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Abstract:
Criminal law and economics rests on the expectation that deterrence incentives can be employed to reduce crime. Prison survey evidence however suggests that a majority of criminals are biased and may not react to deterrence incentives. This study employs an extra-laboratory experiment in a German prison to test the effectiveness of deterrence. Subjects either face potential punishment when stealing, or they can steal without deterrence. We confirm Gary Becker's deterrence hypothesis that deterrence works for criminals.

Keywords: Crime, Stealing, Deterrence, Prison, Extra-laboratory experiment, Artefactual field experiment

JEL classification: C72, C91, C93, K42

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1 Introduction

Since Gary Becker's (1968) seminal paper, criminal law and economics assume that welfare loss from crime can be minimized by optimal deterrence policy. The underlying assumption that individuals react to incentives and changes in expected payoffs constitutes the deterrence hypothesis. A number of empirical tests of the deterrence hypothesis have been criticized for their estimation techniques and issues of simultaneity, data collection, data aggregation, and possible incapacitation bias (Levitt and Miles, 2007; notable exceptions include Levitt, 1997; Corman and Mocan, 2000; Fisman and Miguel, 2007).

For this reason experimental economic studies have recently focused on investigating crime and deterrence in controlled environments. Recent studies provide evidence that an increase in the expected punishment decreases criminal activity of *students* (e.g. Abbink et al., 2002; DeAngelo and Charness, 2012; Khadjavi, forthcoming; Nagin and Pogarsky, 2003; Rizzolli and Stanca, 2012; Schildberg-Hörisch and Strassmair, 2012).

Representing a certain social status, university students are only one and not the most usual target of deterrence incentives. Anderson (2002) presents results from a prison survey and formulates doubt about the effectiveness of deterrence incentives for criminals. He argues that there are two necessary conditions for the deterrence hypothesis to hold for criminals: (1) sufficient information about probabilities and punishment and (2) rational behavior. A great majority of criminals in his survey study appeared uninformed and ignorant of deterrence measures. Accordingly, he questions the effectiveness of stricter deterrence policy to curtail crime.

This study directly investigates stealing decisions of *prison inmates* in an extra-laboratory experiment that was set up in a women's penitentiary[1] in Northern Germany.[2] We use experimental methods to disentangle the two conditions discussed by Anderson (2002). By creating an environment with complete information, we are able to uncover potential rationality biases of criminals. This innovation is important as criminals are a major target group of deterrence policy.

The finding is in the title: in our controlled environment with complete information, deterrence incentives work to reduce stealing of criminals. That is, we confirm that deterrence incentives work for a major target group of deterrence policy. This work thus does not support Anderson's (2002) concern that criminals are systematically irrational. As a robustness check, we also replicate the effectiveness of deterrence with student subjects, providing external validity of former results of deterrence experiments with students in the literature.

This article is organized as follows; section 2 introduces the experimental design and its predictions. The procedures of this study, especially regarding the experiment in prison, are discussed on section 3. Section 4 presents the results and section 5 concludes.

2 Experimental Design

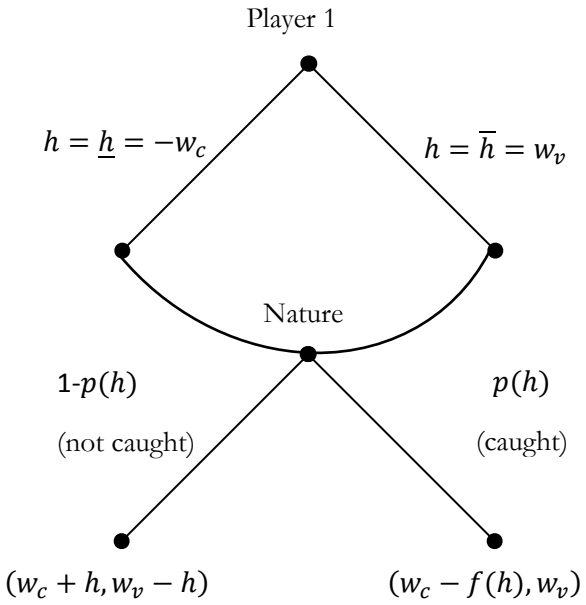
The structure of our stealing game is depicted in Figure 1. It closely corresponds to the game of Schildberg-Hörisch and Strassmair (2012) with slight innovations. In the remainder of this work we will always refer to player 1 as *criminal* and player 2 as *victim*; note that our work applies this wording for easy reading while our experiment instructions and programs use a strictly neutral

[1] We acknowledge that men account for the majority of prisoners. Still current statistics report more than 625,000 female prisoners worldwide (Walmsley, 2012). We therefore see no reason to disregard studies with prisoners on the grounds that the subjects are female.

[2] Note that Block and Gerety (1995) also analyze decision making under risk of prison inmates. Their auction experiment does not involve stealing.

language. The endowments of the criminal and the victim are denoted w_c and w_v respectively. Potential criminals decide to stealing from or give to potential victims by choosing haul *h*, with $h \in \{-w_c, \dots, w_v\}$. Our first innovation is that we allow for stealing *and* giving and thereby try to avoid suggestiveness of the action space (motivated by findings of List, 2007 and Bardsley, 2008). All giving and neutral decisions, i.e. $h \leq 0$, are certain. Depending on the deterrence scheme, a taking decision, i.e. $h > 0$, triggers a positive probability of conviction $p(h)$ and a possible fine $f(h)$ if convicted.[3] After a criminal has made her decision, the deterrence scheme at hand either punishes her with fine *f* (with probability *p*) or lets her keep *h*.

Figure 1. The Stealing Game.



In our experimental design we set the endowments at $w_c = 2$ Taler and $w_v = 10$ Taler, and the stealing increment is 1 Taler.[4] We employ two deterrence schemes to test the deterrence hypothesis. Scheme *NoDeter_* resembles a risk free environment and is comparable to a

[3] Note that either *p* or *f* needs to be increasing in *h* to avoid marginal deterrence issues (see Stigler, 1970).

[4] Additionally, both players were endowed with 7 Taler (which were needed to rule out negative payoffs).

manipulation of the dictator game. Hence, in *NoDeter_* $f = 0$ and $p = 0$. *NoDeter_* is needed as a baseline against risky decision making. In the *DeterFine_* treatment, criminals face the risk of being fined for stealing, i.e. when choosing some $h > 0$. The probability of conviction in *DeterFine_* reads $p(h) = 0.5 \;\; if \; h > 0$ and $p(h) = 0 \; if \; h \leq 0$. Fine *f* is increasing in *h,* that is: $f = 1.25 - 0.25h + 0.1h^2$.

Table 1. Overview of the Deterrence Schemes.

h	Deterrence Scheme					
	NoDeter			*DeterFine*		
	f in EUR	*P*	π in EUR	*f* in EUR	*p*	E(π) in EUR
-2	0	0	-2	0	0	-2
-1			-1			-1
0			0			0
1			1	1.10	0.5	-0.05
2			2	1.15		0.425
3			3	1.40		0.80
4			4	1.85		1.075
5			5	2.50		1.25
6			6	3.35		**1.325**
7			7	4.40		1.3
8			8	5.65		1.175
9			9	7.10		0.95
10			**10**	8.75		0.625

Note: Fine *f* is a function of stealing *h*, that is: $f = 1.25 - 0.25h + 0.1h^2$. Accordingly, an individual *i* with risk neutral, narrowly self-interested preferences maximizes her utility by choosing h^*=6.25≈6.

Corresponding to the description and Figure 1 above, a potential criminal *i* maximizes expected utility $\max_{h_i} U_i = \big(1 - p(h_i)\big)u_i(w_i + h_i) + p(h_i)u_i\big(w_i - f(h_i)\big)$ where $u_i(\cdot)$ denotes the Bernoulli utility function. In *NoDeter* criminals do not face any risk, such that the maximization problem collapses to $\max_{h_i} u_i = w_i + h_i$. The standard game theoretic prediction is that she chooses the maximum haul, $h^*_{NoDeter} = \overline{h} = w_v = 10$ Taler. In *DeterFine* a criminal maximizes her expected payoff by stealing $h^*_{DeterFine} = 6.25$ Taler which for the available increments

rounds to 6 Taler. It is an important and novel feature of our design that we do not predict the extreme case of no stealing in *DeterFine*, but offer an interior solution. If the deterrence hypothesis holds for criminals, then we should find $h_{NoDeter} > h_{DeterFine}$. Table 1 provides an overview of the two deterrence schemes.

3 Procedures

The five experimental sessions with prisoners were conducted at *JVA für Frauen* (penitentiary for women) in Vechta, Germany, on June, 14 2012.[5] Inmates serve sentences ranging from a couple of days to life sentences. Three weeks before the experiment, official invitations were distributed in the prison. The invitations included information on the nature of the experiment, that participation is strictly voluntary, and that we guarantee absolute anonymity.[6] As cash is forbidden in German prisons, we followed the suggestion of the responsible state institution to offer either a jar of instant coffee or a pack of tobacco as show-up fees (worth approx. 5 EUR). Prison subjects received individual phone credit depending on their decisions in the experiment. We set up a mobile computer laboratory with laptops and separation walls in the prison's gymnasium.

The four sessions with female students were conducted in the experimental economic laboratory at the University of Hamburg three weeks later, in the first week of July, 2012. Female students for our lab sessions were recruited from the subject pool via ORSEE (Greiner, 2004). The payment vehicle for students was a sum of cash consisting of a 5-EUR show-up fee and money determined by the decisions made in the experiment.

[5] Further information (in German) on the JVA für Frauen in Vechta: www.jva-fuer-frauen.niedersachsen.de.

[6] Despite our efforts to ensure credible anonymity, one may argue that some inmates may have acted in response to a demand effect. That is, some inmates may abstain from stealing as they believe that their actions will be traced. If this effect was present, it would work against finding a difference between *NoDeter* and *DeterFine*. Note that a decrease in stealing from *NoDeter* to *DeterFine* of the same subject cannot occur in our between-subject design.

The stealing game was the first game of a sequence of games within a session (see Khadjavi and Lange, 2013). All decisions were made one-shot without feedback and all games were paid out. Subjects learnt about the content of the next game only after the current game was over. All participants made their decisions as player 1. It was only at the end of the experiment that subjects were informed about the outcome of the games and randomly matched and selected as being either player 1 or player 2.

90 inmates and 92 students participated in our experiment, yielding a total of 182 subjects. We employed a between-subject design: a subject either participated in *NoDeter* or in *DeterFine*. No subject participated in the experiment more than once. We used *Taler* as the experimental currency, with 1 EUR equal to 5 Taler. Sessions lasted about 45 minutes each. Average earnings in the stealing game were 12.76 Taler for students and 12.79 Taler for prisoners. Including the show-up fees, average earnings in prison were approx. 14.40 EUR compared to approx. 13.20 EUR in the student lab. We used z-Tree (Fischbacher, 2007) to program and run our experiment.

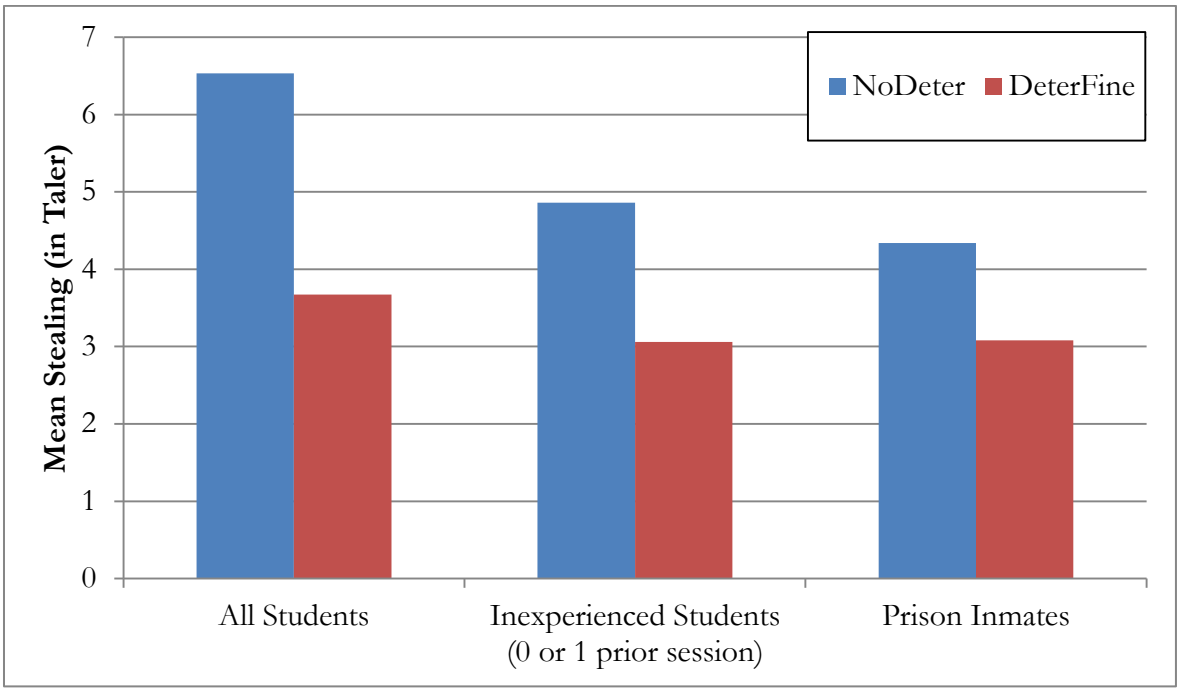
4 Results

In our between-subject design we had 40 students and 38 prison inmates in our *NoDeter* treatment and 52 students and 52 inmates in the treatment with deterrence, *DeterFine*. Figure 2 provides an overview of the results. On average inmates stole 4.34 Taler in *NoDeter* and 3.08 Taler in *DeterFine*. This difference is statistically significant at p = 0.0643 (two-tailed Mann-Whitney test). Testing the deterrence hypothesis, i.e. $h_{NoDeter} > h_{DeterFine}$, the one-tailed Mann-Whitney test yields p = 0.03215. Hence, deterrence works for criminals: they steal significantly less with punishment incentives in place.

The treatments with students replicate results of earlier deterrence experiments with students and act as a robustness check. Students decided to steal an average amount of 6.53 Taler in *NoDeter* compared to 3.67 Taler in *DeterFine* (different at p<0.000, two-tailed Mann-Whitney test). Using our design, we thus replicate the result in the literature that deterrence works in the conventional

lab with students. We find that criminals react to deterrence incentives and provide further support for Gary Becker's deterrence hypothesis.

Figure 2. Mean Stealing of Students and Prison Inmates.



5 Concluding Remarks

In line with current extension of experimental economic research to criminals (Chmura et al., 2010; Birkeland et al., forthcoming; Khadjavi and Lange, 2013; Cohn et al., 2013), this study tests the effectiveness of deterrence incentives for prisoners. This aim is of central importance for law and economic policy. If this target group of policy does not react to incentives in the desired way and reduces criminal activity – a central assumption in all deterrence policy – then this policy may be ineffective to reduce crime.

We confirm that deterrence incentives mitigate stealing behavior of inmates. Anderson (2002) discusses that both lack of information on the incentive structure and systematical biases may cause the deterrence hypothesis to fail for criminals. This is one of the reasons why the randomized and controlled approach of experimental research is useful here. In our experiment

inmates receive complete information about the deterrence incentives – and they react to these incentives. Our finding therefore does not support the conjecture of criminals' decision making to be systematically biased and ignorant of deterrence incentives. Finally, this finding is assuring for researchers who invite student subjects for experimental studies on criminal behavior.

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I am grateful to the *JVA für Frauen* in Vechta and especially Petra Huckemeyer and Elsbeth Lübbe for their dedicated cooperation and to the *Kriminologischer Dienst* in Lower Saxony for its permission to conduct this study. Funding and guidance for this experiment was provided by the chair of Andreas Lange at the University of Hamburg. Sarah Mörtenhuber and Jan Papmeier provided excellent research assistance.

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Appendix – English Translations of the Instructions

General Instructions for Participants

Welcome to the Study!

Thank you for participating in our study today. You will be able to earn a considerable amount of money. It is therefore important that you read these instructions carefully.

It is prohibited to communicate with other participants during the study. Should you have any questions please raise your hand and an instructor will come to answer them. If you violate this rule, we will have to exclude you from the study and from all payments.

During the experiment you will make decisions **anonymously**, other participants will not learn about your decisions.

In any case you will earn *[Field: a pack of coffee or a pack of tobacco; Lab: 5 Euros]* for participation in this experiment. The additional earnings depend on your decisions *[Field: and will be paid to your phone account]*. During the study your earnings will be calculated in Taler. At the end of the experiment your earned Taler will be converted into Euros at the following exchange rate:

1 Taler = 0,20 €.

The study consists of five independent tasks. Your decision in a task does not have any impact on the other tasks.

The instructions for the five tasks will be handed out one after another. You will first receive instructions for task 1 and then make your decision at the computer terminal. After this task 1 is done.

Thereafter you will receive instructions for task 2 and again make your decision at the computer terminal. This procedure continues until the end of the study. In the end we will also ask you to answer some general questions.

At the end of the study you will receive your payment. Your payment is the sum of payments from all five tasks. All earned Taler will be converted to Euros and paid to you *[Field: in addition to a pack of coffee or tobacco]*. Hence you will get

Your total payment

=

Your payment from task1, 2, 3, 4 and 5 + *[Field: a pack of coffee or tobacco, Lab: 5 EUR]*

All payments will be done separately, without any other participant being able to see what you have earned. Apart from the instructor nobody will know what you have earned.

[We do not include instructions for tasks 2, 3 and 5 in this appendix. They will be included in companion papers on our prison study and are available upon request. Readers interested in the original German instructions may also contact us.]

Instructions for Task 1

[The Stealing Game, NoDeter Treatment:]

In task 1 you need to decide how many Taler to transfer between your account and the account of another participant who is randomly matched with you. You will not receive information on the identity of the other participant. Neither will the other participant receive information on your identity.

At the end of the experiment one half of the participants will be randomly selected to be person 1, the other half will be person 2. Your own decision will count if you are selected as person 1. If you are selected as person 2, you will receive your payment in accordance with the decision of a person 1 who is matched with you.

There are 9 Taler in your account while the account of the other person holds 17 Taler.

You are able to decide freely how many Taler you would like to transfer between the account of the other person and your own account. That is, you are able to transfer up to 2 Taler from your account to the account of the other person (transfer "-2") or up to 10 Taler from the account of the other person to your account (transfer "10").

For example, if you decide to transfer -2 Taler, you will receive 7 Taler in this task while the person who is matched with you will receive 19 Taler. If you decide to transfer 7 Taler, then you will receive 16 Taler in this task and the matched person will receive 10 Taler.

In summary, your transfer between the account of the other person and your own account may be between "-2" and "10".

Please make a decision on the screen to decide how many Taler to transfer to your account from the account of person 2.

Instructions for Task 1

[The Stealing Game, DeterFine Treatment:]

In task 1 you need to decide how many Taler to transfer between your account and the account of another participant who is randomly matched with you. You will not receive information on the identity of the other participant. Neither will the other participant receive information on your identity.

At the end of the experiment one half of the participants will be randomly selected to be person 1, the other half will be person 2. Your own decision will count if you are selected as person 1. If you are selected as person 2, you will receive your payment in accordance with the decision of a person 1 who is matched with you.

There are 9 Taler in your account while the account of the other person holds 17 Taler.

You are able to decide freely how many Taler you would like to transfer between the account of the other person and your own account. That is, you are able to transfer up to 2 Taler from your account to the account of the other person (transfer "-2") or up to 10 Taler from the account of the other person to your account (transfer "10").

If you decide to transfer Taler from the account of the other person to your own account, this transfer will only be successful half of the times, i.e. the probability of success is 50 %. If the transfer is not successful, you will have to pay a fee that is shown on your screen.

For example, if you decide to transfer -2 Taler, you will receive 7 Taler in this task while the person who is matched with you will receive 19 Taler. If you decide to transfer 7 Taler and your transfer is successful, then you will receive 16 Taler in this task and the matched person will receive 10 Taler. If your transfer is not successful, then you will receive the initial 9 Taler minus the fee and the person who is matched with you keeps 17 Taler.

In summary, your transfer between the account of the other person and your own account may be between "-2" and "10".

Please make a decision on the screen to decide how many Taler to transfer to your account from the account of person 2. Mind the respective fee in case your transfer is not successful.