Düsseldorf Institute
for Competition Economics

DISCUSSION PAPER

No 90

Cheap Talk About the Detection Probability

Florian Baumann,
Tim Friehe

April 2013

HEINRICH HEINE
UNIVERSITÄT DÜSSELDORF

IMPRINT

DICE DISCUSSION PAPER

Published by
Heinrich-Heine-Universität Düsseldorf, Department of Economics, Düsseldorf Institute for Competition Economics (DICE), Universitätsstraße 1, 40225 Düsseldorf, Germany

Editor:

Prof. Dr. Hans-Theo Normann
Düsseldorf Institute for Competition Economics (DICE)
Phone: +49(0) 211-81-15125, e-mail: normann@dice.hhu.de

DICE DISCUSSION PAPER

ISSN 2190-9938 (online) – ISBN 978-3-86304-089-5

Cheap Talk About the Detection Probability

Florian Baumann[*] Tim Friehe[†]

April 2013

Abstract

This paper analyzes whether the behavior of potential offenders can be guided by information on the actual detection probability transmitted by the policy maker. It is established that, when viewed as a cheap-talk game, the existence of equilibria with information transmission depends on the level of the sanction, the level of costs related to imposing the sanction, and the level of social harm resulting from the offense. In addition, we find that the policy maker (i.e., society as a whole) is not necessarily better off ex ante when more information is transmitted in equilibrium, but that potential offenders always are.

Keywords: crime, cheap talk, law enforcement, imperfect information

JEL-Classification: K42, H23, C72

[*]University of Düsseldorf, Duesseldorf Institute for Competition Economics, Universitätsst. 1, 40225 Düsseldorf, Germany. E-mail: fbaumann@dice.hhu.de.

[†]University of Bonn, Center for Advanced Studies in Law and Economics, Adenauerallee 24-42, 53113 Bonn, Germany. CESifo, Munich, Germany. E-mail: tim.friehe@uni-bonn.de.

1 Introduction

1.1 Motivation and main results

"Crime doesn't pay!" - The use of this cliché by policy makers such as the European Commission[1] is an attempt to inform potential offenders about the probability of detection and the sanctions imposed thereafter. Another everyday example is the ubiquitous local transport company's informational poster warning that fare evasion is not worth the risk. However, while such announcements clearly state the applicable fine for fare-dodging, they neglect to provide information on the probability of a ticket check. In fact, if probability information were supplied, riders might reason that the transit company was overstating the risk of a ticket control, questioning the credibility of information related to the detection probability. In other words, in this particular context and in many others, the level of the sanction can be observed at negligible or moderate cost, but the level of the detection probability cannot. This paper studies the circumstances under which policy makers' announcements regarding detection probabilities can actually influence potential offenders' decisions.

The detection probability for a given crime at a given location and point in time can be hard to determine. Even if the budget for detection and prosecution remains the same, there may be variations in enforcement, as resources are used to fight crime A in location X in one period of time and crime B in location Y in another.[2] Some guidance might originate from a potential offender's personal experiences with enforcement, from the experiences of their peers, or from official statistics (although crime statistics tend to be unreliable since crime reporting is highly inaccurate). For example, using the officially reported clear-up rate for crimes provided by the police of the German state of Hesse as a proxy for the detection

[1] Communication From the Commission to the European Parliament and the Council - Proceeds of Organised Crime: Ensuring that "Crime Does not Pay," COM(2008) 766 final.

[2] For example, Kleiman (2009) reports several examples of concentrations of police activity in terms of offenses, location, and time.

probability, we find that rates vary significantly even at relatively high levels of aggregation (see Table 1).[3] As an example, the clear-up rate for car theft with aggravating circumstances was 32.5 percent in 2009, but the rate dropped to only 21 percent in 2010. In general, even if potential offenders were to consult available information sources, this would still leave substantial uncertainty regarding the current level of detection probabilities.[4]

	2006	2007	2008	2009	2010
Car theft without aggravating circumstances	58.4	55.4	57.9	60.7	65.5
Car theft with aggravating circumstances	22.6	23.4	25.2	32.5	21.0
Pickpocketing	6.9	5.1	6.8	4.5	7.2
Burglary	17.5	22.8	20.6	19.1	16.0

Table 1: Clear-up rates for crimes in the German state of Hesse

Policy makers may wish to remedy the lack of information about actual policing, but they face the difficulty of doing so credibly. For instance, Cameron (1989) argues that "increased police activity ... might have no impact on criminals because they do not ... believe publicity claiming that it has happened." Accordingly, this paper interprets the policy maker's transmission of information regarding the actual level of detection probabilities as cheap talk. Given this basic assumption we derive two main results, the first with respect to the possibility of information transmission, and the second concerning welfare consequences.

Our first central result is that information transmission is indeed possible. In line with the seminal paper by Crawford and Sobel (1982), we establish in a static framework that under certain conditions, potential offenders' decisions can be influenced by the policy maker's message regarding the level of the detection probability. This comes despite arguments to

[3] We are including crimes labeled with codes 3001, 4001, 3900, and 435*, relying on Table 1 of the published statistics (Polizeiliche Kriminalstatistik, http://www.polizei.hessen.de/).

[4] Arguments put forth by Robinson and Darley (2004) and Kenkel and Koch (2001), for example, suggest that potential offenders do not actually consult available information sources.

the contrary, arguing, for instance, that transmission of information can only be accomplished by putting the policy maker's reputation at risk in a dynamic context (see, e.g., Ben-Shahar 1997). In our framework, whether or not information transmission is possible depends on the level of the sanction, the level of costs related to imposing the sanction, and the level of social harm resulting from the offense. The different levels of costs of imposing sanctions may be related to the different possible forms of sanctions. Monetary fines are more likely to induce only moderate costs for society, with the fine itself representing a transfer (Becker 1968), whereas incarceration of offenders might be associated with very high costs.[5] The roles that these three aspects - the level of the sanction, sanctioning costs, and harm - perform in the analysis are relatively intuitive. The policy maker is interested in optimal deterrence, such that the expected sanction (i.e., the product of the uncertain detection probability and the sanction) ideally mirrors the expected social costs (consisting of the level of harm and the expected sanctioning costs). The potential offender is interested in whether or not criminal gains will outweigh the expected sanction. Social harm is inflicted on society whenever the offense is committed (detected or not) and is therefore independent of the level of detection probability. In contrast, costs related to imposing a sanction are only incurred when the offender is detected, implying that expected sanctioning costs increase with the level of the actual detection probability. When the level of sanctioning costs is negligible, the policy maker would like to distort the detection probability perceived by potential offenders so that the expected sanction is equal to the level of harm (i.e., independent of the actual detection probability). In this case, information transmission cannot be precise because there is no alignment of interests. The situation is very different should the level of harm be small and the level of sanctioning costs high. In this case, the policy maker is interested in sending signals to the effect that the detection probability expected by potential offenders is indeed low (high) for low (high) realizations of the detection probability. This coincides more strongly with the potential offenders' needs, and therefore some credibility can be conferred

[5] In the US, for example, the average cost of keeping an offender in jail or prison is about $26.000 per year (Schmitt et al. 2010).

to the policy maker's message.

Our second central finding regards the payoff consequences of information transmission. The benevolent policy maker (i.e., society as a whole) is not necessarily better off in an equilibrium with information transmission in comparison to an equilibrium without the transmission of information. We establish that there are certain parameter constellations of the level of the sanction, the level of harm, and the level of sanctioning costs that allow for some information transmission, but in which this transmission disadvantages the policy maker ex ante. This result occurs for constellations in which the costs of imposing the sanction are relatively low. The explanation is that in such a scenario, the level of harm is the dominant argument from the policy maker's standpoint when it comes to optimal deterrence. If information transmission is possible, there will be low (high) deterrence for low (high) realizations of the detection probability. However, an intermediate level of deterrence irrespective of the level of the detection probability would be preferable from the policy maker's point of view. In contrast, the policy maker (i.e., society as a whole) is better off in an equilibrium with information transmission when the costs related to imposing the sanction are sufficiently high. In such circumstances, the policy maker's benefits from aligning potential offenders' decisions with the actual detection probability are greater, especially for high levels of the detection probability and corresponding high expected costs of imposing sanctions. For potential offenders, information transmission is always beneficial.

1.2 Relationship to the literature

The present paper is related to the literature on optimal law enforcement and to contributions dealing with cheap talk. The economic analysis of crime, a field pioneered by Becker (1968), studies how changes in the level of sanctions and the level of detection probabilities influence the supply of offenses, usually assuming that potential offenders are aware of the enforcement variables at the policy maker's discretion (see, e.g., Polinsky and Shavell 2009).

In contrast, Sah (1991) presumes that individual beliefs about the detection probability are determined by the number of people they observe committing crimes and their arrest rates, and studies what this implies for the evolution of crime over time. Bebchuk and Kaplow (1992) analyze how potential offenders' imperfect information about the detection probability influences optimal law enforcement, establishing that it may no longer be optimal to impose the maximum sanction, a policy recommendation that otherwise results in the basic model. The framework of Bebchuk and Kaplow is used by Garoupa (1999) to consider the dissemination of information by the policy maker, but without discussing the critical issue of the credibility of this information. In another line of inquiry, Ben-Shahar (1997) studies optimal law enforcement when individuals learn about enforcement by being detected, and Lochner (2007) empirically establishes that personal experience is indeed an important determinant of the perceived detection probability.

Crawford and Sobel (1982) provide the ground-breaking contribution on cheap talk. For reasons of tractability, their illustrative example has been used as the basic set-up for most subsequent work (for a survey, see, e.g., Farell and Rabin 1996, Krishna and Morgan 2008). In their example, the receiver's action that the sender prefers differs from the action preferred by the receiver by a constant amount. Our application differs in this regard. The preferences of the policy maker (i.e., the sender) include the level of harm resulting from the crime and the costs of imposing sanctions. In contrast, the potential offenders' decisions are guided by the level of the sanction, which generally differs from the cost of imposing the sanction. This implies that the difference in the actions preferred by the policy maker and by offenders cannot be generally described by a constant. It is this distinction that is responsible for the contrast between our results and those of Crawford and Sobel (1982): We find that the policy maker is not necessarily better off ex ante in an equilibrium with information transmission. Subsequent to Crawford and Sobel (1982), the literature has explored new applications of their basic model and remedies for the information loss in cheap-talk games, such as multiple experts and mediators (see, e.g., Austen-Smith 1990, Krishna and Morgan

2001, Ivanov 2010), topics that are outside the scope of our contribution.

The balance of this paper is as follows: In Section 2, we describe the model to be used for the analysis in Section 3. Section 4 concludes our study.

2 Model

We consider a simple set-up similar to that used by Polinsky and Shavell (2001) and Polinsky (2006), among others, augmented by asymmetric information about the detection probability and information transmission in line with Crawford and Sobel (1982). Risk-neutral individuals can determine whether or not to commit an act that imposes harm $h > 0$ on society. Individuals differ in their criminal gains b from the act, where criminal gains fall into the interval $[0, B]$ according to a uniform distribution. Potential offenders commit the offense whenever the benefit b from doing so exceeds the perceived expected sanction $p^e f \equiv \bar{b}$, i.e., when $b \geq \bar{b}$, where f is the sanction imposed when the offender is detected and p^e is the detection probability expected by potential offenders. The level of the sanction is assumed to be exogenous, smaller than or equal to B, and commonly known, as it is explicitly set out in the law. Potential offenders have an expected payoff of zero if they abstain from the offense and of $b - \bar{b}$ if they commit the act. The assumption of $f \leq B$ implies that some potential offenders are non-deterrable at any perception regarding the detection probability (given that indifferent individuals choose to offend).

The probability of apprehension expected by potential offenders does not need to correspond to the actual level of the detection probability, denoted by p. The actual detection probability is modeled as a random variable drawn from the interval $[q, Q]$ according to a uniform distribution where $0 \leq q, Q \leq 1$. The draw of the actual detection probability from the distribution is observed only by the policy maker, who then sends a message p^m to potential offenders. There are several possible interpretations of this setting. The random nature of the detection probability may be due to the assignment of financial resources for crime control based on budgetary decisions made at higher levels (making it exogenous for enforcement authorities). Similarly, it may be that the policy maker is a regulatory body that may announce the level of the detection probability, while it is selected by the police which - due to agency costs - may have discretion as to the precise level of the detection probability. The regulatory body should still be able to correctly assess the actual detection probability as it understands the incentives for the police, but is not able to choose the detection probability itself. The possible range $[q, Q]$ may be rather broad due to temporary concentrations of crime-fighting resources on specific types of offense and/or locations, for example.

Before describing the policy maker's objective function, we briefly summarize the timing of events in our model. (i) Nature draws the actual level of the detection probability, p, which is observed by the policy maker. (ii) The policy maker sends a message to potential offenders, p^m. For ease of intuition, we assume that the set of feasible messages is the set of feasible levels for p (i.e., the interval $[q, Q]$). (iii) Potential offenders determine whether or not to offend, implying a crime rate of $1 - \bar{b}/B$. (iv) Nature determines which offenders are detected and sanctioned.

The policy maker is benevolent and seeks to maximize welfare, defined by

$$W = \frac{1}{B}\left(\int_{\bar{b}}^{B}(b-h)db - (B-\bar{b})p\tau f\right), \tag{1}$$

where τf, $\tau \in (0, T)$, is the cost of imposing the sanction as a multiple of the sanction itself (Polinsky and Shavell 1992).[6] With respect to the level of deterrence $\bar{b}$, the policy maker's

[6]We consider the standard welfare formulation that includes criminal gains as social gains (see, e.g., Polinsky and Shavell 2009). Note that the cost term τf may also be interpreted as imprisonment costs (see, e.g., Polinsky and Shavell 1984).

objective function features the following derivatives:

$$W_{\bar{b}} = \frac{1}{B}(h + p\tau f - \bar{b}) \tag{2}$$

$$W_{\bar{b}\bar{b}} = -\frac{1}{B} \tag{3}$$

$$W_{\bar{b}p} = \frac{\tau f}{B}. \tag{4}$$

From (2), optimal deterrence from the policy maker's point of view would be achieved for $\bar{b} = h + p\tau f$, that is, when only those crimes are committed for which the offender's benefit surpasses the sum of harm done and the expected costs of imposing the sanction. The second derivative assures that this would constitute a maximum of the policy maker's objective function. The fact that the cross-derivative $W_{\bar{b}p}$ is positive means that the optimal level of deterrence from the policy maker's standpoint is a strictly increasing function of the actual value of the detection probability. Thus, both potential offenders and the policy maker share a preference for fewer offenses, given a higher level of p. In other words, there is some alignment of the policy maker's and potential offenders' interests for positive costs of imposing sanctions, $\tau > 0$. This is a prerequisite for information transmission to occur. Note that in our framework, as is standard for cheap-talk games, the level of the message p^m does not itself affect either the policy maker's or potential offenders' well-being. Only by influencing potential offenders' beliefs about the actual level of the detection probability (p^e), which in turn determines the crime rate, does the policy maker's message affect social and individual welfare.

When sending the message at Stage 2, the policy maker would like to ensure that the level of deterrence is fixed at the level of social costs implied by the commission of the act (i.e., that $\bar{b} = p^e f = h + p\tau f$). As a result, the policy maker would like potential offenders to expect a detection probability equal to $h/f + p\tau$ when the actual level of the detection probability is p. This means that the difference between what the policy maker would like potential offenders to believe and the actual detection probability (denoted by Δ) is a function of the random variable p,

$$\Delta = h/f + p\tau - p = h/f - (1-\tau)p, \quad (5)$$

whenever the level of costs of imposing the sanction differ from the level of the sanction itself (i.e., $\tau \neq 1$). Note that the present problem encounters a sender bias that cannot be represented by a constant as long as the level of the sanction and the level of the cost of its implementation differ, $\tau \neq 1$, a fact that sets our framework apart from most studies on cheap talk (see, e.g., Krishna and Morgan 2008). For $\tau = 1$, the optimal level of deterrence from the policy maker's point of view ($b^* = h + pf$) is, except for the constant level of harm, equal to the one that would be chosen by potential offenders if they were aware of the actual detection probability (pf). This case coincides with the characteristics of the widely applied example in Crawford and Sobel (1982) and will be discussed in more detail in Section 3. More generally, the difference Δ is positive as long as $(1-\tau) < \frac{h}{pf}$. In other words, the policy maker would always like potential offenders to believe that the detection probability is higher than it actually is when the costs of imposing sanctions are relatively high, $\tau \geq 1$, whereas relatively low costs of imposing sanctions, $\tau < 1$, allows for a positive (negative) bias for low (high) levels of p. For relatively high costs of imposing sanctions, the sum of these costs and social harm would surpass the expected sanction if potential offenders knew the actual detection probability. This implies that the policy maker would like to make potential offenders believe that the probability of apprehension is higher than it actually is and explains the overall positive bias in this case. In contrast, for relatively low costs of imposing sanctions, the expected sanction when expectations are formed using the actual level of the detection probability can surpass actual social costs for high levels of the detection probability (i.e., over-deterrence might result). The lower the level of harm associated with the act, the more likely this is to occur. In this case, the policy maker might be interested in encouraging the criminal act by making potential offenders believe that the probability of apprehension is lower than it actually is.

3 Analysis

Our framework includes sequential moves and asymmetric information. Accordingly, in the following analysis, we seek to establish perfect Bayesian equilibria, consisting of (i) a privately optimal message by the policy maker at Stage 2, p^m, contingent on the realization of the detection probability at Stage 1 and on potential offenders' beliefs, (ii) privately optimal decisions by potential offenders at Stage 3, contingent on the message sent by the policy maker at Stage 2 and their beliefs, and (iii) the consistent beliefs $p^e(p^m)$ held by potential offenders. Our interest is in the equilibria in which some information is transmitted, which may thus be compared to the so-called "babbling" equilibrium. In the latter case, potential offenders expect that the policy maker's message contains no information and thus base their decision of whether or not to offend solely on prior information. Since the actual level of p can range from q to Q according to the uniform distribution, the *a priori* expected value of the detection probability is given by $P = (q + Q)/2$. As a result, the share of offenders in the "babbling" equilibrium is $1 - fP/B$. Indeed, given the strategy and beliefs of potential offenders, $p^e = P$ for all p^m, the policy maker indeed has no incentive to convey any information and thus "babbles".

We will proceed as follows: In Section 3.1, we begin by detailing whether the interval for the detection probability can be divided into two subintervals, such that the policy maker's message is either that of a high or a low detection probability. This allows us to establish the general possibility of information transmission with respect to the detection probability. Next, we generalize the possible partition of the interval into n subintervals, creating a finer information transmission. For the special case in which the level of the sanction is equal to the level of the costs of imposing the sanction, $\tau = 1$, we explicitly solve for the maximum number of potential subintervals; we provide a graph to illustrate the possibility for information transmission when $\tau \neq 1$ holds. In Section 3.2, we demonstrate that information transmission is not always beneficial from the policy maker's point of view.

3.1 The possibility of information transmission

Let us now consider the possibility that the interval $[q, Q]$ can be divided into two subintervals as follows: The policy maker sends the message p_1^m whenever $p \in [q, p_1^2]$ and a different message p_2^m whenever $p \in (p_1^2, Q]$; potential offenders decide whether to commit the act based on the expected detection probability $p^e(p_1^m) = (q + p_1^2)/2$ when receiving the former message and based on $p^e(p_2^m) = (p_1^2 + Q)/2$ when receiving the latter.[7] In deriving the expected detection probability, we again assume a uniform distribution of the actual detection probability within the subintervals. Correspondingly, the crime will be committed when $b \geq \bar{b}_1 = \frac{(q+p_1^2)f}{2}$ in the former case and when $b \geq \bar{b}_2 = \frac{(p_1^2+Q)f}{2}$ in the latter case. For this to be an equilibrium, the policy maker must prefer the crime rate $1 - \bar{b}_1/B$ to the crime rate $1 - \bar{b}_2/B$ for $p \in [q, p_1^2]$ and vice versa, and have no preference among the two crime rates when the realization of the detection probability is equal to p_1^2. Formally, this last condition can be stated as

$$\frac{1}{B}\int_{\bar{b}_1}^{B}(b - h - p_1^2\tau f)db = \frac{1}{B}\int_{\bar{b}_2}^{B}(b - h - p_1^2\tau f)db, \tag{6}$$

implying

$$\left[\frac{1}{2}b^2 - (h + p_1^2\tau f)b\right]_{\bar{b}_1}^{\bar{b}_2} = 0. \tag{7}$$

Solving (7) for the level of p_1^2 gives

$$p_1^2 = \frac{\bar{b}_1 + \bar{b}_2 - 2h}{2\tau f}, \tag{8}$$

which may be rearranged to

$$h + p_1^2\tau f = \frac{1}{2}(\bar{b}_1 + \bar{b}_2); \tag{9}$$

this simply states that at the critical level p_1^2, the expected social costs of a marginal offense (the left-hand side of the equation) are equal to the average of the critical benefit levels (the

[7] In the notation with p_t^n, the superscript indicates that the interval $[q, Q]$ is split into n intervals and the subscript indicates that we are considering the t-th critical value for the upper limit of the corresponding subinterval.

right-hand side).

Based on $W_{\bar{b}p} > 0$, we can argue that the policy maker indeed prefers $\bar{b}_2$ to $\bar{b}_1$ when $p > p_1^2$ and $\bar{b}_1$ to $\bar{b}_2$ when $p < p_1^2$. For instance, should the actual detection probability be rather high, $p > p_1^2$, then the policy maker would want fewer potential offenders to actually commit the offense since, in addition to social harm, committing the act implies sanctioning costs τf with the rather high detection probability p. This is thus consistent with the policy maker sending p_1^m whenever $p \in [q, p_1^2]$ to elicit $\bar{b}_1$ and p_2^m whenever $p \in (p_1^2, Q]$ to elicit $\bar{b}_2$.

Inserting the terms for the critical values $\bar{b}_1$ and $\bar{b}_2$ from above into (8), we can state p_1^2 solely as a function of exogenous parameters:

$$p_1^2 = \frac{4h/f - (q+Q)}{2(1-2\tau)}. \tag{10}$$

The existence of an equilibrium in which the interval for the detection probability is partitioned into two subintervals requires that $q < p_1^2 < Q$, which translates into

$$\frac{P}{2} + \frac{q(1-2\tau)}{2} < \frac{h}{f} < \frac{P}{2} + \frac{Q(1-2\tau)}{2} \tag{11}$$

for $\tau < 1/2$, using $P = (q+Q)/2$, and

$$\frac{P}{2} + \frac{q(1-2\tau)}{2} > \frac{h}{f} > \max\left\{\frac{P}{2} + \frac{Q(1-2\tau)}{2}, 0\right\} \tag{12}$$

for $\tau > 1/2$. Accordingly, whether or not the condition for the existence of the subintervals is fulfilled depends on the ratio of the harm and the sanction as well as on the sanctioning costs parameter τ. This will be discussed in more detail later in this section; for now, it is sufficient to note that the above condition can indeed be fulfilled.[8]

We are now in the position to state the following result:

[8] Assume, for example, that $\tau = 1$. In this case, the above condition is fulfilled for every sanction f with $f > 4h/(Q-q)$.

Proposition 1 *Suppose that* $q < p_1^2 < Q$. *There is a partition equilibrium in which the policy maker announces* $p^m \in [q, p_1^2]$ *as a draw from a uniform distribution when* $p \in [q, p_1^2]$ *(*$p^m \in (p_1^2, Q]$ *when* $p \in (p_1^2, Q]$*), where* p_1^2 *is given by* (10)*. Potential offenders choose to offend when criminal gains are greater than or equal to* $\bar{b}_1$ *(*$\bar{b}_2$*), believing that*

$$p^e(p^m) = \begin{cases} (q + p_1^2)/2 & \textit{if } p^m \in [q, p_1^2] \\ (p_1^2 + Q)/2 & \textit{if } p^m \in (p_1^2, Q] \end{cases} \tag{13}$$

Proof. Follows from the above. ■

The characteristics of the equilibrium are such that the policy maker may use any message from the relevant range. The specification of (13) implies that potential offenders' belief after observing any $p^m \in [q, p_1^2]$ ($p^m \in (p_1^2, Q]$) is that p is uniformly distributed on $[q, p_1^2]$ ($(p_1^2, Q]$). As a consequence, there are no messages which are off the equilibrium path, because all possible levels of p are actually used with positive probability in equilibrium. However, note that the equilibrium specified in Proposition 1 is only one possibility of many.[9] However, irrespective of how the partition equilibrium is described, it will always hold that potential offenders' decisions are based on the critical values $\bar{b}_1$ and $\bar{b}_2$ in response to the informative message sent by the policy maker.

The above analysis describes in detail the case of two segments, showing that the decision of whether or not to offend can be (at least somewhat) fine-tuned to the actual detection probability, rather than being based on the *a priori* expected level of p alone. The restriction $q < p_1^2 < Q$ makes it clear that this result is obtained only for certain parameter configurations. Before we turn to illustrations of parameter constellations for which partition equilibria are indeed possible, we propose that finer partitions (implying n segments) may also present equilibria:

[9] Gibbons (1992: 216-217) offers a brief discussion on this subject for the case of the Crawford and Sobel example.

Proposition 2 *Suppose that* $q < p_t^n < Q$ *for all* $t = 1, ..., n-1$. *There is a partition equilibrium in which the policy maker announces* $p^m \in [p_{t-1}^n, p_t^n]$ *as a draw from a uniform distribution when* $p \in [p_{t-1}^n, p_t^n]$ ($p^m \in (p_t^n, p_{t+1}^n]$ *when* $p \in (p_t^n, p_{t+1}^n]$), $t = 1, ..., n-1$, *where* p_t^n *is*

$$p_t^n = \frac{4h/f - (p_{t-1}^n + p_{t+1}^n)}{2(1-2\tau)}, \tag{14}$$

and potential offenders choose to offend when criminal gains are greater than or equal to

$$\bar{b}_t = f(p_{t-1}^n + p_t^n)/2, \tag{15}$$

for $t = 1, ..., n$, *believing that*

$$p^e(p^m) = \begin{cases} (p_{t-1}^n + p_t^n)/2 & \text{if } p^m \in [p_{t-1}^n, p_t^n] \\ (p_t^n + p_{t+1}^n)/2 & \text{if } p^m \in (p_t^n + p_{t+1}^n] \end{cases} \tag{16}$$

Proof. This proposition is a generalization of the result for the partition of the interval for the detection probability into two subintervals, and the calculations required to arrive at the critical values for the subintervals follow those explicated for the case with two subintervals. ■

Equation (14) can be rearranged to yield a second-order linear difference equation with constant coefficients and a constant term. An explicit solution can be derived when the level of sanctioning costs is equal to the level of the sanction itself, $\tau = 1$. A value of $\tau = 1$ implies that the policy maker's preferences are perfectly aligned with the preferences of potential offenders, except for the policy maker's consideration of social harm (the constant bias h/f from (5)). For $\tau = 1$, we can solve (14) to obtain

$$p_t^n = q + (p_1^n - q)t + 2t(t-1)h/f \tag{17}$$

where $p_0^n = q$ and p_1^n is left undetermined. In accordance with Crawford and Sobel (1982), we argue that the finest possible partition can be found by solving $2n(n-1)h/f < Q - q$, which gives the critical value

$$n_c = \frac{1}{2}\left(1 + \sqrt{1 + 2f(Q-q)/h}\right). \tag{18}$$

The maximum number of subintervals equals the maximum integer less than or equal to n_c.

Proposition 3 *Suppose that $q < p_t^n < Q$ for all $t = 1, ..., n-1$ and $\tau = 1$. Then, the finest possible partition n^* follows from (18) as $n^* = int(n_c)$, and increases with the level of the sanction, decreases with the level of harm, and increases with the difference $Q - q$.*

Proof. Follows from the above and the derivatives of (18). ■

Note that both an increase in the level of the sanction and a decrease in the level of harm mean that the subintervals become smaller. This does not need to hold for an increase in the difference $Q - q$, because such an increase widens the interval $[q, Q]$ and thus implies a greater number of subintervals.

Next, we turn to a graphical illustration for the parameter constellations that actually allow for partition equilibria. To this end, we fix $q = 0$, $Q = 1$, $f = B = 1$ in Figure 1, which depicts combinations of the level of sanctioning costs $\tau \in (0, 2)$ and the level of harm $h \in (0, 1)$. Accordingly, in the graph, the level of the sanction always exceeds the level of harm. In line with intuition, finer partitions are possible only when the region features fewer possible combinations of τ and h than more coarsely partitioned regions. In our graph, the shaded areas indicate the existence of equilibria with between two and five subintervals. The darkest area indicates combinations for which five segments are possible. The parameter combinations with finer information transmission are always a subset of the parameter combinations allowing for less fine information transmission. In general, the parameters allowing for finer partitions are such that the level of sanctioning costs is relatively high compared to the level of social harm resulting from the criminal act. This can be traced back to the fact that the sanctioning costs are the factor causing the alignment of the respective preferences of the policy maker and potential offenders, whereas the level of harm creates a divergence in preferences. The findings with respect to social harm correspond to what may be deduced from (18).

The shaded area in the upper left-hand corner of Figure 1 indicates additional parameter combinations for which a partition into two subintervals is possible. The parameter configurations of this area are such that the difference Δ is positive (negative) for low (high) levels of the detection probability, implying that the policy maker would like to make potential offenders believe that p is higher (lower) than it actually is for low (high) levels. Let us consider an illustrative example. It is possible to have a partition with two segments when $h = .6$ and $\tau = .05$. In this case, the difference is $\Delta = .4 - .95p$ and equals zero when $p = .63$. The critical level p_1^2 in this case is equal to .78, balancing the fact that the policy maker tends toward an overstatement in the first segment of the partition and toward an understatement in the second.[10] The scenario in which parameters are such that Δ is positive or negative depending on the level of p is not a case that allows for a finer partition.

3.2 The expected payoffs of the policy maker and of offenders

In this subsection, we briefly discuss the influence of the fineness of information transmission on the payoffs of the policy maker and of potential offenders. With regard to potential offenders, who act as receivers of the message, the results of Crawford and Sobel (1982) carry over to our framework, i.e., an equilibrium with a finer partition benefits potential offenders ex ante but not necessarily ex post. Before the actual detection probability is drawn according to its distribution function, a finer partition ensures that potential offenders' beliefs are closer to the actual value, thereby enabling decisions regarding crime that are on average more accurately aligned with the actual detection probability. In contrast, after the actual detection probability is drawn according to its distribution function, it may be that the actual level of p is such that another partition with less information transmission

[10] The ranking of the level of p for which $\Delta = 0$ and p_1^2 need not be such that the latter is always greater than the former in the upper left-hand shaded area; the reverse may also be true. This results, for example, for $\tau = .2$ and $h = .26$.

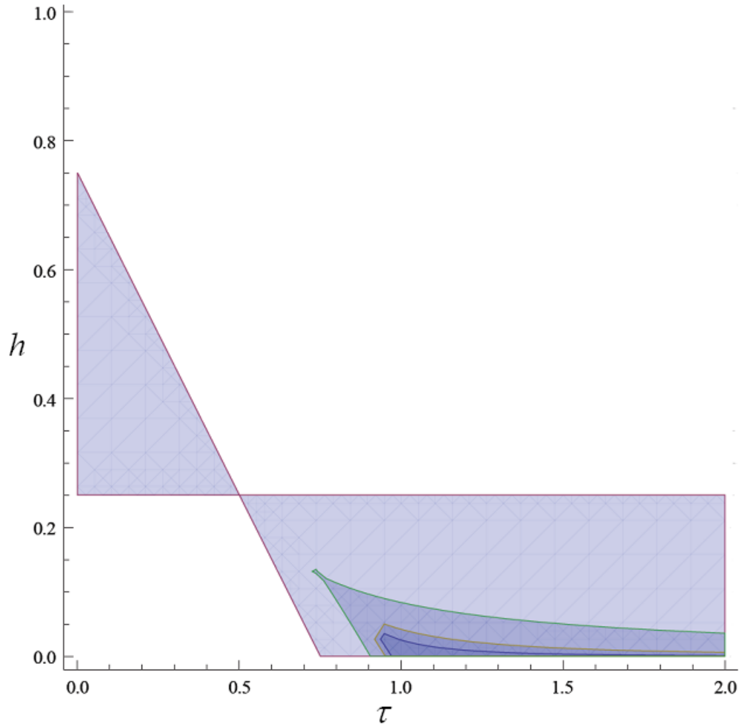

Figure 1: Parameter ranges of $\tau \in (0, 2)$ and $h \in (0, 1)$ for partition equilibria

would have led to a more profitable decision from the point of view of potential offenders. For example, suppose that the actual draw of p is equal to $P = (q + Q)/2$. In this case, the "babbling" equilibrium induces privately optimal offense decisions made by potential offenders, whereas finer partitions induce a deviation. In contrast to the above discussion for potential offenders, with regard to the policy maker as the sender of the message, we find that a finer partition may actually decrease expected payoffs ex ante.

Proposition 4 *Suppose that $q < p_1^2 < Q$. The policy maker (i.e., society) benefits from a finer equilibrium partition of the range of detection probabilities into two subintervals ex ante only if $\tau > 1/2$.*

Proof. The societal welfare level without information transmission is

$$W_1 = \int_q^Q \frac{1}{Q-q} \int_{f(q+Q)/2}^B (b - h - p\tau f) \frac{db}{B} dp,$$

and

$$W_2 = \int_q^{p_1^2} \frac{1}{Q-q} \int_{f(q+p_1^2)/2}^B (b - h - p\tau f) \frac{db}{B} dp + \int_{p_1^2}^Q \frac{1}{Q-q} \int_{f(p_1^2+Q)/2}^B (b - h - p\tau f) \frac{db}{B} dp$$

when there is a partition of the full interval into two subintervals. The policy maker benefits from information transmission when

$$\begin{aligned} W_2 - W_1 &= \frac{(4h - f[Q + q(3-4\tau)])(4h - f[q + Q(3-4\tau)])}{32B(1-2\tau)} \\ &= \frac{f^2}{2B(1-2\tau)} \left(\frac{h}{f} - \frac{Q + q(3-4\tau)}{4} \right) \left(\frac{h}{f} - \frac{q + Q(3-4\tau)}{4} \right) \\ &= \frac{f^2}{2B(1-2\tau)} \left(\frac{h}{f} - \left(\frac{P}{2} + \frac{q(1-2\tau)}{2} \right) \right) \left(\frac{h}{f} - \left(\frac{P}{2} + \frac{Q(1-2\tau)}{2} \right) \right) > 0 \end{aligned}$$

Equations (11) and (12) imply that the product of the last two terms in brackets in the above equation is negative when $q < p_1^2 < Q$. As a result, the policy maker is better off in the equilibrium with a partition into two subintervals than in the "babbling" equilibrium only if $\tau > 1/2$. ■

The constellations identified by the requirements $q < p_1^2 < Q$ and $\tau < 1/2$ are instances in which Δ is positive for low realizations of p and negative for high realizations of p. In other words, if perfect information transmission were possible ($p^e = p$), there would be underdeterrence (overdeterrence) for low (high) values of p. Consequently, a finer information partition also implies that offenders would be led further astray from optimal deterrence if the actual detection probability is rather low or high. For the parameter range in question, the level of harm caused by criminal acts is relatively high (see Figure 1). Accordingly, the negative influence of a deterrence level that is inappropriate in view of the harm caused is more important from the social welfare perspective than it is for the other parameter range that allows an equilibrium with two segments. In summary, our findings contradict the results of the classic example in Crawford and Sobel (1982).

The negative effect on the ex-ante expected payoffs of the policy maker in the case of two subintervals results for low levels of τ, that is, in a scenario in which the costs of imposing a sanction are relatively low compared to the level of the sanction. This may be interpreted as being more likely in the case of minor offenses in which the sanction is often a monetary transfer. In contrast, in a case in which the sanction includes incarceration of the offender, it might be supposed that the costs of imposing the sanction would be rather high. This latter case is relevant for more severe crimes.

4 Conclusion

Potential offenders are often agnostic about law enforcement policy. This suggests that many misguided decisions about the commission of crimes are made, and provides a public policy rationale for the dissemination of information on law enforcement policies. However, any attempt to publicize law enforcement policies in order to prevent unwise offense decisions may suffer from problems of credibility. We analyze this problem in terms of a cheap-talk game and establish that policy makers can under certain conditions transmit information about law enforcement policy. This paper delineates the influence of important parameters, such as the level of the sanction, the level of costs associated with the imposition of the sanction, and the level of social harm due to the commission of the activity in this context. Instances characterized by a high level of costs associated with the imposition of the sanction or with high levels of the sanction are more conducive to finer information transmission, whereas instances with high levels of harm are less conducive, ceteris paribus. With regard to expected payoffs, we find that the transmission of information is not necessarily beneficial to social welfare.

References

Austen-Smith, D., 1990. Information transmission in debate. American Journal of Political Science 34, 124-152.

Bebchuk, L., Kaplow, L., 1992. Optimal sanctions when individuals are imperfectly informed about the probability of apprehension. Journal of Legal Studies 21, 365-370.

Becker, G., 1968. Crime and punishment: An economic approach. Journal of Political Economy 76, 169-217.

Ben-Shahar, O., 1997. Playing without a rulebook: Optimal enforcement when individuals learn the penalty only by committing the crime. International Review of Law and Economics 17, 409-421.

Cameron, S., 1988. The economics of crime deterrence: A survey of theory and evidence. Kyklos 41, 301-323.

Crawford, V., Sobel, J., 1982. Strategic information transmission. Econometrica 50, 1431-1451.

Farrell, J., Rabin, M., 1996. Cheap talk. Journal of Economic Perspectives 10, 103-118.

Garoupa, N., 1999. Optimal law enforcement with dissemination of information. European Journal of Law and Economics 7, 183-196.

Gibbons, R., 1992. A primer in game theory. Essex: Pearson.

Ivanov, M., 2010. Communication via a strategic mediator. Journal of Economic Theory 145, 869-884.

Kenkel, D., Koch, S., 2001. Deterrence and knowledge of the law: The case of drunk driving. Applied Economics 33, 845-854.

Kleiman, M., 2009. When brute force fails. Princeton: Princeton University Press.

Krishna, V., Morgan, J., 2001. A model of expertise. Quarterly Journal of Economics 116, 747-775.

Krishna, V., Morgan, J., 2008. Cheap talk. In: Durlauf, S., Blume, L. (Eds.). The New

Palgrave Dictionary of Economics. Second Edition. Palgrave Macmillan.

Lochner, L., 2007. Individual perceptions of the criminal justice system. American Economic Review 97, 444-460.

Polinsky, A.M., 2006. The optimal use of fines and imprisonment when wealth is unobservable. Journal of Public Economics 90, 823-835.

Polinsky, A.M., Shavell, S., 1984. The optimal use of fines and imprisonment. Journal of Public Economics 24, 89-99.

Polinsky, A.M., Shavell, S., 1992. Enforcement costs and the optimal magnitude and probability of fines. Journal of Law and Economics 35, 133148.

Polinsky, A.M., Shavell, S., 2001. Corruption and optimal law enforcement. Journal of Public Economics 81, 1-24.

Polinsky, A.M., Shavell, S., 2009. Public enforcement of law. In: Garoupa, N. (Ed.). Criminal Law and Economics. Northhampton, MA: Edward Elgar.

Robinson, P.H., Darley, J.M., 2004. Does criminal law deter? A behavioral science investigation. Oxford Journal of Legal Studies 24, 173-205.

Sah, R., 1991. Social osmosis and crime. Journal of Political Economy 99, 1272-1295.

Schmitt, J., Warner, K., Gupta, S., 2010. The high budgetary cost of incarceration. CEPR Report June 2010.

PREVIOUS DISCUSSION PAPERS

90 Baumann, Florian and Friehe, Tim, Cheap Talk About the Detection Probability, April 2013.

89 Pagel, Beatrice and Wey, Christian, How to Counter Union Power? Equilibrium Mergers in International Oligopoly, April 2013.

88 Jovanovic, Dragan, Mergers, Managerial Incentives, and Efficiencies, April 2013.

87 Heimeshoff, Ulrich and Klein Gordon J., Bargaining Power and Local Heroes, March 2013.

86 Bertschek, Irene, Cerquera, Daniel and Klein, Gordon J., More Bits – More Bucks? Measuring the Impact of Broadband Internet on Firm Performance, February 2013.
Forthcoming in: Information Economics and Policy.

85 Rasch, Alexander and Wenzel, Tobias, Piracy in a Two-Sided Software Market, February 2013.
Published in: Journal of Economic Behavior & Organization, 88 (2013), pp. 78-89.

84 Bataille, Marc and Steinmetz, Alexander, Intermodal Competition on Some Routes in Transportation Networks: The Case of Inter Urban Buses and Railways, January 2013.

83 Haucap, Justus and Heimeshoff, Ulrich, Google, Facebook, Amazon, eBay: Is the Internet Driving Competition or Market Monopolization?, January 2013.
Forthcoming in: International Economics and Economic Policy.

82 Regner, Tobias and Riener, Gerhard, Voluntary Payments, Privacy and Social Pressure on the Internet: A Natural Field Experiment, December 2012.

81 Dertwinkel-Kalt, Markus and Wey, Christian, The Effects of Remedies on Merger Activity in Oligopoly, December 2012.

80 Baumann, Florian and Friehe, Tim, Optimal Damages Multipliers in Oligopolistic Markets, December 2012.

79 Duso, Tomaso, Röller, Lars-Hendrik and Seldeslachts, Jo, Collusion through Joint R&D: An Empirical Assessment, December 2012.
Forthcoming in: The Review of Economics and Statistics.

78 Baumann, Florian and Heine, Klaus, Innovation, Tort Law, and Competition, December 2012.

77 Coenen, Michael and Jovanovic, Dragan, Investment Behavior in a Constrained Dictator Game, November 2012.

76 Gu, Yiquan and Wenzel, Tobias, Strategic Obfuscation and Consumer Protection Policy in Financial Markets: Theory and Experimental Evidence, November 2012.

75 Haucap, Justus, Heimeshoff, Ulrich and Jovanovic, Dragan, Competition in Germany’s Minute Reserve Power Market: An Econometric Analysis, November 2012.

74 Normann, Hans-Theo, Rösch, Jürgen and Schultz, Luis Manuel, Do Buyer Groups Facilitate Collusion?, November 2012.

73 Riener, Gerhard and Wiederhold, Simon, Heterogeneous Treatment Effects in Groups, November 2012.

72 Berlemann, Michael and Haucap, Justus, Which Factors Drive the Decision to Boycott and Opt Out of Research Rankings? A Note, November 2012.

71 Muck, Johannes and Heimeshoff, Ulrich, First Mover Advantages in Mobile Telecommunications: Evidence from OECD Countries, October 2012.

70 Karaçuka, Mehmet, Çatik, A. Nazif and Haucap, Justus, Consumer Choice and Local Network Effects in Mobile Telecommunications in Turkey, October 2012.
Forthcoming in: Telecommunications Policy, 37 (2013), pp. 334-344.

69 Clemens, Georg and Rau, Holger A., Rebels without a Clue? Experimental Evidence on Partial Cartels, April 2013 (First Version October 2012).

68 Regner, Tobias and Riener, Gerhard, Motivational Cherry Picking, September 2012.

67 Fonseca, Miguel A. and Normann, Hans-Theo, Excess Capacity and Pricing in Bertrand-Edgeworth Markets: Experimental Evidence, September 2012.
Forthcoming in: Journal of Institutional and Theoretical Economics.

66 Riener, Gerhard and Wiederhold, Simon, Team Building and Hidden Costs of Control, September 2012.

65 Fonseca, Miguel A. and Normann, Hans-Theo, Explicit vs. Tacit Collusion – The Impact of Communication in Oligopoly Experiments, August 2012.
Published in: European Economic Review, 56 (2012), pp. 1759-1772.

64 Jovanovic, Dragan and Wey, Christian, An Equilibrium Analysis of Efficiency Gains from Mergers, July 2012.

63 Dewenter, Ralf, Jaschinski, Thomas and Kuchinke, Björn A., Hospital Market Concentration and Discrimination of Patients, July 2012.

62 Von Schlippenbach, Vanessa and Teichmann, Isabel, The Strategic Use of Private Quality Standards in Food Supply Chains, May 2012.
Forthcoming in: American Journal of Agricultural Economics.

61 Sapi, Geza, Bargaining, Vertical Mergers and Entry, July 2012.

60 Jentzsch, Nicola, Sapi, Geza and Suleymanova, Irina, Targeted Pricing and Customer Data Sharing Among Rivals, July 2012.
Published in: International Journal of Industrial Organization, 31 (2013), pp. 131-144.

59 Lambarraa, Fatima and Riener, Gerhard, On the Norms of Charitable Giving in Islam: A Field Experiment, June 2012.

58 Duso, Tomaso, Gugler, Klaus and Szücs, Florian, An Empirical Assessment of the 2004 EU Merger Policy Reform, June 2012.

57 Dewenter, Ralf and Heimeshoff, Ulrich, More Ads, More Revs? Is there a Media Bias in the Likelihood to be Reviewed?, June 2012.

56 Böckers, Veit, Heimeshoff, Ulrich and Müller Andrea, Pull-Forward Effects in the German Car Scrappage Scheme: A Time Series Approach, June 2012.

55 Kellner, Christian and Riener, Gerhard, The Effect of Ambiguity Aversion on Reward Scheme Choice, June 2012.

54 De Silva, Dakshina G., Kosmopoulou, Georgia, Pagel, Beatrice and Peeters, Ronald, The Impact of Timing on Bidding Behavior in Procurement Auctions of Contracts with Private Costs, June 2012.
Published in: Review of Industrial Organization, 41 (2013), pp.321-343.

53 Benndorf, Volker and Rau, Holger A., Competition in the Workplace: An Experimental Investigation, May 2012.

52 Haucap, Justus and Klein, Gordon J., How Regulation Affects Network and Service Quality in Related Markets, May 2012.
Published in: Economics Letters, 117 (2012), pp. 521-524.

51 Dewenter, Ralf and Heimeshoff, Ulrich, Less Pain at the Pump? The Effects of Regulatory Interventions in Retail Gasoline Markets, May 2012.

50 Böckers, Veit and Heimeshoff, Ulrich, The Extent of European Power Markets, April 2012.

49 Barth, Anne-Kathrin and Heimeshoff, Ulrich, How Large is the Magnitude of Fixed-Mobile Call Substitution? - Empirical Evidence from 16 European Countries, April 2012.

48 Herr, Annika and Suppliet, Moritz, Pharmaceutical Prices under Regulation: Tiered Co-payments and Reference Pricing in Germany, April 2012.

47 Haucap, Justus and Müller, Hans Christian, The Effects of Gasoline Price Regulations: Experimental Evidence, April 2012.

46 Stühmeier, Torben, Roaming and Investments in the Mobile Internet Market, March 2012.
Published in: Telecommunications Policy, 36 (2012), pp. 595-607.

45 Graf, Julia, The Effects of Rebate Contracts on the Health Care System, March 2012.

44 Pagel, Beatrice and Wey, Christian, Unionization Structures in International Oligopoly, February 2012.
Published in: Labour: Review of Labour Economics and Industrial Relations, 27 (2013), pp. 1-17.

43 Gu, Yiquan and Wenzel, Tobias, Price-Dependent Demand in Spatial Models, January 2012.
Published in: B. E. Journal of Economic Analysis & Policy,12 (2012), Article 6.

42 Barth, Anne-Kathrin and Heimeshoff, Ulrich, Does the Growth of Mobile Markets Cause the Demise of Fixed Networks? – Evidence from the European Union, January 2012.

41 Stühmeier, Torben and Wenzel, Tobias, Regulating Advertising in the Presence of Public Service Broadcasting, January 2012.
Published in: Review of Network Economics, 11, 2 (2012), Article 1.

40 Müller, Hans Christian, Forecast Errors in Undisclosed Management Sales Forecasts: The Disappearance of the Overoptimism Bias, December 2011.

39 Gu, Yiquan and Wenzel, Tobias, Transparency, Entry, and Productivity, November 2011.
Published in: Economics Letters, 115 (2012), pp. 7-10.

38 Christin, Clémence, Entry Deterrence Through Cooperative R&D Over-Investment, November 2011.
Forthcoming in: Louvain Economic Review.

37 Haucap, Justus, Herr, Annika and Frank, Björn, In Vino Veritas: Theory and Evidence on Social Drinking, November 2011.

36 Barth, Anne-Kathrin and Graf, Julia, Irrationality Rings! – Experimental Evidence on Mobile Tariff Choices, November 2011.

35 Jeitschko, Thomas D. and Normann, Hans-Theo, Signaling in Deterministic and Stochastic Settings, November 2011.
Published in: Journal of Economic Behavior and Organization, 82 (2012), pp.39-55.

34 Christin, Cémence, Nicolai, Jean-Philippe and Pouyet, Jerome, The Role of Abatement Technologies for Allocating Free Allowances, October 2011.

33 Keser, Claudia, Suleymanova, Irina and Wey, Christian, Technology Adoption in Markets with Network Effects: Theory and Experimental Evidence, October 2011.
Published in: Information Economics and Policy, 24 (2012), pp. 262-276.

32 Çatik, A. Nazif and Karaçuka, Mehmet, The Bank Lending Channel in Turkey: Has it Changed after the Low Inflation Regime?, September 2011.
Published in: Applied Economics Letters, 19 (2012), pp. 1237-1242.

31 Hauck, Achim, Neyer, Ulrike and Vieten, Thomas, Reestablishing Stability and Avoiding a Credit Crunch: Comparing Different Bad Bank Schemes, August 2011.

30 Suleymanova, Irina and Wey, Christian, Bertrand Competition in Markets with Network Effects and Switching Costs, August 2011.
Published in: B. E. Journal of Economic Analysis & Policy, 11 (2011), Article 56.

29 Stühmeier, Torben, Access Regulation with Asymmetric Termination Costs, July 2011.
Published in: Journal of Regulatory Economics, 43 (2013), pp. 60-89.

28 Dewenter, Ralf, Haucap, Justus and Wenzel, Tobias, On File Sharing with Indirect Network Effects Between Concert Ticket Sales and Music Recordings, July 2011.
Published in: Journal of Media Economics, 25 (2012), pp. 168-178.

27 Von Schlippenbach, Vanessa and Wey, Christian, One-Stop Shopping Behavior, Buyer Power, and Upstream Merger Incentives, June 2011.

26 Balsmeier, Benjamin, Buchwald, Achim and Peters, Heiko, Outside Board Memberships of CEOs: Expertise or Entrenchment?, June 2011.

25 Clougherty, Joseph A. and Duso, Tomaso, Using Rival Effects to Identify Synergies and Improve Merger Typologies, June 2011.
Published in: Strategic Organization, 9 (2011), pp. 310-335.

24 Heinz, Matthias, Juranek, Steffen and Rau, Holger A., Do Women Behave More Reciprocally than Men? Gender Differences in Real Effort Dictator Games, June 2011.
Published in: Journal of Economic Behavior and Organization, 83 (2012), pp. 105-110.

23 Sapi, Geza and Suleymanova, Irina, Technology Licensing by Advertising Supported Media Platforms: An Application to Internet Search Engines, June 2011.
Published in: B. E. Journal of Economic Analysis & Policy, 11 (2011), Article 37.

22 Buccirossi, Paolo, Ciari, Lorenzo, Duso, Tomaso, Spagnolo Giancarlo and Vitale, Cristiana, Competition Policy and Productivity Growth: An Empirical Assessment, May 2011.
Forthcoming in: The Review of Economics and Statistics.

21 Karaçuka, Mehmet and Çatik, A. Nazif, A Spatial Approach to Measure Productivity Spillovers of Foreign Affiliated Firms in Turkish Manufacturing Industries, May 2011.
Published in: The Journal of Developing Areas, 46 (2012), pp. 65-83.

20 Çatik, A. Nazif and Karaçuka, Mehmet, A Comparative Analysis of Alternative Univariate Time Series Models in Forecasting Turkish Inflation, May 2011.
Published in: Journal of Business Economics and Management, 13 (2012), pp. 275-293.

19 Normann, Hans-Theo and Wallace, Brian, The Impact of the Termination Rule on Cooperation in a Prisoner's Dilemma Experiment, May 2011.
Published in: International Journal of Game Theory, 41 (2012), pp. 707-718.

18 Baake, Pio and von Schlippenbach, Vanessa, Distortions in Vertical Relations, April 2011.
Published in: Journal of Economics, 103 (2011), pp. 149-169.

17 Haucap, Justus and Schwalbe, Ulrich, Economic Principles of State Aid Control, April 2011.
Forthcoming in: F. Montag & F. J. Säcker (eds.), European State Aid Law: Article by Article Commentary, Beck: München 2012.

16 Haucap, Justus and Heimeshoff, Ulrich, Consumer Behavior towards On-net/Off-net Price Differentiation, January 2011.
Published in: Telecommunication Policy, 35 (2011), pp. 325-332.

15 Duso, Tomaso, Gugler, Klaus and Yurtoglu, Burcin B., How Effective is European Merger Control? January 2011.
Published in: European Economic Review, 55 (2011), pp. 980-1006.

14 Haigner, Stefan D., Jenewein, Stefan, Müller, Hans Christian and Wakolbinger, Florian, The First shall be Last: Serial Position Effects in the Case Contestants evaluate Each Other, December 2010.
Published in: Economics Bulletin, 30 (2010), pp. 3170-3176.

13 Suleymanova, Irina and Wey, Christian, On the Role of Consumer Expectations in Markets with Network Effects, November 2010.
Published in: Journal of Economics, 105 (2012), pp. 101-127.

12 Haucap, Justus, Heimeshoff, Ulrich and Karaçuka, Mehmet, Competition in the Turkish Mobile Telecommunications Market: Price Elasticities and Network Substitution, November 2010.
Published in: Telecommunications Policy, 35 (2011), pp. 202-210.

11 Dewenter, Ralf, Haucap, Justus and Wenzel, Tobias, Semi-Collusion in Media Markets, November 2010.
Published in: International Review of Law and Economics, 31 (2011), pp. 92-98.

10 Dewenter, Ralf and Kruse, Jörn, Calling Party Pays or Receiving Party Pays? The Diffusion of Mobile Telephony with Endogenous Regulation, October 2010.
Published in: Information Economics and Policy, 23 (2011), pp. 107-117.

09 Hauck, Achim and Neyer, Ulrike, The Euro Area Interbank Market and the Liquidity Management of the Eurosystem in the Financial Crisis, September 2010.

08 Haucap, Justus, Heimeshoff, Ulrich and Luis Manuel Schultz, Legal and Illegal Cartels in Germany between 1958 and 2004, September 2010.
Published in: H. J. Ramser & M. Stadler (eds.), Marktmacht. Wirtschaftswissenschaftliches Seminar Ottobeuren, Volume 39, Mohr Siebeck: Tübingen 2010, pp. 71-94.

07 Herr, Annika, Quality and Welfare in a Mixed Duopoly with Regulated Prices: The Case of a Public and a Private Hospital, September 2010.
Published in: German Economic Review, 12 (2011), pp. 422-437.

06 Blanco, Mariana, Engelmann, Dirk and Normann, Hans-Theo, A Within-Subject Analysis of Other-Regarding Preferences, September 2010.
Published in: Games and Economic Behavior, 72 (2011), pp. 321-338.

05 Normann, Hans-Theo, Vertical Mergers, Foreclosure and Raising Rivals' Costs – Experimental Evidence, September 2010.
Published in: The Journal of Industrial Economics, 59 (2011), pp. 506-527.

04 Gu, Yiquan and Wenzel, Tobias, Transparency, Price-Dependent Demand and Product Variety, September 2010.
Published in: Economics Letters, 110 (2011), pp. 216-219.

03 Wenzel, Tobias, Deregulation of Shopping Hours: The Impact on Independent Retailers and Chain Stores, September 2010.
Published in: Scandinavian Journal of Economics, 113 (2011), pp. 145-166.

02 Stühmeier, Torben and Wenzel, Tobias, Getting Beer During Commercials: Adverse Effects of Ad-Avoidance, September 2010.
Published in: Information Economics and Policy, 23 (2011), pp. 98-106.

01 Inderst, Roman and Wey, Christian, Countervailing Power and Dynamic Efficiency, September 2010.
Published in: Journal of the European Economic Association, 9 (2011), pp. 702-720.

Heinrich-Heine-University of Düsseldorf

Düsseldorf Institute for
Competition Economics (DICE)

Universitätsstraße 1 _ 40225 Düsseldorf
www.dice.hhu.de

ISSN 2190-9938 (online)
ISBN 978-3-86304-089-5