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## Do banks crowd in or out business ethics? An indirect evolutionary analysis

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# Do Banks Crowd in or out Business Ethics?\*

## – An Indirect Evolutionary Analysis –

Werner Güth<sup>†</sup>

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### Abstract

The evolution of trustworthiness as a major aspect of business ethics depends crucially on whether it can be signaled. If this is impossible, only opportunistic traders will survive. Whereas previous studies have analysed detection agencies (Güth and Kliemt, 1994 and 1998) or have substituted signaling by ex post-punishment, e.g. in the form of courts (Brennan, Güth, Kliemt, 1997a and b), we here introduce the institution of banks which can guarantee payment. It is shown that this can crowd in trustworthiness, i.e. trustworthy traders can survive in the evolutionary race. Compared to detection agencies the result may, however, be both, crowding out and crowding in of business ethics. The crucial feature is the bank's ability to discriminate between trustworthy and unreliable debtors which, in our model, is formally captured by the probability difference of accepting their respective credit applications.

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## 1. Introduction

A major weakness of most neoclassical studies of market interaction is that their predictions depend on the rules of the game which, at best, can be partly known or found out by empirical research. An especially difficult rule aspect are the preferences of the interacting parties, e.g. the degree by which their market behavior is constrained by business ethics.

**Indirect evolution** (Güth and Yaari, 1992) allows to derive the rules governing social interaction instead of imposing them exogenously. The method is a two step-procedure: One first determines the behavior for all possible rule constellations and then studies the evolution of rules. Only the evolutionarily stable rules should be expected. In case of rules specifying preferences only the evolutionarily stable business ethics will prevail when one neglects transitory phases.

Our analysis continues the previous research by Güth and Kliemt (1993, 1994, 1998) as well as by Brennan, Güth, and Kliemt (1997a and b) who have analysed the evolution of trustworthiness for the simple **game of trust**. In this game a first mover (here a seller) can trust the other (the second mover, in the case at hand the buyer) or refrain from cooperation. Whereas the latter decision ends the game, it continues after “trust” with the buyer’s decision to pay or not. What is studied evolutionarily is whether or not a conscience evolves preventing the buyer from not paying.

The result depends crucially on what the seller knows about the **buyer’s type**: Only trustworthy buyers will survive if the seller can recognize the buyer’s type. If, however, only the buyer knows his type, i.e. in case of private type information, the opposite is true: only opportunistic exploiters, who do not pay the price, win the evolutionary race (see Güth and Kliemt, 1993, and the general results of Güth and Peleg, 1996).

Of course, perfect signaling of types or no type signaling are just the extremes. In actual life we sometimes are able to deduce something about others’ types and

sometimes we are not, usually depending on one's own efforts to acquire information. Güth and Kliemt (1994 and 1998) have analysed **detection agencies** who at some cost can provide more or less reliable type signals. If the costs are non-prohibitive and if the type signals are informative enough, there exists a stable bimorphism, i.e. the population is composed of trustworthy and unreliable buyers.

Brennan, Güth, and Kliemt (1997a and b) do not rely on detection agencies, but on **courts** to which the seller can appeal in case of exploitation. An interesting aspect of their analysis is that the judge is randomly drawn from the same population as the buyer and that the legal verdict depends on the judge's type. The results are compared to those of detection agencies.

Our analysis here was inspired by Schils (1998) who suggests to view the basic game of trust as a sales transaction and to introduce **banks** which can guarantee that the seller will receive the sales price. Of course, this may only transform the problem of buyer reliability into one of debtor's trustworthiness. Banks, furthermore, can only survive when they do not make losses.

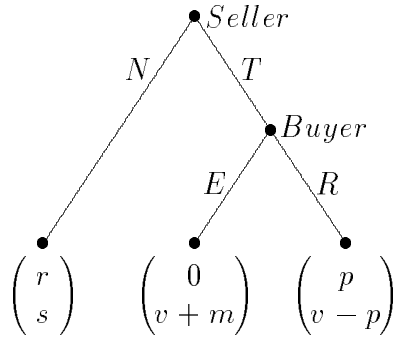
Introducing banks allows to study whether such an institution will crowd in or out business ethics in the form of trustworthy buyers and debtors and also to compare it to detection agencies, studied previously by Güth and Kliemt (1994 and 1998). The crucial feature of banks will be their ability to distinguish between trustworthy and unreliable debtors. In our model, which avoids to model the bank as a player, this ability is formally captured by the possibly different probabilities of granting a credit or guarantee to trustworthy and unreliable applicants, respectively.

In the following section 2 the "trust game with bank" is introduced whose possible solutions are derived in section 3 whereas section 4 looks at the condition that the bank is making no loss. How to explore the evolution of trustworthiness is discussed in section 5, 6, and 7. Banks can enhance, i.e. crowd in business ethics, but also, when compared to detection agencies, crowd them out. Section 8 looks at mixed strategy equilibria. Section 9 concludes by summarizing our results and indicating possible lines of future research.

## 2. The trust game with bank

Let us start by introducing the **basic game of trust** which is graphically represented in Figure II.1 where the non-negative payoff parameters (the upper/lower payoff is the one of the seller/buyer) must satisfy

$$(II.1) \quad p > r > 0 \text{ and } v - p > s \geq 0.$$



**Figure II.1:** The basic game of trust

Here  $N$  stands for  $N$ (ot trading);  $T$  for  $T$ (rust the buyer). The buyer rewards seller's trust by  $R$ (eward the seller), namely by paying the price  $p$ . In case of  $E$ (xploit the seller) he, however, keeps the commodity which he values at  $v$  without paying.  $r$  and  $s$  are the profits of the seller, respectively the buyer, when not trading.

So far all payoff parameters were representing material payoffs, e.g. monetary profits. This is, however, not true for payoff parameter  $m$  which just represents the buyer's feelings (of remorse) after exploiting the seller (for a more general discussion of such **intrinsic motivation** see Frey, 1994). We will refer to  $m$  as the **buyer's conscience** (parameter). Our task will be to derive the evolutionarily stable conscience, i.e. we do not impose restrictions for  $m$ , but try to derive them. For the purpose of this study business ethics are restricted to whether  $m$  prevents

exploitation of others or not. Which business ethics finally prevail will not be imposed exogenously, but endogenously derived.

The payoffs in Figure II.1 are the player's cardinal utilities which can be standardized by choosing the 0-levels and the units of the utility scales. To simplify our analysis we can therefore redefine the payoffs by assuming

$$(II.2) \quad p = 1 \text{ and } s = 0$$

so that (II.1) becomes

$$(II.1') \quad v > 1 > r > 0.$$

In case of  $m = 0$ , i.e. of no conscience, the buyer would exploit (choose  $E$ ) so that the seller prefers  $N$  over  $T$ . In case of  $m = \underline{m}$  satisfying  $v + \underline{m} < v - 1$  or

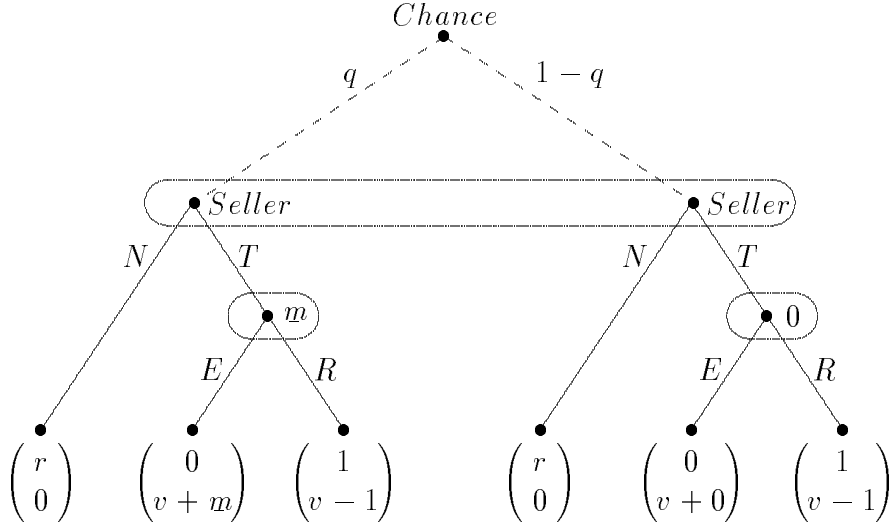
$$(II.3) \quad \underline{m} < -1$$

the buyer would, however, pay the price. Restricting attention to the two possible types  $m = \underline{m}$  and  $m = 0$  the result is

$$(II.4) \quad \begin{cases} (T, R) & \text{for } m = \underline{m} < -1 \\ (N, E) & \text{for } m = 0 \end{cases}$$

when the seller knows the buyer's  $m$ -type.

Let us now assume that the population of buyers is composed of a  $q$ -share of  $\underline{m}$ -types whereas the complementary share  $1 - q$  are all  $m = 0$ -types. Thus if the buyer's  $m$ -type is **private information**, the seller will expect an  $m = \underline{m}$ -type with probability  $q$  and an  $m = 0$ -type with probability  $1 - q$ . Representing the seller's incomplete information by a fictitious initial chance (Harsanyi, 1967/1968) move allows us to graphically illustrate this situation as in Figure II.2 which relies on the standardized parameters of (II.2). The task of endogenizing  $m$  by studying the evolution of a "conscience" is then transformed to determine endogenously



**Figure II.2:** The basic game of trust with no type information

the population share  $q$  of trustworthy buyers. This is done by first solving all games with  $q \in [0, 1]$  and then studying the evolution of  $q$ , i.e. by studying the development of  $q$  over time.

Since  $\underline{m} (< -1)$  chooses  $R$  and  $m = 0$  the move  $E$ , the (expected payoff maximizing) seller will rely on  $T$  if

$$(II.5) \quad q > r.$$

It can be shown (see Güth and Kliemt, 1993 and 1994) that only  $\underline{m}$ -types survive in case of Figure II.1, i.e. when the buyer's type is known, whereas only  $m = 0$ -types survive when the buyer's type is private information. Thus the evolutionarily stable population composition is  $q^* = 1$  in case of Figure II.1 and  $q^* = 0$  in case of Figure II.2.

Now when  $m$  is private information,  $T$  is chosen only when  $q > r$ . In this range of the population share  $q$  the opportunistic  $m = 0$ -buyers fare strictly better than the trustworthy  $\underline{m}$ -types so that  $q$  should decline rapidly. In the range  $q < r$  when the seller prefers  $N$  over  $T$ , the further decline can be justified by rare mistakes



in the sense of unintentional trust (see Güth and Kliemt, 1993 and 1994). This, however, implies that the decline of  $q$  in the range  $0 < q < r$  is rather slow.

Let us now introduce a bank which may help to engage in trade even when the trustworthiness of the buyer is uncertain. When representing the “trust game with bank” we neglect the dominated move  $E$  of  $m = \underline{m}$  and  $R$  of  $m = 0$  to simplify the game tree (see Figure II.3).

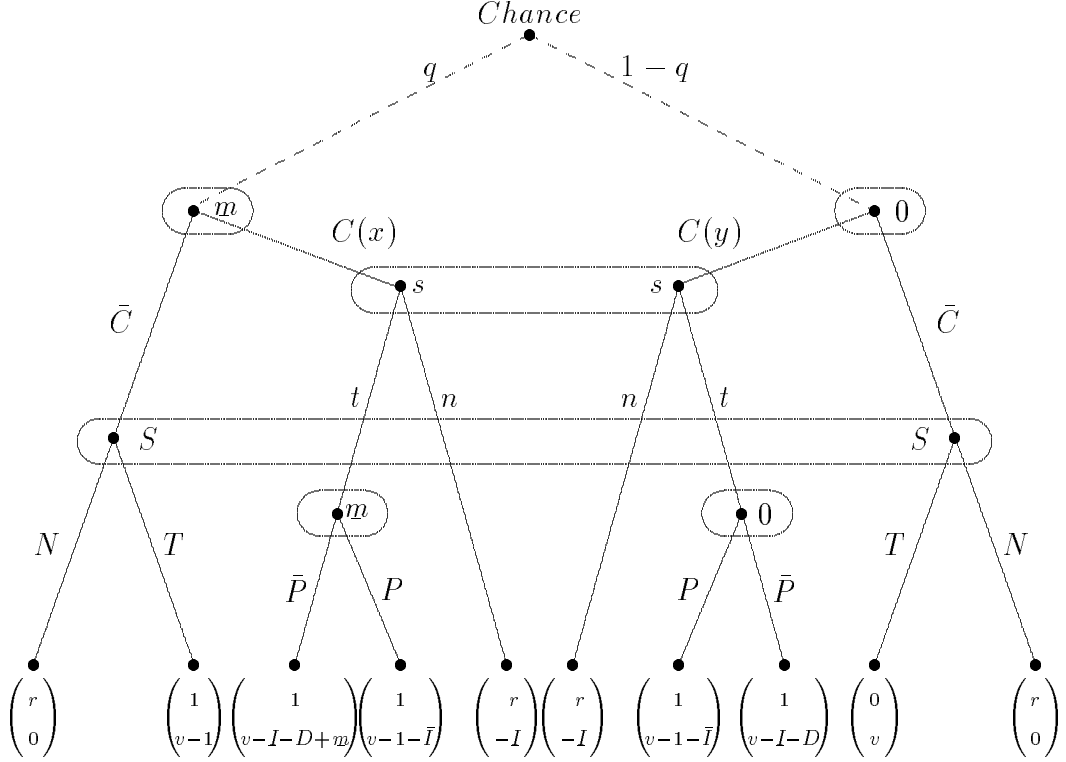
Before engaging in trade the buyer, who is aware of the seller’s trust problem, can ask for a credit guaranteeing that the seller will receive the price. But, of course, this only transforms the problem of buyer reliability into one of debtor’s trustworthiness. The “game of trust with bank”, as graphically illustrated by Figure II.3, does not introduce the bank as an additional player. Rather it is assumed that a credit application by  $m = \underline{m}$  will be granted with probability  $x$  whereas an application by  $m = 0$  is accepted with probability  $y$  where

$$(II.6) \quad 1 > x \geq y > 0.$$

In case of  $x > y$  the bank can better detect the buyer’s type than the seller. In the limiting case  $x = y$  the bank is as bad in type detection as the seller. Although we do not introduce the bank as a player, its mere existence preassumes, of course, that it does not make a loss.

If the buyer asks for a credit (the move  $C$  in Figure II.3), the notation  $C(x)$ , respectively  $C(y)$ , means that the credit is granted only with probability  $x$ , respectively  $y$ . With probability  $1 - x$  or  $1 - y$  the result is as if the buyer would not have asked at all for the credit, i.e. as if move  $\overline{C}$  would have been chosen. After  $\overline{C}$  the seller with no bank guarantee (we refer to him as the seller agent  $S$ ) plays the game of trust with no type information of Figure II.2. If, however, the credit is granted, the seller agent  $s$  with a guaranteed price can choose between  $t$ (rade) or  $n$ (o trade). After  $n$  the game ends whereas it continues with the  $m$ -types’ choices between  $P$ (aying the price) and  $\overline{P}$  (not paying).

The additional payoff parameters in Figure II.3 have the following interpretation:



**Figure II.3:** The reduced game of trust with bank (after the choice of  $T$  type  $\underline{m}$ 's move  $E$  and type  $0$ 's move  $R$  are neglected)

- $\underline{I}$  cost of credit guarantee
- $\bar{T}$  cost of credit use (including  $\underline{I}$ )
- $D$  security deposit (which is lost for the buyer in case of not paying the price)

It will be assumed that

$$(II.7) \quad v > 1 + \bar{T}, \quad \bar{T} > \underline{I} > 0, \quad 1 > \underline{I} + D > 0, \quad \text{and } D > 0$$

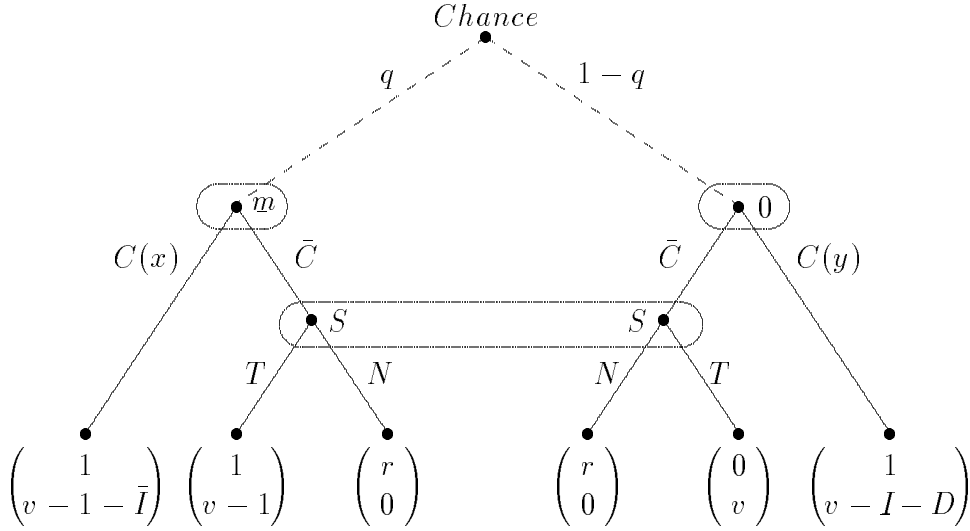
holds which implies that  $1 + \bar{T} > \underline{I} + D$ . Thus the  $m = 0$ -type of the buyer uses  $\bar{P}$  instead of  $P$  whereas an  $\underline{m}$ -type, satisfying

$$(II.8) \quad \underline{m} < \underline{I} + D - 1 - \bar{T} (< 0),$$

chooses  $P$  instead of  $\bar{P}$ . Furthermore, seller  $s$  always prefers  $t$  over  $n$  since, after

$t$ , he is sure to receive the price. Eliminating all these dominated moves yields the “further reduced game of trust with bank” which is graphically described by Figure II.4.

In the following this game with only three decision makers, namely the  $m = \underline{m}$ - and the  $m = 0$ -type of the buyer as well as the buyer (agent)  $S$  without price guarantee, will be analysed: first by solving the game and then by analysing the evolution of  $q$ , i.e. of the relative share of trustworthy buyers or debtors.



**Figure II.4:** The “further reduced game of trust with bank” (compared to Figure II.3 the dominated moves  $n$  for  $s$ ,  $\bar{P}$  for  $\underline{m}$ , and  $P$  for  $m = 0$  are neglected)

### 3. Solutions

Let  $\alpha$  and  $\beta$  denote the probability by which  $m = \underline{m}$ , respectively  $m = 0$ , chooses  $C$ . These probabilities determine the posterior probability of seller (agent)  $S$  for confronting the  $\underline{m}$ -type of the buyer according to

$$(III.1) \quad q(\alpha, \beta) = \frac{q[\alpha(1-x)+1-\alpha]}{q[\alpha(1-x)+1-\alpha] + (1-q)[\beta(1-y)+1-\beta]}.$$

Now seller  $S$  prefers  $T$  over  $N$  if

$$(III.2) \quad q(\alpha, \beta) > r$$

whereas  $N$  is better if

$$(III.3) \quad q(\alpha, \beta) < r.$$

In case of (III.2) both  $m$ -types of the buyer would choose  $\overline{C}$ , i.e.  $\alpha = \beta = 0$ , so that (III.2) becomes

$$(III.2') \quad q(0, 0) = q > r.$$

**Proposition 1:**

*In case of  $q > r$  no buyer-type asks for the credit since both seller agents  $S$  and  $s$  rely on trust (the move  $T$ , respectively  $t$ ).*

Consider now the case (III.3) when  $S$  uses  $N$ . Due to the parameter restriction (II.7) the  $\underline{m}$ -type of the buyer then prefers  $C(x)$  over  $\overline{C}$ , i.e.  $\alpha = 1$ . Since the conditions in (II.7) imply that  $v > \underline{I} + D$  also the  $m = 0$ -type of the buyer avoids  $\overline{C}$ , i.e.  $\beta = 1$ . Condition (III.3) thus becomes

$$(III.3') \quad q(1, 1) = \frac{q(1-x)}{q(1-x) + (1-q)(1-y)} < r$$

or

$$(III.3'') \quad q < \frac{(1-y)r}{1-yr - (1-r)x}.$$

In case of  $x = y$ , i.e. when the bank cannot differentiate at all between the  $m = \underline{m}$ - and the  $m = 0$ -type of the buyer, the left hand-side of (III.3') would be equal to  $q$  whereas it is smaller than  $q$  for  $x > y$ . Together with Proposition 1 this proves

**Proposition 2:**

- (i) *If  $(x = y \text{ and } q > r)$  or  $(x > y \text{ and } r < q(1, 1))$ , both  $m$ -types of the buyer do not ask for the credit (choose  $\overline{C}$ ) and seller agent  $S$  relies on trust (the move  $T$ ).*

- (ii) If  $(x = y \text{ and } r > q)$  or  $(x > y \text{ and } r > q(1, 1))$ , both  $m$ -types of the buyer ask for the credit (choose  $C(x)$  and  $C(y)$ , respectively) and seller agent  $S$  relies on  $N$ .
- (iii) If  $x > y$  and  $q(1, 1) < r < q$ , both, the outcome in (i) as well as the one in (ii), are pure strategy-equilibria.

Proposition 2 considers only pure strategy equilibria. More specifically, it neglects the multiplicity of best replies in unreached information sets what can be easily justified by perfectness considerations (Selten, 1975) or by requiring sequential rationality (Kreps and Wilson, 1982), as well as the generically mixed strategy equilibria.

In a mixed strategy-equilibrium seller agent  $S$  as well as one of the buyer's types engage in random choice behavior. If  $m = \underline{m}$  is randomizing,  $S$  must use  $T$  with probability  $\gamma(\underline{m}) = (v - 1 - \bar{T}) / (v - 1)$ ; if  $m = 0$  is supposed to do so, this probability must be  $\gamma(0) = (v - \underline{L} - D) / v$ . This shows that usually at most one  $m$ -type of the buyer can engage in random choice behavior.

For seller agent  $S$  to be indifferent between  $T$  and  $N$  one needs

$$(III.4) \quad q(\alpha, 1) = r$$

when  $m = 0$  uses  $\beta = 1$ , whereas one must have

$$(III.5) \quad q(0, \beta) = r$$

when  $m = \underline{m}$  relies on  $\alpha = 0$ . Inserting equation (III.1) allows us to rewrite these equations in the form

$$(III.4') \quad \alpha = \frac{q-r+yr(1-q)}{xq(1-r)} \text{ with } \alpha'(q) > 0$$

and

$$(III.5') \quad \beta = \frac{r-q}{y(1-q)r} \text{ with } \beta'(q) < 0,$$

respectively.

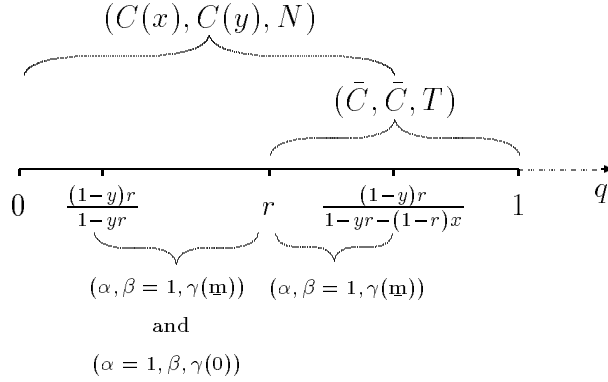
The condition  $0 < \alpha < 1$  is equivalent to

$$(III.4'') \quad (1 >) \frac{(1-y)r}{1-yr-(1-r)x} > q > \frac{(1-y)r}{1-yr} (> 0)$$

whereas for  $0 < \beta < 1$  the equivalent inequalities are

$$(III.5'') \quad r > q > \frac{(1-y)r}{1-yr}.$$

The possible equilibria as depending on the population share  $q$  of trustworthy  $\underline{m}$ -types are graphically represented in Figure III.1.



**Figure III.1:** The pure strategy (above the  $q$ -axis) and mixed strategy (below the  $q$ -axis) equilibria as depending on  $q$

In the interval  $0 \leq q < (1-y)r/(1-yr)$  the only equilibrium is  $(C(x), C(y), N)$ . In the neighboring interval  $(1-y)r/(1-yr) < q < r$ , this equilibrium coexists with both mixed strategy equilibria  $(\alpha, \beta = 1, \gamma(\underline{m}))$  and  $(\alpha = 1, \beta, \gamma(0))$ . Only the mixed strategy equilibrium  $(\alpha, \beta = 1, \gamma(\underline{m}))$  remains when  $q$  increases to  $r < q < (1-y)r/[1-yr-(1-r)x]$  where it coexists with both pure strategy equilibria  $(C(x), C(y), N)$  and  $(\bar{C}, \bar{C}, T)$ . For  $1 \geq q > (1-y)r/[1-yr-(1-r)x]$  the only equilibrium is  $(\bar{C}, \bar{C}, T)$ .

Mixed strategy equilibria allow for a more continuous transition from one pure strategy equilibrium to another when  $q$  changes. Here we wanted to illustrate that such a transition is only possible via adjusting the probability  $\alpha$  or  $\beta$ , respectively. Neither the probability  $\gamma(\underline{m})$  nor  $\gamma(0)$ , determining how seller agent  $S$  behaves, depends on the population share  $q$  of trustworthy buyers, respectively debtors.

Notice also that only in case of  $\alpha \neq \beta$ , i.e. in case of the mixed strategy equilibria, intentional type signaling results. For the two pure strategy solutions  $(\overline{C}, \overline{C}, T)$  and  $(C(x), C(y), N)$  one either has  $\alpha = \beta = 0$  or  $\alpha = \beta = 1$ , i.e. no intentional type signaling. For  $x > y$  and  $\alpha = \beta > 0$  observing whether or not a credit has been granted is an important signal nevertheless as can be seen from equation (III.1) defining the corresponding posterior beliefs of seller agent  $S$ . Whenever  $\alpha = \beta > 0$  and  $x > y$  holds, there is unintentional signaling of the buyer's  $m$ -type.

When demonstrating that banks may crowd in or out trustworthiness we only rely on pure strategy equilibria. In the following the mixed strategy equilibria will thus be neglected.

#### 4. Survival conditions for bank

Even when the bank is not formally included as an active player, its existence, especially over an evolutionary time span, presupposes that it does not incur a loss. The solution, described in Proposition 1, does not actually involve credit applications. The long run existence of the bank or, more generally, of the bank system is thus not endangered.

The solution, described in part (ii) of Proposition 2, however, involves active bank participation so that one has to check the no loss-constraint for this solution which exists when

$$(IV.1) \quad x = y \text{ and } r > q$$

or

$$(IV.2) \quad x > y \text{ and } r > q(1, 1).$$

According to this solution the bank grants the credit to  $m = \underline{m}$  with probability  $qx$  and to  $m = 0$  with probability  $(1 - q)y$  so that its “no expected loss-constraint” is

$$(IV.3) \quad qx\bar{I} + (1 - q)y(\underline{I} + D - 1) \geq 0$$

since it earns  $\bar{I}$  in case of encountering  $m = \underline{m}$  and loses  $(1 - (\underline{I} + D))$  in case of  $m = 0$  when it has to pay the price and receives only  $\underline{I} + D$ . The lower bound for  $q$  implied by (IV.3) is given by

$$(IV.3') \quad q \geq \frac{y(1 - \underline{I} - D)}{x\bar{I} + y(1 - \underline{I} - D)}.$$

Due to (II.7) the right hand-side of (IV.3') is positive and smaller than 1. For  $x = y$  it becomes

$$(IV.4) \quad q \geq \frac{1 - \underline{I} - D}{1 + \bar{I} - \underline{I} - D}.$$

In case of  $x > y$  the right hand-side of (IV.3') is smaller than the one of (IV.4). This substantiates the obvious intuition that better banks (in the sense of larger differences  $x - y$ ) are profitable under more general circumstances. Our conclusions are summarized by

### Proposition 3:

*The solution prescribing the C-choice for both buyer types  $m = \underline{m}$  and  $m = 0$  and the N-choice for seller agent  $S$  is sustainable (in the sense of no expected loss by the bank) only if*

$$(IV.5) \quad r > q \geq \frac{1 - \underline{I} - D}{1 + \bar{I} - \underline{I} - D} \text{ for } x = y$$



and

$$(IV.6) \quad r > q(1, 1) \text{ and } q \geq \frac{y(1-I-D)}{xI+y(1-I-D)} \text{ for } x > y.$$

By using inequality (III.3'') condition (IV.6) can be expressed as

$$(IV.6') \quad \frac{(1-y)r}{1-yr-(1-r)x} := R > q \geq \frac{y(1-I-D)}{xI+y(1-I-D)} =: L.$$

It is interesting that the interval (IV.5) for  $q$  does not depend at all on the – for both  $m$ -types identical – probability  $x = y$  of accepting a credit application. All that matters in case of  $x = y$  is the a priori-probability  $q$  of the  $m$ -types representing the population share of trustworthy buyers.

To illustrate condition (IV.6') one can look at the extreme case  $x = 1$  and  $y = 0$  when the bank accepts the credit application by  $m = \underline{m}$  and rejects the one by  $m = 0$  with certainty. For this case (IV.6') becomes  $1 > q \geq 0$  and implies no essential restriction at all. Since (IV.5) is just the limiting case in the sense of  $|x - y| \rightarrow 0$ , all our results are summarized by

#### Theorem 4:

*The “further reduced game of trust with bank” has two possible solutions (in pure strategies), namely*

- (i) *the one with both  $m$ -types of the buyer choosing  $\overline{C}$  and the seller agent  $S$  choosing the move  $T$  when*

$$(IV.7) \quad q > r, \text{ and}$$

- (ii) *the one with both  $m$ -types of the buyer choosing  $C(x)$  and  $C(y)$ , respectively, and the seller agent  $S$  choosing the move  $N$  when*

$$(IV.8) \quad R > q \geq L$$

where  $R$  and  $L$  are defined as in (IV.6').

The interval (IV.8) for  $q \in [0, 1]$  may, of course, be empty. The interval is generically non-empty if

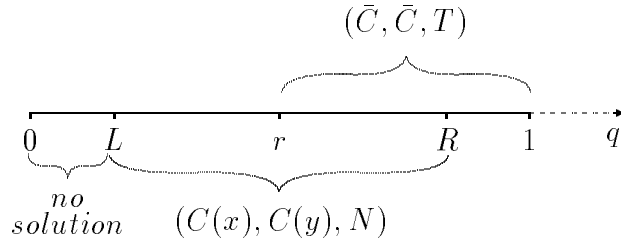
$$(IV.9) \quad \frac{x}{1-x} \cdot \frac{1-y}{y} > \frac{1-r}{r} \cdot \frac{1-I-D}{I}.$$

For inequality (IV.9) the result of Theorem 4 is graphically illustrated in Figures IV.1 and IV.2 visualizing the  $q$ -interval  $[0, 1]$ . Since  $x \geq y$  the left hand-side of (IV.8), the parameter  $R$  defined in (IV.6'), is larger than  $r$ . Figure IV.1 illustrates the case where

$$(IV.10) \quad R > r > \frac{y(1-I-D)}{xI+y(1-I-D)}$$

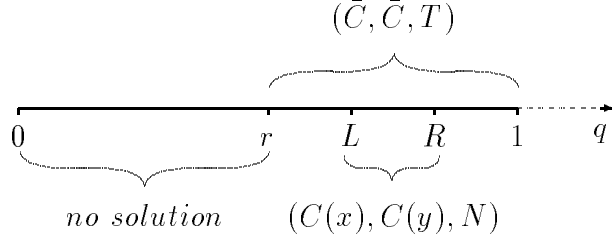
whereas Figure IV.2 assumes the inverse inequality

$$(IV.11) \quad r < \frac{y(1-I-D)}{xI+y(1-I-D)} < R.$$



**Figure IV.1:** The case (IV.9) and (IV.10)

If inequality (IV.9) is reversed, the equilibrium prescribing the credit application  $C(x)$ , respectively  $C(y)$  by both  $m$ -types of the buyer together with  $N$ -choice of the seller agent  $S$  does not exist as a sustainable solution since it is inconsistent with the no expected loss-condition for the bank.



**Figure IV.2:** The case (IV.9) and (IV.11)

## 5. The evolution of trustworthiness

An **evolutionary game** (see the survey of evolutionary game theory of Hammerstein and Selten, 1994, as well as of Weibull, 1995) is defined by its strategy set  $M$  as well as by its (reproductive) success function  $R(m, \widetilde{m})$  specifying for all pairs  $(m, \widetilde{m})$  with  $m, \widetilde{m} \in M$  the success of an  $m$ -type when confronting an  $\widetilde{m}$ -type. For the case at hand we assume

$$(V.1) \quad M = \{\underline{m}, 0\} \text{ with } \underline{m} \text{ satisfying (II.8).}$$

The success of an  $m$ -type buyer is just the material success implied by the solution. This implies a major difference between utilities resulting from material payoffs and the payoff component  $m$  in Figure II.3 which can determine the buyer's success only indirectly, namely via influencing the buyer's solution behavior.

Notice, however, that for the “further reduced game of trust with bank” of Figure II.4 this distinction does not really matter. The  $\underline{m}$ -type of the buyer neither chooses  $E$  or  $\overline{P}$  so that  $\underline{m}$  never enters the solution payoff of  $m = \underline{m}$ . For  $m = 0$  it, furthermore, vanishes by assumption.

Now in our case an  $m$ -type cannot recognize the  $\widetilde{m}$ -type of its encounter. We therefore have to adapt  $R(m, \widetilde{m})$  to the case of incomplete information (see originally Güth, 1995) by relying on the expected success function

$$(V.2) \quad R(m, q) \text{ for } m \in M = \{\underline{m}, 0\}$$

where  $R(m, q)$  is the expected material payoff of an  $m$ -type buyer.

In case of the solution  $(\overline{C}, \overline{C}, T)$  one obtains

$$(V.3) \quad R(m, q) = \begin{cases} v - 1 & \text{for } m = \underline{m} \\ v & \text{for } m = 0 \end{cases}$$

in the range  $q > r$ . It seems natural to assume that the population share  $q$  of trustworthy buyers or debtors is a function  $g(t)$  of time  $t$  which increases (decreases) with  $t$  when  $R(\underline{m}, q(t)) > R(0, q(t))$  (respectively vice versa). Since  $R(m = 0, q) > R(m = \underline{m}, q)$  for all  $q > r$  where the solution  $(\overline{C}, \overline{C}, T)$  exists, this solution implies that  $q$  must decrease in the interval  $q > r$  (any reasonable concept of evolutionary stability will imply such a result).

**Proposition 5:**

*According to the solution  $(\overline{C}, \overline{C}, T)$  the population share  $q$  of trustworthy buyers will decrease in the interval  $q > r$ .*

Let us now turn to the solution  $(C(x), C(y), N)$  under assumption (IV.9) guaranteeing that it exists for all  $q$  in the generic  $q$ -interval (IV.8). This solution implies

$$(V.4) \quad R(m, q) = \begin{cases} x(v - 1 - \overline{I}) & \text{for } m = \underline{m} \\ y(v - \underline{I} - D) & \text{for } m = 0. \end{cases}$$

The condition  $R(\underline{m}, q) > R(0, q)$  is equivalent to

$$(V.5) \quad v(x - y) > x\overline{I} - y(\underline{I} + D).$$

**Proposition 6:**

*Assume that condition (IV.9) holds, i.e. that the  $q$ -interval (IV.8) for the solution  $(C(x), C(y), N)$  is non-empty. In this  $q$ -interval the population share  $q$  of*

*trustworthy buyers will increase in case of inequality (V.5) whereas it will decrease when*

$$(V.6) \quad v(x - y) < x\bar{T} - y(\underline{L} + D).$$

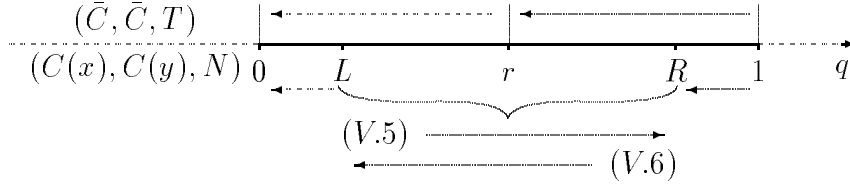
In the following we will rely on Propositions 5 and 6 when demonstrating the possible crowding in or crowding out of trustworthiness due to the existence of the bank. When doing so we encounter two major problems, namely

- the existence of two pure strategy solutions for the same generic parameter region, e.g. for the  $q$ -interval from  $r$  to  $R$  in Figure IV.1, and
- the non-existence of any pure strategy solution which, in view of Proposition 2, is solely due to the survival conditions of the bank (see the interval from 0 to  $L$  in Figure IV.1 and from 0 to  $r$  in Figure IV.2).

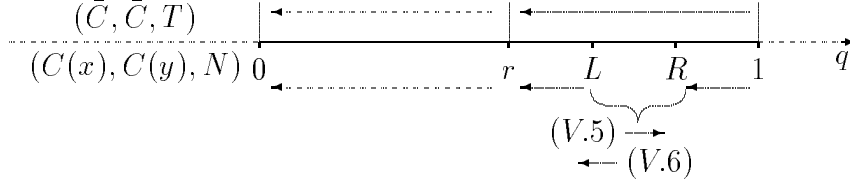
The first problem could be resolved by applying the theory of equilibrium selection (Harsanyi and Selten, 1988). Here we, however, do not want to burden our approach by imposing the more restrictive rationality requirements of equilibrium selection. Instead we simply will rely on an ad hoc-selection of the solution candidate when justifying a case of crowding in or crowding out business ethics.

The second problem of no pure strategy equilibrium simply states that the banking system, as captured by our model, cannot exist when such circumstances prevail. We therefore will capture such situations by the basic game of trust without a bank (see Figure II.2) where  $q$  decreases over the whole range (notice that for the range  $q < r$ , where the seller wants to use  $N$ , this presupposes that  $T$  is sometimes chosen by mistake, see Güth and Kliemt, 1994).

Keeping this in mind we can return to Figures IV.1 and IV.2 and indicate the movement of  $q$  over time by horizontal arrows for the respective  $q$ -intervals. Here an arrow above the  $q$ -axis indicates the direction in which  $q$  moves in view of the solution  $(\overline{C}, \overline{C}, T)$  whereas the arrows below refer to the solution  $(C(x), C(y), N)$ .



**Figure V.1:** The case (IV.9) and (IV.10)



**Figure V.2:** The case (IV.9) and (IV.11)

The dotted arrow in the left interval above the  $q$ -axis indicates the slow decline of  $q$  which would result in case of rare mistakes by the seller who wants to use  $N$  in the interval  $q < r$  (see Proposition 1), but occasionally fails to do so (see the related idea of limit evolutionarily stable strategies suggested by Selten, 1983).

Arrows below the  $q$ -axis and outside the  $q$ -interval between  $L$  and  $R$  result from the non-existence of the bank where  $q$ , according to the previous results of Güth and Kliemt (1993 and 1994) must always decline. Of course, this decline is fast in the range  $q > r$  and slow (dotted arrows) in the range  $q < r$  where it depends how rarely  $N$  is chosen by mistake.

In the  $q$ -interval between  $L$  and  $R$  the direction of the arrows below the  $q$ -axis depends on whether condition (V.5) or (V.6) holds. In view of Proposition 6 the  $q$ -share of trustworthy buyers increases in case of (V.5) and decreases if (V.6) holds.

What remains is the case where inequality (IV.9) is reversed, i.e. where the interval (IV.8) or (IV.6') is empty. Here the arrows below the  $q$ -axis are simply the same as the ones above the  $q$ -axis (see Figure V.3) since we interpret this situation as the basic game of trust.



**Figure V.3:** The case of (IV.9) being inversed

## 6. A case of crowding in

To provide a case of crowding in trustworthiness one obviously must rely on the equilibrium  $(C(x), C(y), N)$  together with inequalities (IV.9) and (V.5) implying generic region  $\subset (0, 1)$  where  $q$  increases (see Figures V.1 and V.2). Clearly for any initial population composition  $q_0$  with  $L < q_0 < R$  the share  $q$  of trustworthy types will increase till it reaches the evolutionarily stable bimorphism  $q = R$  for (IV.9) and (V.5). Thus depending on the initial conditions crowding in of trustworthiness in the sense of an increase of  $q$  is possible. In the following we want to compare the result  $q = R$  with the situation where no banking system exists.

Recall that without the bank only  $q^* = 0$  is evolutionarily stable (see Güth and Kliemt, 1993 and 1994). Thus for crowding in it suffices to specify a case where  $q$  increases from  $q = 0$ . In view of Proposition 6 we thus have to find a situation satisfying conditions (IV.9), (IV.8), and (V.5).

Let us explore the three conditions for

$$(VI.1) \quad x = 1 - \varepsilon \text{ and } y = \varepsilon$$

where  $\varepsilon$  with  $0 < \varepsilon < \frac{1}{2}$  will be assumed to be rather small. Substituting (VI.1) into (IV.9), (IV.8), and (V.5) yields

$$(VI.2) \quad \left( \frac{1-\varepsilon}{\varepsilon} \right)^2 > \frac{1-r}{r} \cdot \frac{1-I-D}{I},$$

$$(VI.3) \quad \frac{(1-\varepsilon)r}{\varepsilon(1-r)+(1-\varepsilon)r} > q \geq \varepsilon \cdot \frac{1-I-D}{(1-\varepsilon)I+\varepsilon(1-I-D)},$$

and

$$(VI.4) \quad v > \frac{1-\varepsilon}{1-2\varepsilon} \bar{T} - \frac{\varepsilon}{1-2\varepsilon} (\underline{L} + D),$$

respectively. Since the limiting inequalities for  $\varepsilon \rightarrow 0$  are

$$(VI.2') \quad \infty > \frac{1-r}{r} \cdot \frac{1-L-D}{\bar{T}},$$

$$(VI.3') \quad 1 > q \geq 0,$$

and

$$(VI.4') \quad v > \bar{T},$$

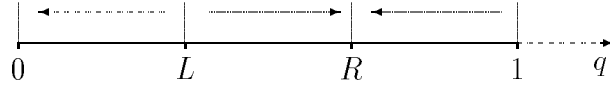
this shows that crowding in of trustworthiness is possible and, furthermore, generic: The smaller  $\varepsilon$  the larger the  $q$ -interval (VI.3) over which  $q$  will increase according to the solution  $(C(x), C(y), N)$ .

**Corollary 7:**

*If the bank can distinguish between the  $m$ -types of the buyer, i.e. if  $x > y$ , crowding in of trustworthiness is possible and generic in view of the solution  $(C(x), C(y), N)$ .*

The result is visualized by Figure VI.1: Relying on the solution  $(C(x), C(y), N)$  whenever  $q < R$  the population share  $q$  of  $\underline{m}$ -types increases fast between  $L$  and  $R$  and decreases fast in the range  $q > R$  where the solution  $(\bar{C}, \bar{C}, T)$  has to be applied. For  $q < L$  the solution  $(C(x), C(y), N)$  would imply a loss of the bank so that one must rely on the solution  $(\bar{C}, \bar{C}, T)$  with rare trembles in the sense of unintended choices  $N$  or must fall back on the game of trust without a bank, i.e.  $q$  must decline slowly. The attraction set of  $q^* = R$  with  $q^* > 0$  is thus the interval from  $L$  to 1 whereas it is the interval from 0 to  $L$  for the alternative stable configuration  $q^* = 0$ .





**Figure VI.1:** Crowding in of trustworthiness to  $q^* = R$  in the range from  $L$  to 1

## 7. A case of crowding out compared to costly detection

In view of the equilibrium  $(\bar{C}, \bar{C}, T)$  only  $q = 0$  is evolutionarily stable. Thus crowding out in the sense of a decline of  $q$  is implied by any initial share  $q_0$  of trustworthy types with  $q_0 > r$  if solution  $(\bar{C}, \bar{C}, T)$  is played. If  $0 < q_0 < r$ , rare trembles would induce a further, but slow decline of  $q$ .

The equilibrium  $(\bar{C}, \bar{C}, T)$  does not deny the existence of the banking system, but implies its factual irrelevance. This, however, does not question the evidence of crowding out. If inequality (V.6) holds, both pure strategy equilibria, i.e.  $(\bar{C}, \bar{C}, T)$  and  $(C(x), C(y), N)$ , imply that  $q$  must decline over the whole range (see Figures V.1 and V.2). Thus for (V.6) crowding out is also possible when  $(C(x), C(y), N)$  is played if it exists and does not imply negative profits for the bank.

One may want to justify the fact that the initial  $q_0$  is positive. One possibility is to assume that the banking system substitutes costly, but perfectly reliable detection. A signaling institution can be either a detection agency or an intrafirm organization. Such institutions provide a reference case for which trustworthiness is evolutionarily stable, i.e. where a population share  $q^*$  with  $q^* > 0$  of m-types would finally result. For the case of costly, but perfectly reliable detection the bimorphism

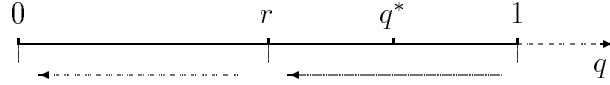
$$(VII.1) \quad q^* = 1 - \frac{2K}{r} \text{ for } 0 \leq K < \frac{r}{2}$$

is evolutionarily stable (see Güth and Kliemt, 1994). Here  $K$  measures the (material) cost of the detection agency which, for the sake of simplicity (see Güth and

Kliemt, 1998, for a more general analysis), is assumed to perfectly recognize the buyer's  $m$ -type.

To provide a case of crowding out compared to  $q^*$ , defined in (VII.1), we can rely on Proposition 5. If  $q^* > r$ , the solution  $(\overline{C}, \overline{C}, T)$  would predict a decline of  $q$ , i.e. the crowding out of trustworthiness. Now for all cost parameters  $K$  with  $\frac{r}{2} > K > 0$ , still allowing the existence of an evolutionarily stable bimorphism  $q^*$ , one has  $q^* > r$  when  $\frac{r}{2}(1-r) > K$ . Given this constraint for  $K$  the condition  $K < \frac{r}{2}$  holds as well and thus imposes no further restriction. Crowding out trustworthiness in the form of a  $q$ -decline starting from  $q^* > r$  is therefore possible. Actually in view of  $(\overline{C}, \overline{C}, T)$  the  $q$ -share of trustworthy buyers will decline fast in the range  $r < q < q^*$  and only slowly after reaching the range  $0 \leq q \leq r$  when assuming the no solution-interpretation (see Figure IV.2).

The result is graphically illustrated in Figure VII.1:



**Figure VII.1:** Crowding out of trustworthiness in the range from 0 to  $q^* = (r - 2K)/r$  for  $K < r(1 - r)/2$

If the institution of perfectly reliable detection, leading to  $q^* = (r - 2K)/r$ , is substituted by the one of banks and if the players do not apply for credits, i.e. rely on  $(\overline{C}, \overline{C}, T)$  for  $q > r$  and on the “no solution” for  $q < r$ , then  $q$  will decline fast from  $q^*$  to  $r$  and slowly from  $r$  to 0.

## 8. Conclusions

Business ethics have been specified in our analysis as the trustworthiness of buyers, respectively debtors. More specifically, one can essentially distinguish two  $m$ -types, the trustworthy ones who would pay the price, regardless of whether it is

guaranteed by the bank or not, and the opportunistic exploiters who are unreliable as buyers and as debtors.

Business has been modelled by the game of trust with the interpretation that delivery precedes payment as it is typically true in actual business. To guarantee that the price will be paid after the delivery the buyer can ask for a credit. We have referred to this situation as the “game of trust with bank” which is a game of incomplete information since only the buyer knows his  $m$ -type.

In the tradition of the indirect evolutionary approach the game has first been solved what then allows to study the evolution of  $q$ , i.e. of the share of trustworthy buyers, respectively debtors. One way of demonstrating the crowding in or out of trustworthiness is to introduce path dependence, i.e. an initial share  $q_0$  of trustworthy types, and to show that  $q$  will become larger (crowding in) or smaller (crowding out) than  $q_0$ . Here we did not confine ourselves to postulating arbitrary initial conditions  $q_0$ , but have also described alternative institutional set ups which would guarantee such initial conditions. When demonstrating the possible crowding in of business ethics by banks we have compared our results to the “basic game of trust with no type information”. To illustrate that also crowding out is possible our standard of comparison has been the evolutionary stable bimorphism which exists in case of detection agencies. Here we therefore have compared the institution of banks with the one of detection agencies.

A major simplification of our analysis is that we have investigated the ethical impact of banks without including the bank as a player. The advantage of this is that our results do not depend on more or less arbitrary assumptions of what the bank decides when, on what it knows when deciding and on how it evaluates the various possible outcomes.

What essentially matters is the bank’s ability to distinguish between trustworthy and unreliable debtors (in our model captured by the difference  $x - y$ ). If, for instance,  $x = y$ , there is no multiplicity of pure strategy-equilibria (for  $x = y$  one has  $(1 - y)r / [1 - yr - (1 - r)x] = r$ , see Figure III.1). This also excludes

the possibility of just one mixed strategy-equilibrium. Furthermore, according to the solution  $(C(x), C(y), N)$  the share  $q$  would always have to decline in case of  $\bar{T} > \underline{I} + D$  (check (V.6) for  $x = y$ ). In view of  $(\bar{C}, \bar{C}, T)$  Proposition 2 states similar results for  $x = y$  (cooperation, purely based on trust, exists only for  $q > r$ ) as for the basic game of trust with no type information. More interesting results require  $x > y$  and thus the bank's ability to be better than the seller in distinguishing between  $m$ -types. In our view, this is what one naturally would expect from a bank which can inquire more thoroughly than a seller whether or not a customer is reliable.

The bank's fees for the credit guarantee ( $\underline{I}$ ), the credit use ( $\bar{T}$ ), and the deposit  $D$ , which it requires, are influential, too. But with regard to crowding in or out trustworthiness the essential parameter seems to be the discrepancy between the probabilities of granting a credit to the trustworthy or the unreliable debtor, respectively.

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