab and were paid privately. On average, a session lasted two hours, including initial instructions and payment of subjects, and a subject earned on average Can $ 35 including the show-up fee.

3. Theoretical predictions

3.1. Benchmark predictions

The game studied here is a repeated two-player sequential move game that consists of two stages. In the endogenous treatment, the first player A (the "tax setter") has the power to set the "tax rate" $t \in [0,1]$ levied on all units of output that the second player B

(the "worker") wishes to produce in the second stage of the game. The tax setter can be viewed as a Leviathan state capturing a share of incomes earned by the second player through taxes. The worker's effort or "work" $e \in [0,\theta]$ is measured in efficiency units and equated with output. For convenience, work and tax rates are treated as continuous variables. The worker derives instantaneous utility from her "wage" $(1-t)e$, and disutility from work effort e. We define $C(e)$ as the net disutility of work and reduction of leisure time and assume for exposition that utility is additive in wage and work[12]

$$W = (1-t)e - C(e) \quad (C' > 0, C'' > 0) \tag{1}$$

The tax setter picks up the revenues from the tax conditional on the worker's effort

$$R = te \tag{2}$$

In a one shot game, the Nash equilibrium is derived by backward induction. The labor supply response to linear wage taxation is determined by maximization of the worker's utility (1). For an interior optimum, it is the solution of

$$(1-t) - C'(e) = 0, \tag{3}$$

which we write

$$e* = g(t). \tag{4}$$

The worker's response to taxation would then be the same, for a given tax rate, whether tax rates were set intentionally or randomly. The revenue function $R \equiv tg(t)$ defines the conventional Laffer curve. It reaches a maximum at the "efficiency tax rate", that a rational tax setter would choose in a one-shot game conditional on the worker's effort function (4). However, since the end of the game is not specified in our experimental design, endogenous treatments of our game are better described as an infinitely-repeated game with discount factor equal to the subjective probability of continuing the game after each period.[13] If the discount factor is close enough to one, the Folk theorem applies and many

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Nash equilibria can hold in the endogenous treatments. Workers should be willing to enforce some cooperation with their partner by agreeing upon a normal tax rate that will ensure them a higher outcome than the efficiency tax and by punishing deviations from the "social norm". Our experimental setting elicits the selected equilibrium and Laffer curve and, therefore, allows us to test whether partners exhibited increased cooperation in the endogenous treatments.

3.2. A focal Nash equilibrium in the repeated game

3.2.1. Emergence of a social norm of fairness:

There is a vast literature on the role of social norms in the making of tax compliance and avoidance (Kirchler 2007). In the remainder of this sub-section, we present a simple theory of the emergence of a social norm of fairness in the repeated power to tax game among partners. Let us suppose the existence of *two subject types: the selfish and the empathic*. Selfish tax setters maximize their own tax revenue as a Leviathan government would and selfish workers maximize their net earnings conditional on the tax rate. Thus, selfish tax setters choose the efficient tax rate determined in sub-section 3.1. In contrast, empathic tax setters are endowed with a "social preference" that they maximize. More precisely, following Lévy-Garboua et al (2006: sections 5-6), we assume that empathic tax setters are able to take the perspective of others like a rational impartial judge who would have to decide an allocation (*t*,*e*) among partners (*A*, *B*).[14] Under these assumptions, empathic tax setters imagine themselves either in the A state or in the B state with equal probability and project their own characteristics (initial wealth, VNM utility function, cost of effort) onto their unknown, but similar, partner. They maximize the following state-dependent expected utility[15]:

$$Max_{t,e} EU(t,e) = \frac{1}{2}U(w+te) + \frac{1}{2}\left[U(w+(1-t)e)-C(e)\right] \qquad ,(U' > 0, U'' < 0)$$
$$s.t. \quad 0 \leq t \leq 1, 0 \leq e \leq \theta \tag{5}$$

The solution of this program provides the following lemma:

Lemma 1:

The preferred tax rate is 50% for all risk-averse empathic players. This social preference is invariant to work opportunities θ and independent from relevant individual characteristics (initial wealth, risk aversion, cost of effort). It is common knowledge.

Proof: See Mathematical Appendix 1.

Lemma 1 ensures that rational players are aware of pre-play intentions of their empathic partners and can tacitly coordinate their own decisions. Thus, a 50% tax rate can serve as a *group norm* for empathic risk-averse players.[16]

Proposition 1:

If the existence of two types (selfish and empathic) is common knowledge but individual types are not observable by tax setters, a 50% tax rate is recognized as a social norm that rational workers of all types wish to enforce on tax setters.

This proposition claims the existence of a *social norm* of fairness under asymmetric information about types. It is a direct consequence of lemma 1. Workers begin to play with a normative expectation for the tax rate which depends on their type. Empathic workers expect a 50% tax rate while selfish workers expect a 79% tax rate. However, once roles have been assigned to players, designated tax setters are no longer committed to respect their pre-play preference and they have an incentive to opt for a 79% tax rate since tax revenues keep on rising in the observed range if workers comply with the tax rate[17]. Such tax rate would fit the normative expectation of selfish workers and cause dissatisfaction to empathic players. However, even selfish (or risk-loving) workers would stand to gain from lower taxation. Therefore, those workers whose normative expectation exceeds one-half

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would benefit from exploiting the *informational asymmetry on type* and pretend that they, too, expected a 50% tax rate. Consequently, all workers would want to enforce the *social norm* of a 50% tax rate, whether the latter does truly reflect their idiosyncratic normative expectation or not.

3.2.2 The optimal enforcement of the social norm of fair taxation:

Reaching permanently the social norm of fair taxation can be seen as a socially desirable objective and a focal equilibrium as it looks like a second-best efficiency equilibrium which would meet a broad consensus within society. The social norm of fair taxation can be enforced in the repeated game through the punishment of norm violators and possibly through the reward of "kind" tax setters who impose low tax rates. In our experimental setting, punishment of norm violators (reward of kind tax setters) remains implicit and consists of a voluntary reduction (increase) of effort. It will be shown in this sub-section and the following that the enforcement of the social norm generates a "behavioral Laffer curve" which peaks at the normal 50% tax rate, far below the conventional revenue-maximizing rate. All proofs are relegated in mathematical appendix 2 (notations in 2.1).

Let us define incentive-compatible punishment (reward) as a sanction ensuring that the norm's violator is no better-off after getting punished (no worse-off after being rewarded) than he would have been by always respecting the social norm. Incentive-compatibility constraints and a rationality constraint -ensuring that the discounted expected net returns from the sanction are non negative- are required to enforce the social norm of fair taxation in the repeated game.

Incentive-compatible punishments force the rational tax setter to respect the norm in the future as long as they do not violate the worker's rationality constraint (see proof in

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appendices 2.2 and 2.3). A sufficient condition for enforcement of the social norm and convergence to a focal equilibrium of fair taxation is to have an infinitely repeated game with a discount rate sufficiently low. The same conclusion would hold in a finitely-repeated game if the number of remaining repetitions were sufficiently high. However, in coming close to the end of the game, incentive-compatible punishments would no longer be feasible and the social norm of fair taxation would eventually cease to be enforced. A similar analysis can be made to characterize the optimal reward. However, the optimal outcomes are not symmetric for rewards and punishments. While it is no more rational for a tax setter to set the tax rate below the norm than above the norm, punishments are needed to bring unkind deviators back to the norm but workers must refrain from rewarding kind tax setters in order to reach the same goal. (See appendices 2.4 and 2.5). The main results are summarized by proposition 2:

Proposition 2 (optimal punishments and rewards of social norm's violations and the behavioral Laffer curve)**:**

Assume that the conventional Laffer curve peaks above the normal rate. However, if the game is infinitely repeated (or repeated many times ahead), the social norm of fair taxation can be enforced through incentive-compatible punishments when the worker's discount rate is sufficiently low. The optimal punishment of above-normal taxation exactly offsets supernormal tax revenues. The optimal reward of below-normal taxation is zero.

A behavioral Laffer curve prevails in weak form, which peaks at the 50% tax rate and remains flat beyond this threshold.

Proof: see Mathematical Appendix 2.

The behavioral Laffer curve in weak form is generated by the asymmetry between the second-best optimal punishments and rewards consistent with fairness. Optimal punishments appear to be "equitable" according to the definition of Adams (1963) but

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optimal rewards turn out to be zero (also see Akerlof and Yellen 1990). While no-punishment and no-reward would have generated an increasing schedule for tax revenues, and while both equitable punishment and reward would have generated a constant schedule, equitable punishment and no-reward generates a behavioral Laffer curve which peaks at the normal tax rate and stays flat thereafter.

3. 3. Emotional enforcement of the social norm of fairness

By measuring emotions felt by the participants to a power-to-take game, Bosman and Van Winden (2002) found that specific emotions were activated by the other player's behavior in proportion to her move in the game and the activated emotional level in turn activated an appropriate response. Emotional responses, though, are not inconsistent with fully rational or cognitive behavior (Damasio 1994). However, we further postulate that, under a *strong* feeling of unfair treatment, the cognitive process is loaded and inhibited, so that workers stay hooked on their prior normative preference for a fair tax. Then, they cease to be fully rational and become emotional (See Kaufman 1999 who develops a similar interpretation of bounded rationality and relates the inhibiting effect of strong emotions to the Yerkes-Dodson law in psychology). Hurting norm violators is the way to burn the latter's illegitimate profits,[18] and, conversely, gift-giving is the way to thank them for their disinterested kindness. Such affective behavior contributes to enforcement of the social norm of fair taxation, even though strongly emotional responses are not best responses to deviations from the norm. Presumably, a fraction of workers will have a strong emotional response to norm violations and this fraction will increase with the distance to the social norm. There is no reason to believe that strong positive emotions have any greater or smaller effects than strong negative emotions. Hence, since emotional effects are "unbiased" and optimal sanctions are biased toward punishment (proposition 2),

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a behavioral Laffer curve will be observed in strong form in the aggregate, first increasing until the 50% tax rate and declining thereafter.

Proposition 3 (the behavioral Laffer curve when some taxpayers are emotional)**:**

Keeping the assumptions of proposition 2, it is further hypothesized that some workers adopt a strong emotional response to norm violations. Then, if emotional responses are unbiased, a behavioral Laffer curve exists in strong form, such that the tax revenue peaks at a 50% tax rate and strictly declines thereafter.

Optimal punishments and rewards generate a behavioral Laffer curve *in weak form* which peaks at the normal tax rate and remains flat thereafter. Emotional punishments and rewards are needed to generate a behavioral Laffer curve *in strong form* that culminates and falls after the peak. Thus, our simple game reveals a rich (2x2) set of behavioral responses to taxation: (punishment/reward)x(cognitive/strongly emotional). The main theoretical findings can be summarized by the following "reciprocity matrix":

Reciprocity matrix

	Punishment of unfair (above norm) **taxation**	**Reward of kind** (below norm) **taxation**
Cognitive (fully rational)	Equitable	No reward
Strongly emotional (boundedly rational)	Hurtful	Gift exchange

4. Experimental evidence on the behavioral Laffer curve

4.1 Tax revenues and Laffer curves

Figures 1a and 1b show the variation of tax revenue with tax rates in the exogenous and endogenous treatments for 26 and 52 tasks respectively. Under the exogenous treatments, tax revenue increases steadily for discrete variation of the tax rate in the two effort conditions. The conventional Laffer curve that we observe does not peak in the [12%, 79%] range.[19] However, under the endogenous treatments, tax revenue increases up to the 50% tax rate and decreases thereafter, most visibly so in the high effort treatment. Thus, we obtain a behavioral Laffer curve and confirm the experimental findings of Sutter and Weck-Hannemann (2003) in this respect.[20]

Turning next to the comparison between the endogenous and exogenous treatments, mean tests (unpaired and assuming unequal variances) show in the low-effort condition a small but statistically significant difference favoring the endogenous treatment for the 28%-tax rate [21], no significant difference for the 50% tax rate, and an effect in the opposite direction for the 79% tax rate. This last difference is significant for the 26-task specification (p<0.02) and borderline for the 52 task-specification. [22] These results support the assumption of a social norm at the 50% tax rate in the endogenous condition whereby workers punish endogenous tax rates above the norm and reward endogenous tax rates below the norm.

[Figures 1a and 1b: about here]

In order to characterize the Laffer curve more precisely, we also ran a two-limit Tobit regression on tax revenues as a function of tax rate dummies for the four treatments.[23] In table 2, for the endogenous treatments, the behavioral Laffer curve appears in a weak form in the low effort treatment (26 tasks) as tax revenue remains approximately constant once the peak has been reached; while it emerges in a strong form in the high effort treatment

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(52 tasks) since tax revenue then falls to non-significant values both below and above the peak. These results are consistent with propositions 2 and 3. Both the focal equilibrium of fair taxation and the role of emotional intensity for explaining the shape of the Laffer curve receive good confirmation from the experimental data.

Coefficients exhibited in table 2 are then converted into elasticity values of tax revenue for various tax rates. The computed elasticity values reported in table 3 are always positive and fairly constant if tax rates are set randomly. They are consistent with the taxable income elasticity of 0.4 that Carroll and Hrung (2005) view as typical for higher-income taxpayers in the recent literature. The picture is totally different if tax rates are set intentionally. Then, the elasticity of tax revenue is positive at lower-than-fifty percent tax rates and turns suddenly null or negative above this threshold. A strongly negative elasticity obtains in the high effort treatment.

[Tables 2 and 3: about here]

4.2. The dynamical response of workers to changes in tax rates

We showed in the theoretical section that the behavioral Laffer curve was generated by the dynamical response of workers to changes in tax rates when all players share the social norm of fairness. Thus we present experimental evidence on the dynamical response of workers to changes in tax rates in figures 2a and 2b, carefully distinguishing the endogenous and the exogenous treatment.

[Figures 2a and 2b: about here]

Figures 2a and 2b elicit the tax responsiveness of work by measuring how the first difference in work responds to the first difference in tax rates. The horizontal axis measures the change

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in tax rate from period *t* to period *t*+1. For example, the number +16 on the horizontal axis of the graph indicates a rise from 12% to 28% in the tax rate between period t and t+1. The vertical axis measures the average change in effort from period t to t+1. The numbers above the bars represent samples' sizes. We observe that about two-thirds of tax setters did not change their preferred tax rate from one period to the next. Given convergence to the social norm (see 5.1), this is further evidence of the equilibrium nature of social norm compliance in this game discussed in the theoretical section. However, whenever tax changes can be observed, they always trigger-off work responses in the same direction.

Figures 2a and 2b also allow direct comparison of tax responsiveness of work whether tax changes were intentional or not. The observed gap between the mean responses in the two treatments measures the amount of punishment and reward. Tax responsiveness should remain unaffected by the intentionality of tax changes if workers complied with any tax rate and always followed their conventional labor supply curve. However, workers systematically overreacted when tax changes had been decided by a tax setter in flesh and blood. The difference of responses for a given tax change between the two treatments is often large, and increasing in the magnitude of tax changes and of work opportunities. Such results on the punishment and reward of tax setters are similar to those obtained in linear public goods games in which the players can observe and sanction low contributions of other players at a small cost.[24]

We can add precision to these findings by running OLS regressions of the first difference in work against the first difference in tax rates.[25] Results for the four treatments are reported in table 4. The coefficient of tax changes in the first row measures the sensitivity of work to a tax on wages. The interaction of ¨tax rate changes¨ with the ¨the worker's productivity level" controls for variations in the relative magnitude of substitution and income effects with productivity level.[26] In addition to tax changes, we added an interaction term of the latter

with a dummy variable taking value one if tax rates had increased and zero otherwise to test the symmetry of reactions to positive and negative changes. The stronger reaction of medium and high productivity subjects to changes in tax rates indicates that substitution effects dominate income effects in our experiment. This result points out at a potential selectivity bias of experimental settings that use monetary incentives since participants are volunteers who mainly apply for money. The regressions demonstrate that an increase and an equal decrease in tax rates produce symmetrical effects since the interaction term is never significant. This rules out any path dependency for the labor supply and Laffer curves. The regressions also confirm that tax responsiveness is strongly increasing in work opportunities, which is consistent with the fact that highest-income individuals are particularly sensitive to tax changes (e.g., Kleven and Kreiner 2006). Furthermore, tax responsiveness seems to be exacerbated by the possibility to identify the tax receiver with a person in flesh and blood who intentionally set the rate of transfer to his exclusive benefit.

[Table 4 about here]

5. On the efficiency of discretionary taxation

5.1. Choosing the tax rate

The Laffer curve phenomenon emphasizes the inefficiency of unfair taxation since excessive taxation will drastically reduce the incomes of the tax setter as well as the worker. However, many tax setters would like to stay away from above-normal taxation in order to maximize their social utility, and all tax setters would end up choosing the normal rate at equilibrium. This is shown by figures 3 and 4. Figure 3 reports the choice frequencies for tax rates in our endogenous treatments. A majority of subjects shared income in two halves with a non-negligible number who chose the 79% tax rate. Very similar patterns of choice can be observed in figure 3 for the low effort treatment (endo26)

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and the high effort treatment (endo52). According to a Mann-Whitney test, there are no significant differences between the two treatments. Very few opted for tax rates lower than 50%!

[Figure 3: about here]

The choice of tax rates offers a different picture in the first round as shown by figure 4. If we interpret choices of tax setters in the first game to reflect their pre-play intentions, before they could experience the worker's response to their own move, it is clear that a number of tax setters, particularly in the high effort treatment, intended to impose the highest tax rate. However, the comparison of figures 3 and 4 shows that they soon complied with a "social norm" of equal sharing of income that emerged in subsequent games.[27] It seems that workers wished and succeeded to enforce a 50% "social norm" on tax setters by punishing norm violators efficiently.

[Figure 4: about here]

Hence, discretionary taxation does not appear to be systematically inefficient. One way to see this on the data is to compare the mean revenues accruing from discretionary taxation with those accruing from random taxation. The first emerging picture is that tax setters are efficient in increasing tax revenues to their own benefit. The average tax revenue slightly increases from 848.58 ECU in the exogenous treatment to 993.91 ECU in the endogenous treatment for the 26-task condition (Mann-Whitney test; $p = 0.071$). It increases more markedly from 1363.24 ECU in the exogenous treatment to 1711.97 ECU in the endogenous treatment under the 52-task condition ($p = 0.011$). Not surprisingly, higher incentives lead to a greater efficiency in taxation for the tax setters.

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5.2. Workers' behavior and the social efficiency of discretionary taxation

Now, discretionary tax setting might be efficient for tax setters but socially inefficient. The way to look at productive efficiency is to measure the sum of money payoffs accruing to both players, which is proportional to the total number of correct[28] tasks performed by players B.[29]

Figures 5a and 5b show the average work by tax rate for both endogenous and exogenous treatments. Figure 5a is concerned with the low effort treatment while figure 5b replicates the results for the high effort treatment. These figures show that the average worker reduces anyway her level of effort and output when tax rates increase. Figure 5a indicates a peak of effort at 28% tax rate for the low effort treatments, and figure 5b indicates a peak at 12% tax rate for the high effort treatments. In the exogenous treatments, effort levels are significantly higher at the 5% level, according to Wilcoxon Sign Rank tests, both under a 12% and a 28% tax rate than under a 79% tax rate. However, work reductions are even stronger in the endogenous treatments.

Two major differences emerge from closer inspection of the endogenous and exogenous treatments. First, the overall reduction of effort (when tax rates increase from 12% to 79%) is significantly larger in the endogenous treatment than in the exogenous one. It jumps from 20% to 50% in the low effort treatment and from 46% to 65% in the high effort treatment.[30] Second, while the effort decline caused by an increase in tax rates is rather linear with random tax setting, it becomes strongly non linear under discretionary tax setting with a kink at the normal tax rate. Indeed, figures 5a and 5b, and table 3, show that work elasticity remains approximately constant and small over the whole range of possible tax rates under the exogenous treatment while it falls abruptly and takes a strongly negative value above the normal tax rate under the endogenous treatment.[31]

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[Figures 5a and 5b: about here]

The higher frequency of affect-driven punishments after a norm's violation may affect the social inefficiency of discretionary taxation. Since emotional drives often take the form of all-or-nothing responses, we should observe that workers refuse to work more frequently at the highest tax rate in the endogenous treatment than in the exogenous treatment and, given the endogeneity of tax rates, they should cease work more often in the high effort condition than in the low effort condition. Indeed, no-work decisions are rare in exogenous treatments, even at the highest tax rate: only 10% for Exo52 and 2% for Exo26. They are much more common in endogenous treatments, since they reach a peak of 29% for the highest tax rate in the low effort condition and a stunning 45% in the high effort condition. In table 5, we test the robustness of this result by estimating a panel probit model in which the observed variable takes value one if the taxpayer has chosen not to work at all and zero otherwise. We are able to control for the worker's average productivity on the experimental task and for a number of characteristics of the game (dummies for the ¨first game, to catch up inexperience or pre-play intentions, and ¨two last games¨, measuring fatigue) and the player (age, gender, student participant, former participation to an experiment, and apparent risk-aversion).[32] Most of them are statistically insignificant with the exception of the period dummies. The econometric results confirm that the probability of refusing to work is substantially higher in the endogenous treatment and rises in a non-linear fashion with tax rate and cost of effort (the inverse of productivity).

[Table 5: about here]

Since tax setters appeared to be successful in raising their own revenues when they receive the power to tax (see pp.19-20), we might fear that social income will not be maximized by discretionary taxation in the endogenous treatment. To test this hypothesis, we compare

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average output/effort per period, measured by the number of correct tasks performed by workers, between the exogenous and endogenous treatments., Output declines from 21.10 tasks for Exo26 to 19.53 tasks for Endo26 (Mann Whitney test; p=.504) in the low effort condition; and from 36.62 tasks for Exo52 to 31.07 tasks for Endo52 (p=.180) in the high effort condition. However, none of these differences is significant. Looking for a stronger test, we regressed the same efficiency variable at the individual level on a treatment dummy (Endo vs Exo), tax rates for each of the six consecutive games, and a number of socio-demographic control variables. Once again, no significant variable was found (results not shown). Thus, discretionary taxation appears at least no less socially efficient than random taxation in terms of output. This is the "miracle" accomplished by the social norm of fairness: workers are willing to work hard as long as the tax rate does not exceed the normal rate. As a result, tax setters can exploit their willingness to work hard by keeping the tax rate at this relatively high level with no (or little) social loss of income.

6. Conclusion: Implications for fiscal policy and the history of tax revolts

Our experiments do not exhibit a Laffer curve in the [12%, 79%] range when tax rates are randomly imposed on a working taxpayer, but a behavioral Laffer curve phenomenon arises in a Leviathan condition in which a tax setter is given the power to maximize tax revenues to his own benefit (Brennan and Buchanan 1977, Buchanan 1979). Tax revenues are then maximized at a 50% tax rate. Since the behavioral Laffer curve peaks at substantially lower tax rates than the conventional curve, the behavioral response to unfair taxation, when present, should not be restricted to the highest income taxpayers. Our experimental findings suggest that, most of the time, fiscal changes will not produce a Laffer effect. Fiscal policies that serve macroeconomic purposes are likely to be perceived as exogenous changes by taxpayers. In order to produce a behavioral Laffer effect, fiscal

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policies need to be felt as intentional, discriminatory and especially hurtful by a group of taxpayers. The latter feel unfairly treated under such conditions, and those who feel it most strongly lose their temper and react emotionally to the breach of the implicit social norm. To be more specific, the workers who respond more emotionally to unfair taxation tend to be those endowed with higher work opportunities, and this is consistent with the history of tax revolts.

Our experiments demonstrate in a highly stylized fashion that the Laffer effect characterizes tax revolts, that is, an affective rejection of discriminatory and hurtful taxation. The Laffer curve phenomenon considerably exceeds the predictable outcome of a standard income-leisure trade-off; and it even exceeds the magnitude of cognitively rational reactions to inequity. However, our experimental revenue-maximizing tax setters at least were effectively monitored by workers and soon refrained from excessive taxation. Consequently, they caused little productive inefficiency, if any, in the long run.

An important goal of our paper has been to provide a theoretical foundation for the behavioral Laffer curve. We used simple tools to formulate prior intentions of players and endogenously generate a social norm of fair taxation at a 50% tax rate under asymmetric information about workers' type. Taxpayers manage to enforce this norm by working less whenever it has been violated but do not systematically reward kind tax setters. Workers who maximize their expected wealth adjust work to an excessive tax rate equitably so that tax revenues remain at a fair level. Remarkably, these workers conform to equity theory (Adams 1963), but only for disadvantageous inequity. Workers who respond affectively to norm violations want to hurt and even refuse to work so that tax revenues are cut down when the tax rate is felt to be excessive. The Laffer curve arises both from the asymmetry of optimal rewards and punishments and from the presence of a substantial share of strongly emotional rejections of unfair taxation.

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Mathematical Appendix

1. <u>Proof of Proposition 1</u>:
We calculate the first-order derivative of (5) with respect to t:

$$\frac{\partial EU}{\partial t} = \frac{1}{2}e[U'(w + te) - U'(w + (1-t)e)] \tag{A1}$$

We first rule out the zero effort condition since all subjects have agreed to participate to the experiment. From now on, $e \neq 0$ is assumed everywhere for work intentions. Hence, the taxation optimum under perceived homogeneity of participants is easily derived for a concave VNM utility function: $t^* = \frac{1}{2}$. Since the latter social preference is independent from relevant individual characteristics, it must be common knowledge. □

2. <u>Proof of Proposition 2</u>:

2.1 Notations:
Recalling that $g(t)$ stands for the worker's best work response to tax rate t (see eq. (4)), notations $R^n(t) \equiv tg(t)$ and $W^n(t) \equiv (1-t)g(t) - C(g(t))$ will designate "non-punishment utilities" (i.e., one-shot efficiency utility levels) of players A and B respectively. Punishment of a tax setter for choosing a "high" tax rate $t > 1/2$ is implemented immediately by the worker through work reduction $e(t) < g(t)$. It automatically reduces the tax revenue $R^p(t) = te(t)$ below $R^n(t)$, at a cost for the worker since punishment is a suboptimal response to taxation in a one-shot game ($W^p(t) \equiv (1-t)e(t) - C(e(t)) < W^n(t)$).

2.2 Incentive-compatibility constraint:
Incentive-compatible punishments impose the tighter constraint:

$$R^p(t) \leq R^n(1/2) < R^n(t) \quad , \text{if } t > \frac{1}{2}. \tag{A2}$$

Incentive-compatible punishments force the rational tax setter to respect the norm in the future as long as they do not violate the worker's rationality constraint. The proof goes as follows. In presence of a social norm, it must be common knowledge that incentive-compatible punishments in one game would be systematically repeated under the same conditions in all future games and that norm violations in one game would be systematically forgiven as soon as the social norm is being respected in a future period. Thus, punishment of unfair taxation in one period becomes a credible threat on all future periods and, after being punished once, the tax setter knows that he will maximize the discounted sum of tax revenues in the future and avoid further punishment by always choosing the normal tax rate. Conditional on norm's compliance by the tax setter after one punishment, the expected discounted utility of the worker is: $W^p(t) + \frac{1}{r}W^n(1/2)$, where r is the discount rate.

2.3 Rationality constraint:
The optimal punishment must further meet the worker's rationality constraint:

$$W^{p}(t) + \frac{1}{r} W^{n}(1/2) \geq \frac{1+r}{r} W^{n}(t) \tag{A3}$$

or

$$\frac{1}{r}\left[W^{n}(1/2) - W^{n}(t)\right] \geq W^{n}(t) - W^{p}(t).$$

This last condition states that the social norm is enforced and the optimal punishment is implemented when the latter is a profitable investment to the worker.

2.4 Optimal incentive-compatible punishment:

(A3) shows that the optimal punishment needed to enforce the social norm of fairness is the incentive-compatible punishment which maximizes worker's current utility $W^{p}(t)$ under constraint (A2). Dividing both sides of the latter inequality by t, we get: $e \leq \hat{e}(t) < g(t)$, where $\hat{e}(t) \equiv \frac{R^{n}(1/2)}{t}$. Thus the optimal effort with punishment would never exceed $\hat{e}(t)$. Furthermore, as $C'' > 0$, $\hat{e}(t) < g(t)$ implies: $C'(\hat{e}(t)) < C'(g(t)) = 1 - t$ because $g(t)$ is the non punishment equilibrium effort given by equation (3). Hence, $1 - t - C'(\hat{e}(t)) > 0$ and the optimal effort is at corner $\hat{e}(t)$. Since $t\hat{e}(t) \equiv R^{n}(1/2)$, the violator always gets the same tax revenue than by respecting the social norm of 50% tax rate and the tax revenue elasticity is just equal to zero.

2.5 Optimal reward:

So far, we haven't ruled out the possibility that the optimal tax rate be lower than 50%. This would happen if it paid a rational tax setter to be "kind" toward workers by setting the tax rate below the 50% norm. This is not the case, however.

Assume that $t < 1/2$ (the normal tax rate) and that worker B chooses an incentive-compatible reward. That is, $e(t) \geq \frac{R^{n}(1/2)}{t} \equiv \hat{e}(t)$.

(i) By the assumption that that exogenous tax revenue elasticity is positive (i.e., the conventional Laffer curve peaks at higher than normal tax rate), $tg(t) < R^{n}(1/2)$ for all $t < 1/2$. Hence, $\hat{e}(t) > g(t)$.

(ii) If $\hat{e}(t) > g(t)$, worker B chooses the minimum effort level $\hat{e}(t)$ that will reward the kind tax setter and reaches a suboptimal utility level while A gets the same tax revenue than he would obtain by respecting the social norm of 50% tax rate. Thus, B has no incentive to reward A's kindness, and, knowing this, A has no incentive to be kind either.

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NOTES

[1] Laffer (2004) does not claim credit for this idea, which had been anticipated at least by the Islamic scholar Ibn Khaldun in the 14th century, by the French economist Frédéric Bastiat in the 19th century, and by John Meynard Keynes. However, the concept was attributed to him in 1974 by a Wall Street Journal columnist.

[2] The empirical literature shows little responsiveness of labor supply to taxation. However, taxable income is much more responsive to tax changes than hours of work because there are many ways for income earners to adjust to a tax increase like reducing their effort (not hours), changing the form of their compensation, switching to less taxed activities and avoiding tax.

[3] For example, the marginal tax rate on the highest-income individuals fell abruptly from 50% to 28% in the US after the 1986 Tax Reform Act.

[4] In contrast, Swenson (1988) and Sillamaa (1999a, 1999b) only had an exogenous treatment and Sutter and Weck Hannemann (2003) only had an endogenous treatment.

[5] Our endogenous treatment differs from the experimental design of Sutter and Weck-Hannemann (2003) on several details. The latter used the strategy method in which taxpayers first indicate their choice of effort for tax rates ranging from 0 to an upper limit in 5%-steps and commit themselves to supply the reported effort once another player has chosen his preferred rate. They also required that the marginal income decrease with the number of tasks, which may be an unnecessary complication since the marginal disutility of effort, which cannot be controlled in a real effort experiment, is likely to increase anyway. The marginal income was kept constant in our design. Finally, Sutter and Weck-Hahnemann limited the game to only two periods and asked participants to vote on the upper limit of taxation in the second round. The effective tax rate was determined by the median vote. We are not concerned with voting in this experiment because we focus on the comparison of behaviors between the four treatments.

[6] These four possible values for tax rates fit the previous literature (Swenson 1988, Sillamaa 1999a), but retain only four of the five tax rates (12, 28, 50, 73 and 87%) used by Swenson (1988). The 79% tax rate is an average of his two highest rates. Choosing 79% breaks the symmetry around 50% that might have driven subjects to choose the 50% rate simply out of symmetry. The tax rates are deliberately ¨slightly¨ odd (except for 50%) so as to reinforce the subjects 'randomness beliefs. Finally, as mentioned in previous studies, these tax rates appear to be quite realistic (the marginal tax rate on the highest-income individuals fell from 50% to 28% in the US after the 1986 Tax Reform Act).

[7] This treatment evokes a context of forced taxation, in which A is the decisive member of a pressure group or a winning majority who acquired the power to tax B to her exclusive benefit.

[8] Our exogenous treatment differs from the experimental design of Swenson (1988). We measure the total effect of tax changes rather than the pure substitution effect and keep different tax rates (12%, 28%, 50%, 79%).

[9] Although As are passive in the exogenous treatment, their presence was important to maintain the same structure in both treatments and to show Bs that the tax drawn from their income was not money burning.

[10] Our experimental design was conducted under a *partner* matching protocol.

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[12] We adopt this standard formulation for simplicity. However, the main theoretical predictions in this section extend to a non-additive formulation of the utility function $V_i(w + I_i(t_A, e_B), e_B)$, where $i = (A, B)$, $I_A(t_A, e_B) = t_A e_B$, $I_B(t_A, e_B) = (1 - t_A) e_B$, w is the individual's endowed wealth and V_i is increasing in wealth and decreasing in effort. An important assumption we make is that the experiment leaves both players with equal time for leisure at home and the latter is determined by the worker's choice of effort.

[13] It is reasonable to assume that the pure time discount factor is one in a (short) lab experiment.

[14] Since, in our experimental conditions, subjects lacked complete knowledge of each other and were thus unable to "take the other's shoes", we postulate that they project onto others, by assuming implicitly that their partner is similar to self (e.g., Cadinu and Rothbart 1996, Dunning and Hayes 1996, Gramzow et al 2001, Lévy-Garboua et al 2006).

[15] Although they make a choice for several successive games, rational players must plan a constant behavior over all future games before the game starts, since they possess exactly the same information on all future periods. Therefore, we may assume a single game to determine the prior social preference.

[16] This implication of our model is not trivial because the group norm prescribes equalization of earnings, not of utility. Only marginal utilities of wealth are equalized, and the worker gets no compensation for his work. This result is a well-known consequence of state-dependent EU (Cook and Graham 1977). Players prefer to

be tax setters than workers and take no coverage against the risk of becoming workers when they are unable to exchange this loss on markets.

[17] If $t' < t$, with $e*(t)$ designating the worker's best response to tax rate t,

$$SW(t) = (1-t)e*(t) - C(e*(t)) < (1-t')e*(t) - C(e*(t))$$
$$\leq (1-t')e*(t') - C(e*(t')) = SW(t')$$
q.e.d.

[18] Emotional (impulsive) responses of this kind are usually observed in cases of emergency and they often take the form of all-or-nothing response (Zajonc 1980). Their existence is attested by the fact that responders commonly reject very unfair proposals in one-shot ultimatum games.

[19] Since tax rates vary by discrete amounts in our experiment, this result suggests a high revenue-maximizing tax rate on wages, lying outside this range or close to its extremity. The value of 71% estimated by Gruber and Saez (2002) on taxable income may be taken as a lower bound estimate of the conventional Laffer curve.

[20] By varying tax rates in 5% steps, Sutter and Weck-Hanneman (2003) obtained a peak for the (behavioral) Laffer curve at 50% sharp. Since this is exactly the value predicted by our theoretical model, we feel confident that tax revenues are maximized at 50% tax rate under the endogenous treatment even though we use much larger intervals.

[21] Our data also indicate that player A's revenues are higher in the endogenous treatments for a 12% tax rate. Average player A's payoffs are 290 ECUs for a 12% tax rate in the endogenous treatment (for the 26 task condition) and only 275 ECUs in the exogenous treatment. Similar results are found for the 52 task condition. However, due to a very small number of independent observations in the endogenous treatment for the 12% tax rate, these differences are not statistically significant.

[22] Although the difference in means is larger in the high effort than in the low effort specification, the larger variances in the 52-task specification explain the test results.

[23] It is important to consider extensive participation responses to taxation, as Tobit permits, as 16.9% (11.0%) did not work at all under the endogenous treatment in the high (low) effort condition and a majority of participants chose the maximum number of tasks at the lower tax rates (12%, 28%). However, such estimation cannot be done in a panel setting with individual effects since tax-revenues result from the interaction of tax setters A with workers B.

[24] Fehr and Gächter (2000), Masclet et al (2003), Egas and Riedl (2005) and Carpenter (2007), have investigated the relationship between punishment received by a player and the change in her contribution in the next period. They all found a positive effect of sanctions on contributions.

[25] The first difference knocks down all individual effects.

[26] The player's productivity in the experimental task is obtained by dividing the total number of correct tasks by the time spent on these tasks. It captures the player's task-specific ability. For the regressions, we have stratified this variable in three dummies for high (the first 33.33%), medium and low productivity workers (last 33.33%).

[27] The picture is less clear-cut for the low effort treatment. However, the incentives for punishing norm violators naturally diminish with the harm caused by "excessive" taxation.

[28] The proportion of incorrect tasks is 10% on average in the 26 task treatments and 17% in the 52 task treatments. However, there is no effect of tax rates on the number of incorrect tasks.

[29] Total outcome= player A' payoff+ player B's payoff= (number of correct tasks*(t)*100)+ (number of correct tasks*(1-t)*100)=number of correct tasks*100.

[30] In figure 5.a, average work falls from 23.3 to 18.7 tasks for Exo 26, but from 25.2 to 12.6 tasks for Endo 26. In figure 5.b, average work falls from 46.2 to 26.8 tasks for Exo 52, but from 49.2 to 17.3 tasks for Endo 52.

[31] Work elasticity is derived from table 3 by subtracting 1 from tax revenue elasticity.

[32] The ¨first game¨ is a dummy variable partly capturing inexperience and pre-play intentions. The ¨two last games¨ is a dummy variable taking value one in the two last games and zero otherwise. It might capture fatigue. Besides, subjects were classified as "risk-averse" if they preferred a $5 show-up fee to a lottery ticket that gave them a 50% chance to get $11 and nothing otherwise. The lottery was drawn at the end of the session.

Table 1. Experimental treatments

	Tax rate	
Work opportunities	random: exogenous treatment	chosen: endogenous treatment
26: low	Exo26 (23 pairs)	Endo26 (36 pairs)*
52: high	Exo52 (23 pairs)	Endo52 (22 pairs)

* The addition of new sessions with 52 tasks led us to reduce the number of participants in those sessions relative to the initial 26 task sessions.

Table 2. Tobit regressions on the determinants of tax revenue

	26 tasks		52 tasks	
	Endogenous	Exogenous	Endogenous	Exogenous
Rate 28	416.44**	345.17*	451.83	580.16*
	(2.49)	(5.62)	(0.87)	(3.78)
Rate 50	767.57*	745.45*	1349.24*	1077.07*
	(5.38)	(12.15)	(3.08)	(7.01)
Rate 79	710.21*	1 289.90*	471.83	1628.21*
	(4.79)	(20.69)	(1.06)	(10.57)
Constant	302.22**	272.20*	590.0	547.66*
	(2.20)	(6.31)	(1.38)	(5.08)
Log Likelihood	-4266.17	-2815.01	-2772.76	-3175.15
Number of observations	648	414	396	414
Censored to 0	71	5	67	19
Censored to 2054 (4108)	(64)	41	(22)	25

Note: t values are in parentheses. * significant at 1%. ** significant at 5%. *** significant at 10%.

Table 3. Tax revenue elasticity

	26 tasks		52 tasks	
	Endogenous	Exogenous	Endogenous	Exogenous
$\eta_{12,28}=\eta_{20}$	0.629	0.739	0.363	0.565
$\eta_{28,50}=\eta_{39}$	0.569	0.825	0.795	0.543
$\eta_{50,79}=\eta_{64,5}$	-0.104	0.898	-0.973	0.598

The unconditional expectations are predicted from the regressions on tax revenues given in Table 4. Tax revenue elasticities η are computed from estimates of $R(t_i)$ and $R(t_{i+1})$ at two adjacent tax rates t_i and t_{i+1}, at the three midpoints (20, 39 and 64.5%), by the formula:

$$\frac{[\hat{R}(t_{i+1})-\hat{R}(t_i)]/[(\hat{R}(t_i)+\hat{R}(t_{i+1}))/2]}{[t_{i+1}-t_i]/[(t_i+t_{i+1})/2]}.$$

Table 4. OLS regressions of first differences in work by treatment

Variable	26 tasks				52 tasks			
	Endogenous		Exogenous		Endogenous		Exogenous	
Tax rate change	-0.3609*	-0.1776*	-0.0613**	-0.0604***	-0.7126*	-0.7586*	-0.3106*	-0.1711***
	(-7.13)	(-3.03)	(-2.25)	(-1.83)	(-6.64)	(-5.09)	(-4.23)	(-1.83)
Tax rate change **x** Tax rate increases (dummy)	0.0193	-0.0282	-0.0685	-0.0649	0.1257	0.1626	0.0542	0.0362
	(0.26)	(-0.40)	(-1.05)	(-1.04)	(0.74)	(1.01)	(0.31)	(0.21)
Tax rate change **x** High productivity worker		-0.2522*		-0.0751**		0.2309		-0.2264**
		(-3.64)		(-2.11)		(1.52)		(-2.33)
Tax rate change **x** Medium productivity worker		-0.3320*		0.0424		-0.6527*		-0.1601***
		(-4.97)		(1.32)		(-3.05)		(-1.79)
Constant	0.0227	0.1885	1.1710	1.2425	-0.9223	-1.3470	-2.6750	-2.6399
	(0.03)	(0.29)	(0.96)	(1.06)	(-0.56)	(-0.88)	(-0.81)	(-0.81)
Observations	180	180	115	115	110	110	115	115
Adj R-squared	0.4305	0.5047	0.2463	0.3164	0.4227	0.5032	0.3390	0.3609

Note: t values are in parentheses. * significant at 1%. ** significant at 5%. *** significant at 10%.

Table 5. Determinants of workers' choosing no task (Panel Probit)

Variable	0 task
Rate 28	-1.100***
	(-1.89)
Rate 50	-0.143
	(-0.40)
Rate 79	1.551*
	(3.87)
High productivity worker x rate 79	0.156
	(0.38)
Medium productivity worker x rate 79	2.426*
	(3.29)
High productivity worker	-0.179
	(-0.35)
Medium productivity worker	-2.721*
	(-3.61)
Endogenous	1.589*
	(3.63)
26 task	-0.235
	(-0.58)
First game	-0.688*
	(-2.68)
Last two games	0.344**
	(2.05)
Age	-0.136**
	(-2.45)
Man	0.430
	(0.99)
Graduate Student	0.076
	(0.15)
Previous Participation	0.042
	(0.10)
Risk aversion	0.212
	(0.53)
Constant	-1.104
	(-0.72)
Rho	0.732*
	(15.81)
Log Likelihood	-259.568

Observations	1872

Note: t values are in parentheses. * significant at 1%. ** significant at 5%. *** significant at 10%.

Figure 1a. Variation of tax revenue by tax rates (26 tasks)
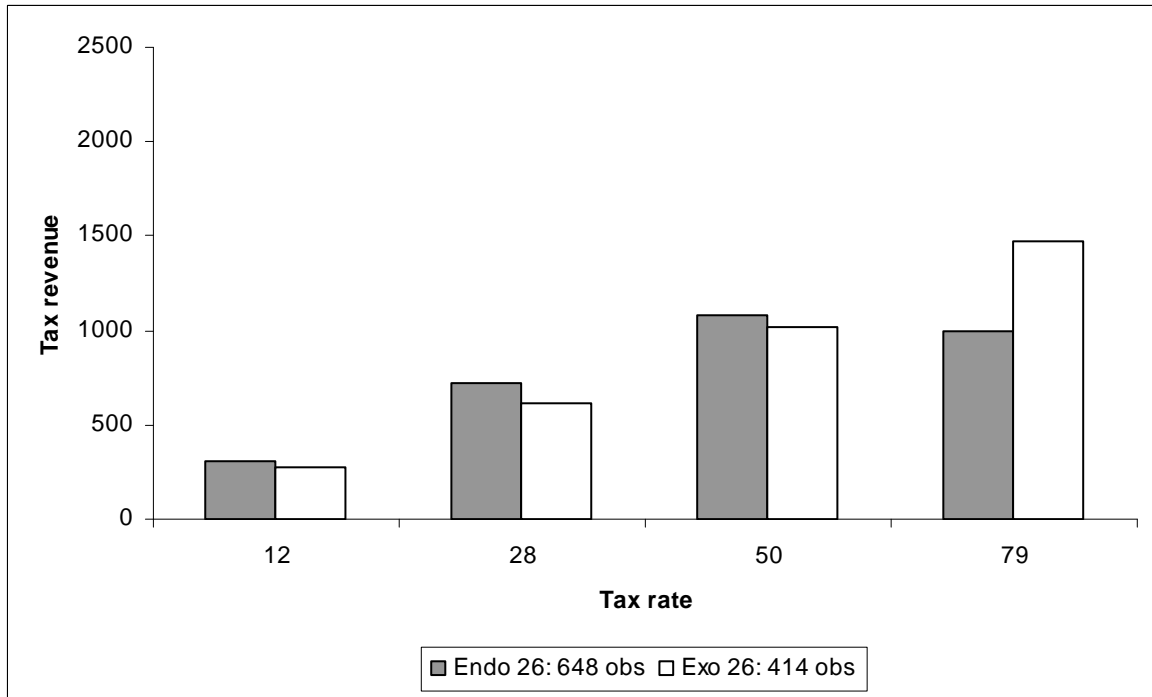
Figure 1b. Variation of tax revenue by tax rates (52 tasks)
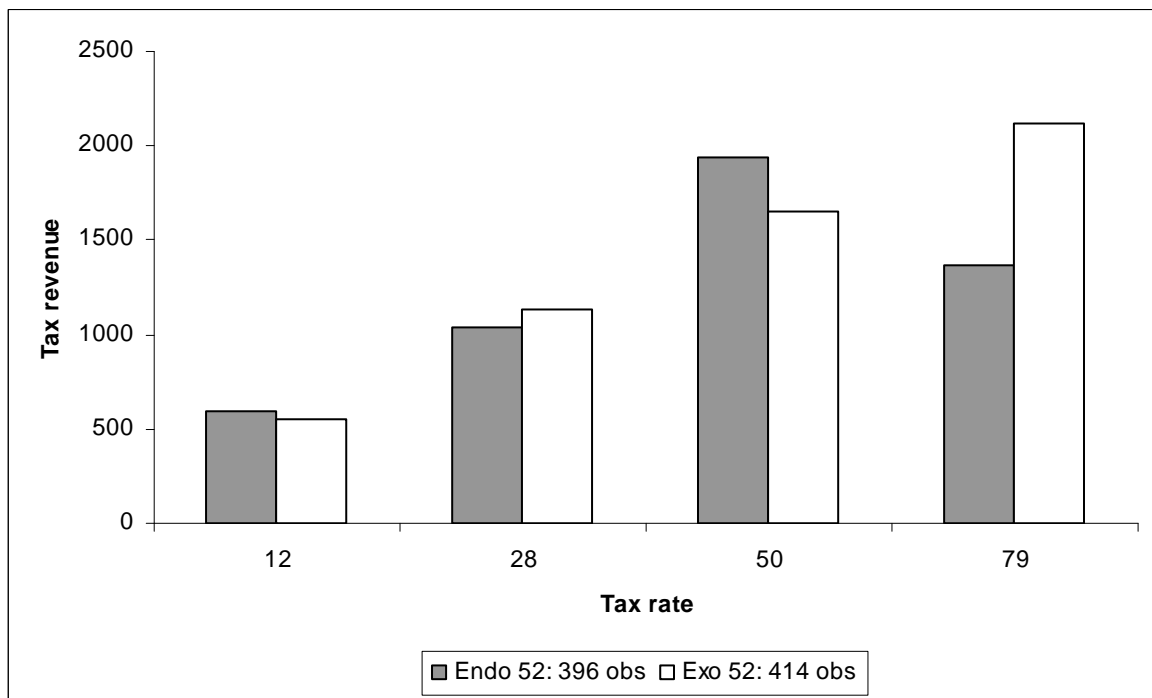
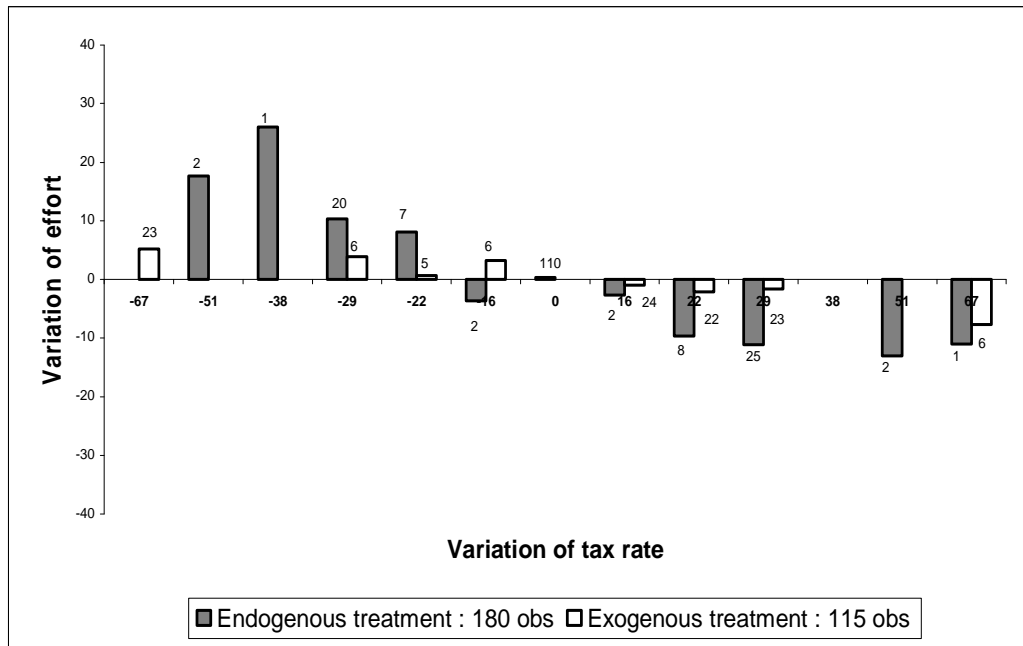**Figure 2a. First differences in work with first differences in tax rates (26 tasks)**

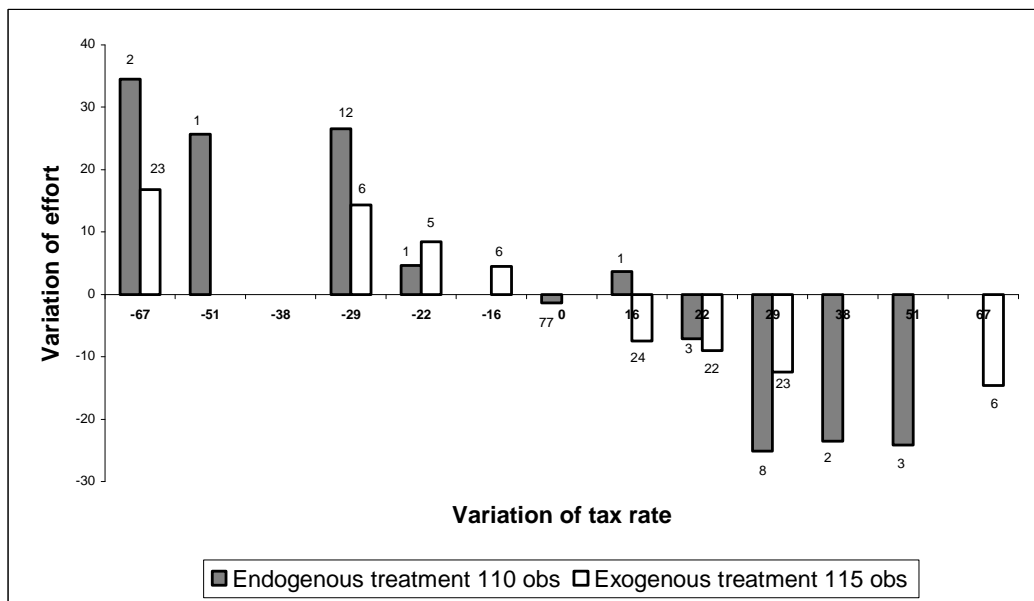**Figure 2b. First differences in work with first differences in tax rates (52 tasks)**

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**Figure 3. Frequency of choice of tax rates by tax setters
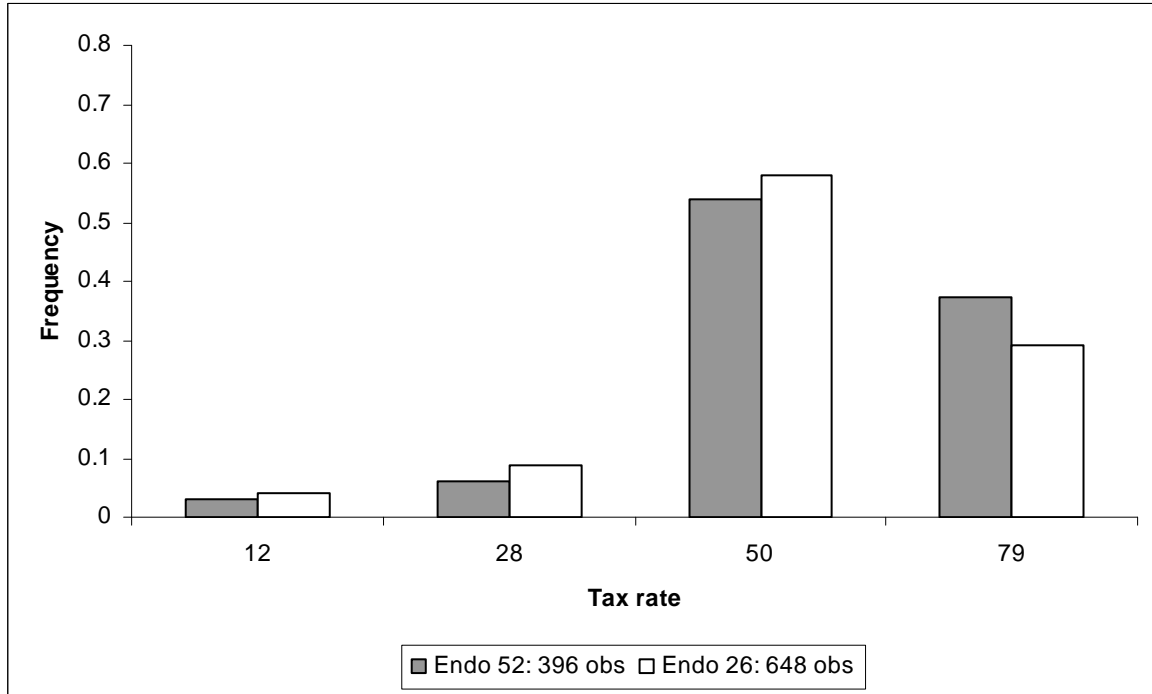in the endogenous treatments**

**Figure 4. Frequency of choice of tax rates by tax setters in the first game
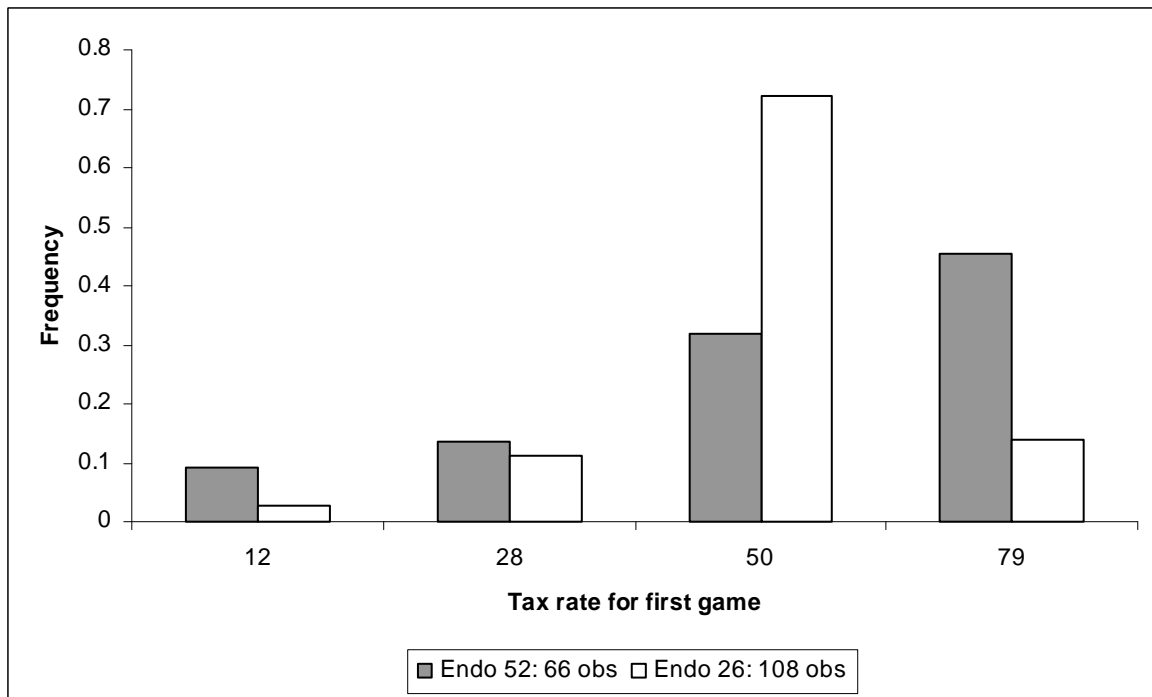in endogenous treatments**

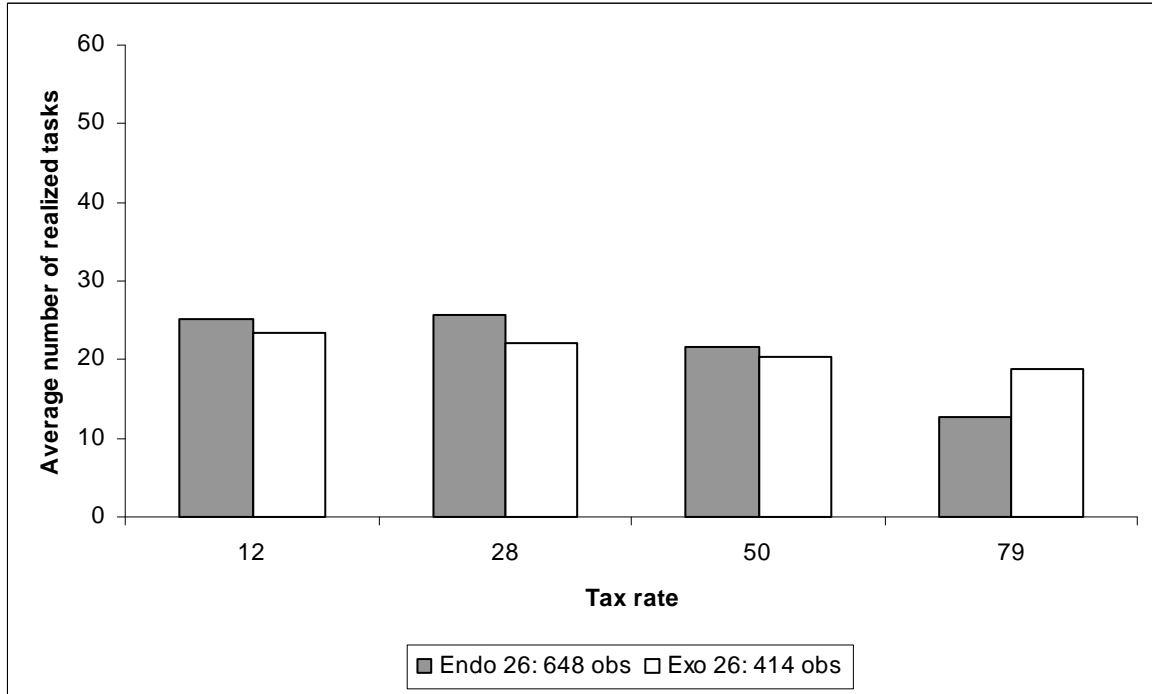**Figure 5a. Average work by tax rate (range [0-26])**

Figure 5b. Average work by tax rate (range [0-52])