

# Criminal behavior and social evolution \*

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## Abstract

In a society with two types of individuals, honest ones and criminals, individual behavioral patterns are individually decided upon through interaction with the rest of society. In deciding its behavioral pattern, an individual considers the behavior of individuals in individual encounters, aggregate behavior in society – the norm –, as well as the gains from criminal activity.

It is shown that dynamically stable equilibria with a low and a high crime rate can obtain under various assumptions. It is further demonstrated that a small exogenous increase in the gain from crime may lead to a non-reversible structural change with a substantial increase in criminal behavior in society.

## 1 Introduction

In the economic literature on crime, individuals are usually seen as rational (expected) utility maximizers, balancing the gains of criminal activity against the expected punishment.<sup>1</sup> Moral constraints on criminal behavior are generally reflected in the form of the utility functions and individuals differ in their utility functions, making some persons honest and others criminal under given institutional setups. If crime pays to a certain individual is then determined by the external constraints facing it. Important variables here are, for instance, probability of being caught and severity of the subsequent punishment, as well as the gain from the crime. Tax evasion is a prime example of this type of analysis, see, for instance, Allingham and Sandmo (1972).

If individuals differ in their moral strength, this, as we noted above, is the main criterion determining who stays honest and who becomes a criminal. That is, for each individual there exists threshold values of the gain from crime and the expected (utility-)cost of punishment, making the individual indifferent between honest behavior and a career as a criminal. We can order the individuals in society according to their propensity for criminal activity. When the cost of crime increases, criminal individuals with a sufficiently low propensity for crime will change their behavior and become honest. Hence, there exists for each institutional set up a pivotal propensity for crime: each individual with a higher value of its propensity for crime will become a criminal, and an individual with a lower propensity than the pivotal one will stay honest. That is, the fraction of individuals with an honest behavior increases as the severity of punishment increases. Generally, the individual propensities for criminal behavior are assumed to be constant and given.

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<sup>1</sup>Among the best-known analyses is the work of G. Becker, see Becker (1968).

In this essay, we take our point of departure in this type of models and extend them in different directions. We assume that the moral restraints are determined in social interactions between different individuals.<sup>2</sup> Norms influencing behavior are endogenously determined by actual behavior.<sup>3</sup> In order to do this, we have to introduce a dynamic aspect. Also this is done in the simplest possible way. We model the dynamics of the aggregate behavior and reduce individual behavior to statistical expectations. This is the same technique that is used in Wickström (2005). We imagine that each individual is characterized by a function  $h(i; n, e)$  describing its moral resistance against crime expressed in monetary terms;  $i$  is the index defining the individual,  $n$  is the strength of the norm implying honest behavior, and  $e$  is the experience of the individual in social encounters. That is,  $h$  is the opposite of the propensity for crime and is the answer to the question: How much do I have to pay you in order to make you a criminal? If  $c$  is the externally given opportunity cost of being a criminal, that is the gain from crime, than  $c - h(i; n, e)$  is the net subjective gain from crime of individual  $i$ . If this, or the expected value of some transformation thereof, is positive, the individual decides to become a criminal – a type 2 –, if negative, it stays honest – type 1.

The central variable in our analysis is the fraction of honest individuals in the total population, denoted by  $p$ . That is, all the individuals above the threshold discussed above. We cause the strength of the norm to be endogenous by letting  $n = p$ . Hence, the threshold for becoming a criminal is assumed to increase with the fraction of individuals being honest. However, an honest individual can also end up in bad company – or a criminal in good company. This can also influence the individual propensity for crime; this is the variable  $e$ . The basic assumption is that you go through life randomly encountering different individuals on your way. If you meet a good person  $h$  as a rule tends to increase, if you meet a bad guy,  $h$  generally tends to decrease; you, generally speaking, become more like the people you meet. This, of course, means that some honest individuals will pass the threshold and become criminal upon encountering a criminal, and some criminals will change their ways and become honest after encountering an honest person. The fraction of honest people which becomes criminal after encountering a criminal – in other words, the probability that an honest person becomes a criminal after meeting a criminal – is denoted by  $\alpha^{12}(2)$  below. Similarly,  $\alpha^{21}(1)$  denotes the probability that a criminal decides to be honest after meeting a good person. Of course, a good person can also take up a criminal career after encountering a good person. This probability,  $\alpha^{12}(1)$ , is, however, assumed to be smaller than  $\alpha^{12}(2)$  and so on.

With this instrumentarium we will analyze the possible social equilibria, that is stable dynamic equilibria in  $p$ . We will demonstrate that multiple equilibria are possible, with a "high" equilibrium of a "good" society and a "low" equilibrium of an unsafe criminal society. We will also show that exogenous changes can cause a "jump" from the high to the low equilibrium, but not so easily a jump from the low to the high one. In other words, the well-ordered, good society is vulnerable to external shocks.

## 2 A simple basic model

We model an economy with a great number of individuals. They are of two types, honest ones, type 1, making up a fraction  $p$  of the total population, and criminals, type 2, making up the rest, a fraction  $1 - p$  of the population. Each individual decides itself if it will be type 1 or type 2. We imagine that the individuals go through life encountering others on the way and by each encounter decide, how to behave. The simplest model we can imagine is one where gains and losses occur due to the encounters and these gains, or losses, depend on the types of the encountering individuals. This can, for instance, be according

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<sup>2</sup>Endogeneity of preferences is treated in, for instance, Stiegler and Becker (1977); see also Wickström (1979).

<sup>3</sup>The idea that aggregate behavior influences individual behavior goes back at least to the relative income hypothesis, see Duesenberry (1949). An approach similar to ours can be found in Schlicht (1981b) and Schlicht (1981a).

to the following matrix, where the payoffs are given as *(row, column)*:

	1	2
1	$w, w$	$x, y$
2	$y, x$	$z, z$

(2.1)

The payoffs satisfy

$$x < z < w < y, \quad (2.2)$$

that is, we have a situation characterized as the Prisoner's dilemma. We can define the opportunity costs of being honest in face of an honest encounter,  $c^1$ , and in face of an encounter with a criminal,  $c^2$ , as

$$\begin{aligned} c^1 &:= y - w > 0 \\ c^2 &:= z - x > 0 \end{aligned} \quad . \quad (2.3)$$

Of course, if the opportunity costs of being honest do not depend on the type of the individual encountered, the  $c$ 's are identical.

## 2.1 Prisoner's dilemma equilibrium

It is easy to see that, in the absence of moral constraints,  $h$ , in such a situation a dominant strategy for each individual is to be a criminal, choosing to be type 2. That is, the only stable equilibrium value of  $p$ ,  $\hat{p}$ , is given by  $\hat{p} = 0$ . This is the situation, if the individuals decide independently of previous experience and feel no pressure from ethic norms or the like. Needless to say, this is not a very efficient outcome.

Of course, if an individual feels moral constraints that are sufficiently strong, that is

$$h > \max \{c^1, c^2\}, \quad (2.4)$$

it would chose to be honest, and if all individuals behave that way, the equilibrium value of  $p$  is 1, and the equilibrium is efficient. Knowing the strength of the norm,  $p$ , a risk-neutral individuum would be honest if

$$h > pc^1 + (1 - p)c^2, \quad (2.5)$$

and an equilibrium value of  $p$  would imply that a fraction  $p$  of the population would satisfy the inequality and the rest of the population, a fraction  $(1 - p)$ , would satisfy the complementary inequality.

## 3 Dynamics

In a dynamic model, we will modify the picture above in two ways. Firstly, we will assume that behavior is influenced by experience. That is, each individual starts out with a certain behavioral pattern, which it reconsiders after each encounter with another individual. If it encounters an honest individual, chances are better that it will remain or become honest than if it encounters a criminal. Secondly, we will assume that in addition to the opportunity costs of being honest, there exists a certain moral pressure to be honest, and that both these aspects influence the individual behavior.

### 3.1 Behavioral sclerosis

We first investigate the consequences of individuals being characterized by a certain behavioral inertia. They do not change their behavior easily, but sometimes change it as a result of the interaction with other individuals. That is, each individual is initially characterized by one of the two behavioral patterns and at each encounter there is a certain probability that it will keep its type and a certain probability that

it will adopt the other pattern. In other words, the opportunity cost of being honest, which is balanced by a "moral cost" of being criminal, will occasionally be adjusted as a result of experience. Write the transition probabilities as  $\alpha^{ij}(k)$ , where  $i$  is the initial type,  $j$  the type after the encounter, and  $k$  the type of the individual encountered. In other words,  $\alpha^{12}(2)$  is the probability that an individual satisfying inequality 2.5 before the encounter with an individual of type 2 (who does not satisfy the inequality), will change its  $h$  such that the inequality is not satisfied any more after the encounter.

### 3.1.1 Dynamic structure

The encounters are at random; that is, the probability that an individual encounters an individual of type 1 is  $p$ , and the probability that it encounters someone of type 2 is  $(1-p)$ . We can now write the probability,  $\pi^{11}$  that any individual of type 1 remains a type 1 individual after a random encounter as

$$\pi^{11} = p\alpha^{11}(1) + (1-p)\alpha^{11}(2). \quad (3.1)$$

Similarly, we find

$$\begin{aligned} \pi^{12} &= p\alpha^{12}(1) + (1-p)\alpha^{12}(2) \\ \pi^{21} &= p\alpha^{21}(1) + (1-p)\alpha^{21}(2) \\ \pi^{22} &= p\alpha^{22}(1) + (1-p)\alpha^{22}(2) \end{aligned} \quad (3.2)$$

Imagining discrete time, and for each individual only one encounter in each period, we will then in every period have an initial value of  $p$  and, as a result of the encounters, a final value of  $p$ ,  $p^*$ . That is, after a first round of random encounters, the fraction of individuals of type 1,  $p^*$ , will be

$$\begin{aligned} p^* &= p\pi^{11} + (1-p)\pi^{21} \\ &= p^2 [\alpha^{11}(1) - 1] + (1-p)^2 [1 - \alpha^{22}(2)] \\ &\quad + p(1-p) [\alpha^{11}(2) - \alpha^{22}(1)] + p \end{aligned} \quad (3.3)$$

and the dynamics is given by

$$\Delta p = p^* - p. \quad (3.4)$$

That is, in continuous time, the dynamics of the system can be written as

$$\begin{aligned} \dot{p} &= p^2 [\alpha^{11}(1) - 1] + (1-p)^2 [1 - \alpha^{22}(2)] \\ &\quad + p(1-p) [\alpha^{11}(2) - \alpha^{22}(1)] \\ &=: f(p). \end{aligned} \quad (3.5)$$

An equilibrium of this system is characterized by  $f(p) = 0$  or  $p = 0$ , if  $f(0) < 0$ , or  $p = 1$ , if  $f(1) > 0$ .

We find the values of  $f$  for  $p = 0$  and  $p = 1$  for different values of  $\alpha^{ii}(i)$ :

$$\begin{aligned} f(0) &= 1 - \alpha^{22}(2) > 0 & \text{for } \alpha^{22}(2) < 1 \\ \lim_{p \rightarrow 0} \frac{f(p)}{p} &= \alpha^{11}(2) - \alpha^{22}(1) & \text{for } \alpha^{22}(2) = 1 \\ f(1) &= \alpha^{11}(1) - 1 < 0 & \text{for } \alpha^{11}(1) < 1 \\ \lim_{p \rightarrow 1} \frac{f(p)}{1-p} &= \alpha^{11}(2) - \alpha^{22}(1) & \text{for } \alpha^{11}(1) = 1 \end{aligned} \quad (3.6)$$

### 3.1.2 Equilibria

If the  $\alpha$ 's are constants, it is readily seen that there exists only one stable equilibrium, since  $f$  is a quadratic function in  $p$  and  $f(0) = 1 - \alpha^{22}(2) \geq 0$  and  $f(1) = \alpha^{11}(1) - 1 \leq 0$ . The location of this equilibrium depends on the relative sizes of  $\alpha^{11}(2)$ ,  $\alpha^{22}(1)$ ,  $\alpha^{22}(2)$  and  $\alpha^{11}(1)$ . Using our somewhat negative impression of basic human nature (inspired by traditional economic theory), that it is easier to

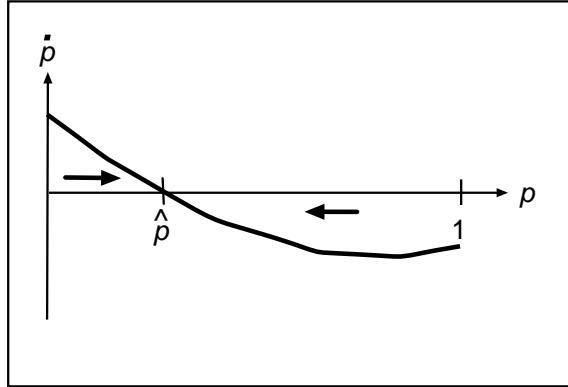


Figure 1: Dynamics with constant transition probabilities and  $\alpha^{22}(2) < 1$ .

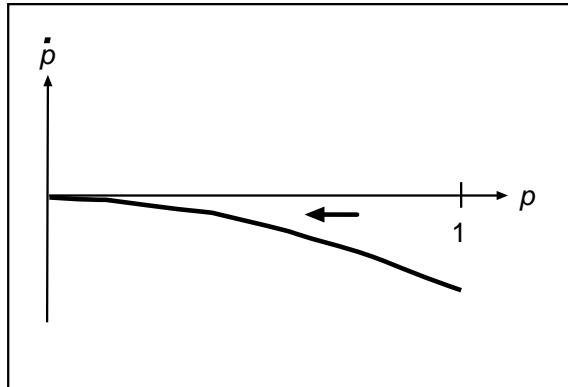


Figure 2: Dynamics with constant transition probabilities and  $\alpha^{22}(2) = 1$ .

make a criminal out of a saint that making a saint out of a criminal, we claim that it is more likely that an honest person encountering another honest person becomes a criminal than that a criminal encountering another criminal becomes an honest person. Similarly, we claim that it is more likely that an honest person encountering a criminal becomes a criminal than that a criminal encountering an honest person becomes honest. Finally, we assume that after encountering an honest person one is more likely to become, or stay, honest than after encountering a criminal. Formally speaking, we make the following assumption:

ASSUMPTION 3.1  $0 < \alpha^{11}(2) < \alpha^{11}(1) \leq \alpha^{22}(2) \leq 1$  and  $0 < \alpha^{11}(2) < \alpha^{22}(1) \leq \alpha^{22}(2) \leq 1$ .

Hence, we order all pairs of  $\alpha^{ij}(k)$  except  $\alpha^{22}(1)$  and  $\alpha^{11}(1)$ . Under this assumption, expression 3.1.1 becomes

$$\begin{aligned} f(0) &= 1 - \alpha^{22}(2) > 0 & \text{for } \alpha^{22}(2) < 1 \\ \lim_{p \rightarrow 0} \frac{f(p)}{p} &= \alpha^{11}(2) - \alpha^{22}(1) < 0 & \text{for } \alpha^{22}(2) = 1 \\ f(1) &= \alpha^{11}(1) - 1 < 0 & \text{for } \alpha^{11}(1) < 1 \\ \lim_{p \rightarrow 1} \frac{f(p)}{1-p} &= \alpha^{11}(2) - \alpha^{22}(1) < 0 & \text{for } \alpha^{11}(1) = 1 \end{aligned} \tag{3.7}$$

and the dynamic equilibrium can be characterized:

PROPOSITION 3.1 We can distinguish two cases for the unique stable equilibrium,  $\hat{p}$ :

1.  $\alpha^{22}(2) < 1$ :  $0 < \hat{p} < 1$ , an internal equilibrium
2.  $\alpha^{22}(2) = 1$ :  $\hat{p} = 0$ , a corner solution

PROOF To show this, one simply has to use the fact that  $f$  is a quadratic function and evaluate the derivative of  $f$  at  $p = 0$ , or simply refer to expression 3.1.2. ■

That is, under our assumption, a society with (some) honest individuals can only exist if some criminals encountering another criminal become honest - a rather unrealistic situation. This result is illustrated in Figures 1 and 2.

### 3.2 Social norms and norm-dependent behavior

We now introduce the influence of social norms on the behavior. First, the social norm and its strength have to be defined. The two possible norms within our framework are

- behaving in an honest manner
- behaving in a criminal manner

Since they are mutually exclusive, we only have to consider one of them, say being honest. In the spirit of the model the strength of the norm has to be endogenous and based on individual behavior. That is, we model the norm as expected behavior, and  $p$ , the fraction of society behaving in an honest way, is its strength. This strength of the norm is a measure of the opportunity cost of being criminal. It is balanced by the opportunity costs of  $c$  of being honest defined in section 2 above. Letting these opportunity costs influence the transition probabilities, the results above in section 3.1.2 can change dramatically. The natural assumption on the dependency of the  $\alpha$ 's on  $p$  and  $c$  then becomes:

ASSUMPTION 3.2  $\alpha^{11}(k; p, c^k)$  is an increasing function in the strength of norm of being honest,  $p$ , and a decreasing function in the opportunity cost of being honest,  $c^k$ .  $\alpha^{22}(k; p, c^k)$  behaves in the opposite manner.

If the influence of the norms is strong enough, the results of Proposition 3.1 will be modified. We make the required assumption:

ASSUMPTION 3.3

$$\begin{aligned} \alpha^{11}(2; 0, c^2) &\leq \alpha^{11}(1; 0, c^1) \leq \alpha^{22}(2; 0, c^2), \\ \alpha^{11}(2; 0, c^2) &< \alpha^{22}(1; 0, c^1) \leq \alpha^{22}(2; 0, c^2), \\ \alpha^{11}(2; 1, c^2) &\leq \alpha^{11}(1; 1, c^1) \leq \alpha^{22}(2; 1, c^2), \text{ and} \\ \alpha^{22}(1; 1, c^1) &< \alpha^{11}(2; 1, c^2) \leq \alpha^{22}(2; 1, c^2). \end{aligned} \tag{3.8}$$

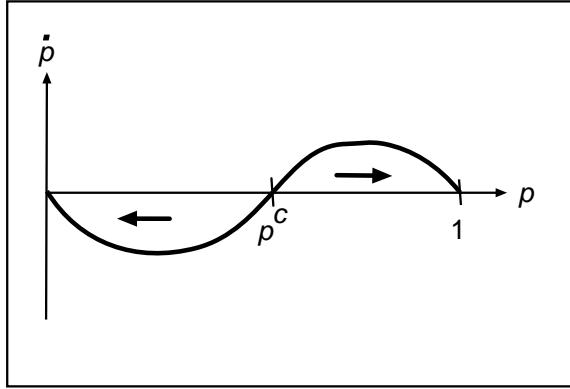


Figure 3: Dynamics in the simplest case with norm-dependent transition probabilities.

In essence, we are assuming that the strength of the norm reverses the order of  $\alpha^{11}(2; p, c^2)$  and  $\alpha^{22}(1; p, c^1)$ . When the norm implying honest behavior is strong enough, the probability that a criminal becomes honest upon encountering an honest person is greater than the probability that an honest person becomes a criminal after an encounter with a criminal.

### 3.2.1 Possible equilibria

Expression 3.1.1 now becomes:

$$\begin{aligned}
 f(0) &= 1 - \alpha^{22}(2; 0, c^2) > 0 && \text{for } \alpha^{22}(2; 0, c^2) < 1 \\
 \lim_{p \rightarrow 0} \frac{f(p)}{p} &= \alpha^{11}(2; 0, c^2) - \alpha^{22}(1; 0, c^1) < 0 && \text{for } \alpha^{22}(2; 0, c^2) = 1 \\
 f(1) &= \alpha^{11}(1; 1, c^1) - 1 < 0 && \text{for } \alpha^{11}(1; 1, c^1) < 1 \\
 \lim_{p \rightarrow 1} \frac{f(p)}{1-p} &= \alpha^{11}(2; 1, c^2) - \alpha^{22}(1; 1, c^1) > 0 && \text{for } \alpha^{11}(1; 1, c^1) = 1
 \end{aligned} \tag{3.9}$$

We first consider the case of  $\alpha^{22}(2; 0, c^2) = \alpha^{11}(1; 1, c^1) = 1$ . In this case, it is readily seen that there exists at least two dynamic equilibria:

**PROPOSITION 3.2** Under Assumption 3.3, if in addition  $\alpha^{22}(2; 0, c^2) = \alpha^{11}(1; 1, c^1) = 1$ , there exist at least two dynamically stable equilibria,  $\hat{p} = 0$  and  $\hat{p} = 1$ .

**PROOF** Follows directly from expression 3.2.1 and continuity of  $f$ .  $\blacksquare$

This means that we have a problem involving a critical mass  $p^C$ . If  $p$  is above the critical mass, society will move towards a totally honest society, and the equilibrium value is  $\hat{p} = 1$ ; if  $p$  is below the critical mass, society will break down and become totally dominated by criminality,  $\hat{p} = 0$ .<sup>4</sup> This is illustrated in Figure 3.

If both  $\alpha^{22}(2; 0, c^2)$  and  $\alpha^{11}(1; 1, c^1)$  are less than one, the equilibria become internal:

<sup>4</sup>This is similar to the structure in Holler and Wickström (1999), where a critical mass is needed to switch from one societal norm to another one. In that analysis, however, the norms are coordinating behavior and the individuals have preferences over the different norms that are unrelated to their behavior, which is strictly determined by self-interests under the prevailing norm. This is a different concept of a social norm from that in this essay.

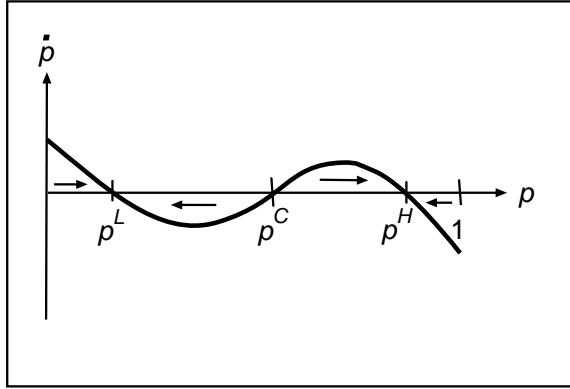


Figure 4: Dynamics in the general case with norm-dependent transition probabilities,  $\alpha^{22}(2; 0, c^2) < 1$ , and  $\alpha^{11}(1; 1, c^1) < 1$ .

**PROPOSITION 3.3** Under Assumption 3.3, if  $k^2 \leq \alpha^{22}(2; 0, c^2) < 1$  and  $k^1 \leq \alpha^{11}(1; 1, c^1) < 1$ , where  $k^1$  and  $k^2$  are some given constants, there exists at least two dynamically stable equilibria, a low one,  $p^L$ , and a high one,  $p^H$ , such that  $0 < p^L < p^H < 1$ .

**PROOF** Follows from continuity of  $f$ . ■

Figure 3 is now altered, and the dynamics looks like in Figure 4. Which of the two equilibria obtains, again depends on the initial value of  $p$ , and we have a path dependent dynamic equilibrium.

Finally, we have the (perhaps) most realistic case of  $\alpha^{22}(2; 0, c^2) = 1$  and  $\alpha^{11}(1; 1, c^1) < 1$ :

**PROPOSITION 3.4** Under Assumption 3.3, if  $\alpha^{22}(2; 0, c^2) = 1$  and  $k^1 \leq \alpha^{11}(1; 1, c^1) < 1$ , where  $k^1$  is some given constant, there exists at least two dynamically stable equilibria, a low one,  $p^L$ , and a high one,  $p^H$ , such that  $0 = p^L < p^H < 1$ .

**PROOF** Follows from continuity. ■

We now have the situation in Figure 5. Here, the low equilibrium is at  $p^L = 0$ , whereas the high equilibrium  $p^H < 1$ .

This last case is the most interesting one and the one we will analyze further.

## 4 Comparative dynamics

We now turn to the discussion of the opportunity costs of being honest. These costs depend on the reaction of society to criminal behavior as well as on the criminal technology. The opportunity costs decrease if law enforcement becomes more strict. They increase if the "technology" of crime becomes more "efficient". We observe in today's societies many examples of more efficient criminal technology. Through globalization and open borders it has become easier for criminals to get away without being caught. Through technological progress in information technology, criminal activity has been facilitated etc. That is, we can observe an increase in the  $c$ 's. The value of the criminal activity can also increase. A good example is an increase in tax burden which makes tax evasion more profitable.

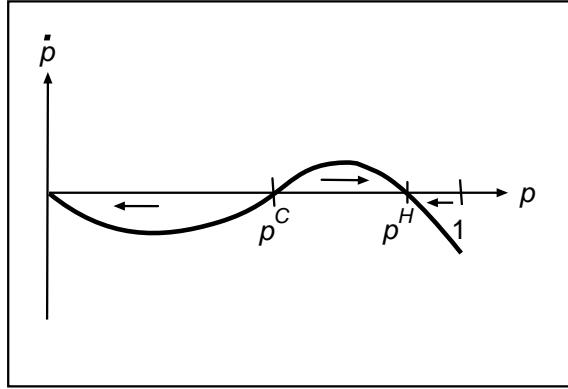


Figure 5: Dynamics in the general case with norm-dependent transition probabilities,  $\alpha^{22}(2; 0, c^2) = 1$ , and  $\alpha^{11}(1; 1, c^1) < 1$ .

From expressions 3.2 and 3.1.1 it is evident that, assuming that  $\alpha^{22}(2; 0, c^2) = 1$ ,  $f(p)$  depends non-positively on the  $c$ 's for all values of  $p$  and negatively if  $p > 0$ . That is, as the opportunity costs of being honest increase, the curve defined by  $f(p)$  moves down, and a stable dynamic equilibrium of the high type in Figure 5 with a society consisting of basically honest individuals and a strong norm implying honest behavior can disappear. Hence, for a sufficiently high value of the  $c$ 's, the situation of Figure 6 can obtain.

That is, the high equilibrium will disappear and the system will move towards the low equilibrium at  $p = 0$ ; the society will break down. We also note that once society ends up at  $p = 0$ , it will not return to  $p^H$  even if the opportunity costs of being honest decrease, for instance through stricter law enforcement, as long as  $\alpha^{22}(2; 0, c^2) = 1$  and  $\alpha^{11}(2; 0, c^2) - \alpha^{22}(1; 0, c^1) < 0$ . We formulate this as propositions:

**PROPOSITION 4.1** If  $\alpha^{22}(2; 0, c^2) = 1$  and  $\alpha^{11}(2; 0, c^2) - \alpha^{22}(1; 0, c^1) < 0$ , a society caught in the low equilibrium  $p = 0$  will never reach a possible high equilibrium  $p^H$  independently of the values of the opportunity costs of being honest,  $c^i$ .

**PROOF** See above. ■

and

**PROPOSITION 4.2** A high equilibrium  $p^H$  can for sufficiently high values of the opportunity costs of being honest,  $c^i$ , become unstable and disappear, causing society to move towards the low equilibrium  $p = 0$ .

**PROOF** See above. ■

## 5 Conclusions

In this essay we have attempted to show in a very simple analytical framework for social evolution that the stability of the social equilibrium might be endangered by exogenous changes in criminal "technology". Such a loss of stability is not very easily reversible once it has occurred. Hence the optimal reaction to exogenous changes in criminal opportunities is an early increase and counteraction in law-enforcement technology. This, however, might very easily endanger the liberal structure of society. Hence, more

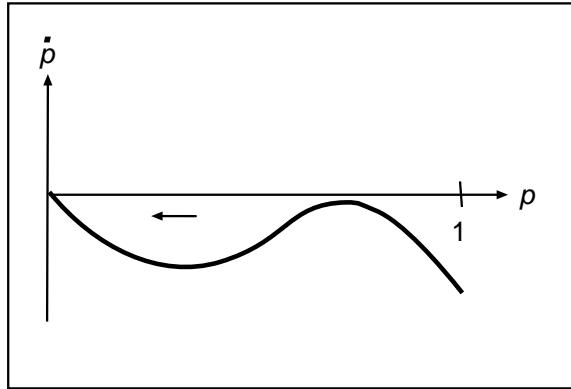


Figure 6: Dynamics in the general case with norm-dependent transition probabilities,  $\alpha^{22}(2; 0, c^2) = 1$ ,  $\alpha^{11}(1; 1, c^1) < 1$ , and a high value of  $c$ .

efficient criminal technology, might leave us with the dilemma of either ending up in a lawless or in a repressive society.

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