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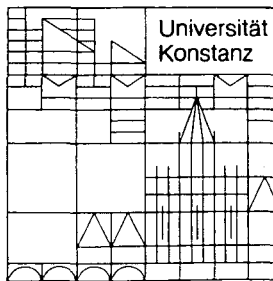
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**Fakultät für  
Wirtschaftswissenschaften  
und Statistik**

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Hans Peter Grüner

**Evolutionary Stability  
of Social Norms  
in a Socio-Economic  
Equilibrium Model**

Diskussionsbeiträge

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# **EVOLUTIONARY STABILITY OF SOCIAL NORMS IN A SOCIO-ECONOMIC EQUILIBRIUM MODEL**

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**Abstract:** A hybrid of a model of economic equilibrium in two markets and a social game is formed. The link between the two is established through a social norm which conditions correct social behavior on economic variables and therefore distorts the economic equilibrium allocation. The initial endowment of an individual determines whether she gains from a social norm. The evolution of norms is examined in a dynamic model where norms are more likely to persist if they deliver higher utility to their believers. Also it is assumed that norms lose importance when they are disobeyed by their believers. Optimally coordinating norms are not necessarily evolutionarily stable and a suboptimal norm can be the outcome of the evolutionary process.

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## 1 Introduction

Economics as "the science which studies how scarce resources are employed for the satisfaction of the needs of men living in society" (Malinvaud (1972, p. 1)) usually considers a restricted set of actions of individuals. These are choices on quantities of goods that are consumed, price settings, investment decisions, production, voting, and government decisions on expenditure, taxes or inflation<sup>1</sup>. Economic theory therefore implicitly defines two sets of actions which one might call "economical behavior" and "non-economical behavior" and assumes that "non-economical behavior" does not interact with the set of decisions considered. Were there an interaction of "non-economical behavior" and "economical behavior" then the channels of interaction would have to be examined. There only is one place in conventional economic theory where non-economical behavior implicitly occurs: in the term "leisure". Leisure is what an individual consumes if he or she does not work. However, behavior during leisure time can take different forms. The same is actually true for ("non-economical") behavior during working time. Individuals can be friendly or unfriendly, they can be creative, aggressive, communicative, authoritarian or submissive etc. Theories of economic behavior may neglect these features of human behavior only if there is some good reason to assume a weak dichotomy in an individual's decisions: the way people make decisions on prices or quantities may be affected by the outcome of interactions in a social world, but there is no interdependence between the two worlds, i.e. no feedback from economic to social decisions, therefore social phenomena can be treated as exogenous to economic problems and affect them only through their influence on the individual's preferences.

Obviously however, the assumption of such a dichotomy is in some fields a rather heroic one. In a number of recent papers economists have therefore made attempts to jointly analyze social and economic activities. A first step has been made by Akerlof (1980) who

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<sup>1</sup> Malinvaud even adds this choice to his definition of economics as a science as he continues: "on the one hand, it is interested in the essential operations of production, distribution and consumption of goods, on the other hand, in institutions and activities whose object it is to facilitate these operations".

was the first to explicitly introduce social norms (or social customs) into the formal analysis of economic phenomena. Sociologists see social norms as an important determinant of human behavior. A rule for behavior can be seen as a social norm, if costs of a deviation from that rule exist. The costs can take at least two forms: costs that arise if other individuals punish disobedience of the rule (exclusion) and costs that arise if the rule is "internalized" by the individual, so that the individual feels badly if he disobeys the rule. Akerlof uses the social custom approach to show how wage setting behavior can be affected by social norms. The social custom approach has recently been applied by Naylor (1989) and Corneo (1992,93) to endogenize the membership and actions of trade unions, by Myles and Naylor (1993) in a model of tax-evasion and by Naylor (1994) in an insider-outsider model. In all these models utility of the individuals is assumed to depend on their own actions on markets and on whether their economic behavior is consistent with social norms or not. In the model by Corneo, the influence of a social custom becomes weaker over time if more individuals disobeyed the custom in the previous period. Other work on the interaction of social and economic activity can be found in Cole, Mailath and Postlewaite (1992) and Fershtman and Weiss (1993). In their endogenous-growth model, Cole, Mailath and Postlewaite assume that individuals wish to marry a person with high social status. They call the assignment rule for social status the "social norm of society". Economic and social action (marriage) are interdependent if social status depends on wealth. Fershtman and Weiss assume in their general equilibrium model that status is linked to an individual's occupation and that it enters the utility function directly. The status of an occupation itself is endogenous and depends on the level of education of the other employees.

The present paper extends this literature on norms and economic behavior with a model where the link between social and economic activity is established through norms that condition "correct" social behavior on economic equilibrium variables. Thus, there is a difference with respect to the earlier social custom models, where individual utility is assumed to depend on whether the *economic* behavior is consistent with the social norm. In

the present general equilibrium model, economic activity consists of trading goods on markets at given prices, while social activity is modeled as a set of two player games. Thus, the second main difference is that in the present model both, social and economic actions are derived explicitly while previous models only implicitly take social actions into account. Total utility is a function of economic activity and of the outcome of the social game. This assumption makes it possible to analyze the effects of different norms on total utility of each individual.

The plan of the paper is the following: in section 2 I develop my basic model with social interaction and economic activity and I define an equilibrium for the model. In this section I will assume that a single social norm is exogenously given in the beginning of the game. In section 3 I introduce a concept of evolutionary stability of social norms which can be seen as an extension of Corneo's norm-persistence mechanism. Here different norms may coexist in the same society and norms will be selected according to their relative performance. Norms which deliver higher average utility to their believers are more likely to persist than others. Also it is assumed that norms which are disobeyed by their believers lose importance. I will show in an example that suboptimal norms can be evolutionarily stable, while optimal norms can be instable. Section 4 presents the conclusion of my results and suggests a number of extensions and applications of this framework.

## **2 The model**

In this section I develop a simple model where individuals act socially and economically and where the link between the two fields is created through a social norm. The economy consists of  $N$  individuals owning labor called workers and one profit-maximizing price-taking firm which belongs to  $M$  capitalists. The firm's production function  $Y=F(K,L)$  is well-behaved ( $y' > 0$ ,  $y'' < 0$ ,  $a F(K,L)=F(aK,aL)$ ). Individuals are indexed by  $i$  and  $j$  with  $i,j = 1..N+M$ . Each individual has to take two kinds of action:

- 1) a market action which consists of trading a certain bundle of goods at market prices,  $w$ ,  $p$ ,  $r$  ;
- 2) a non-market action which consists of the choice of a strategy in a game with each of the other players.

In this section I assume that there is one and only one prominent way to behave in the non-market game. I shall call this rule or norm of society<sup>2</sup>. Utility of the individuals now depends on individual market actions, on the outcomes of the games they play and on whether their social behavior is consistent with the norm or not. I suppose that each individual meets every other individual exactly once. The action of individual  $i$  in the game with individual  $j$  is  $a_{ij}$ . The payoff of individual  $i$  from the game with  $j$  is denoted by

$$(1) \quad \gamma_i(a_{ij}, a_{ji})$$

and utility is supposed to be

$$(2) \quad V_i = u_i(c_i, l_i^e - l_i) + \sum_{j=1}^{N+M} \gamma_i(a_{ij}, a_{ji}) + z_i R_i$$

where  $u$  is a strictly quasiconcave and continuous twice differentiable function and  $z_i > 0$ .  $c_i$  is individual  $i$ 's consumption,  $l_i$  labor supplied by  $i$ ,  $l_i^e$  the labor endowment of  $i$ , and  $R_i$  a variable that is one, if the individual's behavior is consistent with the norm, and zero otherwise.

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<sup>2</sup>The term "social norm" is well-established in sociology. Following Popitz (1961), the main features of norms are:

- 1) Norms refer to classes of behavior.
- 2) Norms refer to classes of persons.
- 3) Individuals can at the same time belong to many different classes of persons, they can play many "social roles". Different norms can therefore be in conflict with each other.
- 4) There are costs of deviations of behavior from the norm. These costs come from sanctions by the rest of society. The action of sanctioning someone is itself prescribed by a norm (and so on).
- 5) Social norms are inherited from one generation to the next.



I do not explicitly model the origin of these costs here. They can be the consequence of sanctions through other members of society. In this case sanctioning itself has to be enforced on a meta level. This kind of costs can be the result of a repeated game, where in equilibrium each player plays the strategy: sanction those players who disobey the norm and sanction those players who do not sanction disobedience of others and so on. A second rationale for the cost term is that an individual can internalize a norm and feel badly if he disobeys it.

I will first specify a time-structure for the actions in the game. After this, I define a condition that has to be satisfied by a state of the socio-economy, i.e. by all the players' actions, the market prices and the exogenous norm, so that the state can be seen as a likely outcome of the game. A state which fulfills the condition is called a socio-economic equilibrium. I will then in an example examine the influence of different rules on the outcome of the socio-economic game.

In this section, the norm is exogenously given in the beginning of the game. I assume that actions on the market are taken in a first step. All individuals act simultaneously on the market. They are assumed to be price-takers. Following that, the actions in the social games are chosen simultaneously. This corresponds to the situation where economic decisions have long-term character (the choice of labor contracts and a corresponding consumption-level or irreversible investment decisions in human or physical capital), while social actions have to be taken at all points of time. I now define

**Definition 1: Socio-Economic Equilibrium** A socio-economic equilibrium (SEE) is a tuple  $(R, p, w, r, \{l_i\}, \{c_i\}, \{a_{ij}\}, \{K_i\})$  so that:

(i) given the norm  $R$  and prices  $p, r$  and  $w$ , the  $\{l_i\}$ ,  $\{c_i\}$  and the  $\{a_{ij}\}$  form a subgame-perfect Nash equilibrium of the socio-economic game which consists of the choice of consumption and labor-offer under the budget constraint in stage one and the

choice of  $a_{ij}$  in stage two of the game.

(ii) There is an equilibrium in the goods market, the labor market and the capital market.

For each rule  $R$  there either does not exist a SEE with  $R$  or a unique SEE with  $R$  exists or more than one SEE with  $R$  exists. I now turn to a simple example where SEEs exist in order to illustrate the model.

### **Example 1**

For this particular example I choose the following additional assumptions.

**Assumption 1**  $a_{ij}$  is chosen from the set  $\{-1, 0, 1\}$ . The payoff of  $i$  from the game with  $j$  is  $a_{ji}$ .

**Assumption 2** All the workers have the same endowment of labor,  $l^e$ .

**Assumption 3** All the workers have identical preferences

$$V_i = u_i(c_i, l_i^e - l_i) + \sum_{j=1}^{N+M} \gamma_i a_{ji} + z_i R_i$$

**Assumption 4** All the capitalists have  $l_i^e = 0$  and identical capital endowments  $K_i > 0$ .

I now want to examine how different rules affect the outcome of the game. There is a priori an infinity of rules imaginable. I examine two simple and prominent rules. I call the first one "*Be nice to everybody*" or BNTE, the second "*Be nice to rich*" or BNTR. The BNTE rule is violated as soon as an individual does not play 1 whenever he meets another person. The BNTR rule demands the individual to play  $a_{ij} = \text{sign}(c_j - c_i)$ . The interpretation of the rule is rather obvious: BNTE specifies a benevolent behavior and BNTR might be interpreted as a social custom that demands individuals to honor successful or diligent individuals, i.e. those with higher consumption or (for workers) higher labor-offer<sup>3</sup>.

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<sup>3</sup>The assumption that the outcome of the game depends only on the other peoples actions in combination with the

The point of reference for the following analysis is the Walrasian equilibrium of the economy if we only consider the economic part. Under my assumptions such an equilibrium exists. Uniqueness is, however, not warranted. In propositions 1 and 2, I assume that there is a unique Walrasian equilibrium. For this case I denote equilibrium values of consumption and labor-offer as  $c_i^W$ ,  $l_i^W$  and the Walrasian price, wage, and interest rates  $p^W$ ,  $w^W$ ,  $r^W$ , and  $w^W/p^W = \omega^W$ .

**Assumption 5** There is a unique Walrasian equilibrium.

Given assumptions 1 and 3, assumption 6 is concerned with the relationship M/N. We have

**Proposition 1** Suppose that the norm is BNTE and assumption 1. For any Walrasian equilibrium  $(p^W, w^W, r^W, c_i^W, l_i^W, K_i^W)$ ,  $(R, p^W, w^W, r^W, c_i^W, l_i^W, K_{iW}, E)$  is a SEE where the strategy profile  $E$  is then the  $n \times n$  matrix with a 1 as elements.

**Proof 1** Obvious. Everybody follows the norm BNTE in the second stage (the game) because this increases utility. Any deviation of  $l_i^W, c_i^W, K_i^W$  in the first (market-) stage does not affect the outcome of the game but decreases the u-utility. Q.E.D.

For the analysis of the norm BNTR some additional notation is helpful.

**Definition 2**  $\omega(l) := F'^{-1}(l)$ .

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simple rule BNTR makes the results equivalent to those of a game under envy, i.e. it would be equivalent to add the term  $\text{sgn}(c_i - c_j)$  to the utility function. Our model in section 2 can therefore be seen as a microfoundation for an envy-term in utility functions. The advantage of the present model is that it makes the normative analysis of norms possible and that it explains economic and social action jointly.

$$\text{Definition 3 } \Phi(l) := \frac{\partial u_i(l_i, \frac{l_i}{\omega(l)})}{\partial l_i} \bigg|_{l_i=l}.$$

This derivative is the marginal gain from individual  $i$ 's increase in the labor-offer, given that the other individuals also sell  $l_i$  and given that the labor market is in equilibrium.

**Proposition 2** Suppose that the norm is BNTR and assumptions 1, 2, 3, 4, 5.

- (i) In all the existing SEE the real wage is below the Walrasian real wage and the total labor-offer is higher.
- (ii) Assume that  $M$  is small so that a capitalist earns more than a worker if  $\omega = \omega^W$ . Then there exists a SEE where all the workers offer the same amount of labor.
- (iii) In all the existing SEE, workers have lower total utility than in the equilibrium from Proposition 1.
- (iv) A capitalist consumes more in the SEE from (ii) than in the Walrasian equilibrium.

**Proof 2** see appendix.

Proposition 2 has a number of interesting implications: first, norms which condition social behavior on economic equilibrium variables can distort the economic equilibrium outcome. Second, the problems of existence and unicity of equilibria have to be re-examined if the existence of social norms is taken into account. Third, a corollary of proposition 2 is that the capitalists ex-ante prefer BNTR to BNTE if the gain from the increase in the labor offer is large enough to compensate for the loss  $\gamma_i M$ . Thus, different groups of society are interested in different rules. The last result is interesting in three different ways: it can be used to explain how norms emerge, why certain norms persist and when rules change. One way to model this would be to think of lobbying for social norms, where norms affect the outcome for interest groups.

There are a number of extensions of this example which are worth studying. One is heterogeneity. Assume for example instead of (2) that utility is

$$(3) \quad V_i = u_i(c_i, l_i^e - l_i) + \sum_j [\theta_i a_{ij} + (1 - \theta_i) a_{ji}] + z_i R_i.$$

Now a large  $\theta$  belongs to an individual which is not only interested in the others' behaviour in the social game, but also directly in his own actions. Suppose that the norm is BNTR. If there are enough individuals who follow the norm in equilibrium, then agents who put more weight on the other's actions have a larger incentive to work more. Thus, under BNTR, we should expect that heterogeneity of social preferences creates economic heterogeneity.

So far I assumed that the norm is given exogenously and that there is only one single norm for all the individuals. In the next section I analyze how norms may gain or lose influence over time when different norms coexist.

### **3. Evolutionarily stable social norms**

This section presents a dynamic extension of the model from section 2. In this evolutionary model different individuals can internalize different social norms. The evolution of norms is now supposed to depend on the past performance of the norm. Norms that deliver lower total utility to their believers are less likely to persist, as are norms that are not followed by their adherents. Time is divided into periods. In each period the individuals play the socio-economic game from section 2.

I call  $p_t$  the distribution of norms in period  $t$ .  $p$  is a vector of shares of each norm with  $\sum p_{jt} = 1$ .  $s_t$  is a strategy profile in period  $t$ . If there is an equilibrium state of the socio-economy in period  $t$  for each given  $p_t$  then I call this the set of equilibria  $S_t(p_t)$ . The law

for the evolution of norms is denoted  $f$ , so that  $p_{t+1} = f(s_t, p_t)$  with  $s_t \in S_t$ . I make the following additional assumptions about the law of evolution  $f$ :

**Assumption 6**

**6.1** The number of individuals living in period  $t$  who believe in a norm  $N_i$  rises if the number of individuals living in period  $t-1$  who internalize  $N_i$  is larger.

**6.2** Suppose that all the individuals who believe in norm  $i$  follow norm  $i$  in period  $t-1$ . Then  $\frac{p_{i,t}}{p_{j,t}} > \frac{p_{i,t-1}}{p_{j,t-1}}$  if the average utility of norm  $i$ -believers was larger in  $t-1$  than average utility of norm  $j$ -believers.

**6.3** Assume that norm  $i$  and  $j$  deliver same average utility in  $t-1$  to their believers. Call  $\alpha_{k,t}$  the percentage of norm  $j$ -believers who follow norm  $j$  in  $t$ . The ratio  $\frac{p_i}{p_j}$  increases if  $\alpha_{i,t} > \alpha_{j,t}$ .

**6.4**  $p_{i,t} > 0 \Rightarrow p_{i,t+1} > 0$ . This means that a norm can only be eliminated by convergence of  $p$  to zero.

A concept for evolutionary (in)stability can now be defined as follows:

**Definition 5:** A **feasible history** consists of a sequence of distributions  $p_0, p_1, \dots, p_T$  and equilibrium actions  $s_1, s_2, \dots, s_T$  for all the individuals so that  $p_{t+1} = f(s_t(p_t), p_t)$  and  $s_t \in S_t$  for all  $t = 1 \dots n-1$ .

**Definition 6:** A  $N_2$ -mutant is an set of individuals of non-zero measure who, in a world with one single rule  $N_1$ , believe in an alternative rule  $N_2$ .

**Definition 7:** A norm  $N_1$  is called **evolutionarily  $N_2$ -instable** if any  $N_2$ -mutant can induce a feasible history which never converges to the initial state where  $p_{N_2} = 1$ . The norm is called **evolutionarily  $N_2$ -stable** if there is no such  $N_2$ -mutant with non-zero mass.

The above concept of evolutionary stability can be illustrated with a simple example which based on the model from section 2:

**Example 2: How bad behavior can become popular**

Assume once again the existence of two rules, BNTE and BNTR. Individuals are workers with identical endowments and utility functions in consumption and leisure, they have measure 1. The production function is  $Y=L$  and the equilibrium real wage is 1. Individuals can either offer  $l_1$  or  $l_2$  labor with  $l_1 < l_2$  and  $u(l_1, c_1) - u(l_2, c_2) =: du > 0$  for  $c_1 = l_1$ . The payoffs of the game are  $\gamma_i(a_{ij}, a_{ji}) = a_{ji} - \min\{a_{ij} - a_{ji}, 0\}$  so that

$$(4) \quad V_i = u_i(c_i, l_i^e - l_i) + \int_0^1 [a_{ji} - \min\{a_{ji} - a_{ij}, 0\}] dj + z_i R_i$$

This payoff function is the same as in section 2 plus a term which measures frustration if the own behavior is more friendly than that of the counterpart in the game. Interestingly, one can show that an optimal norm, like the BNTE norm, need not be evolutionarily stable. I call  $p$  the share of the BNTE- believers in society. We have:

**Proposition 3**

The optimal norm BNTE is evolutionarily-BNTR instable.

**Proof 3:**

Table 1 contains the values of  $\int_0^1 \gamma_i(a_{ij}, a_{ji}) dj$  for situations where the  $(1-p)$  BNTR's and the

$p$  BNTE's choose  $l_1$  or  $l_2$  in stage 1 of the game. The boxes contain the utility values of both types of individuals for the case where the BNTE's either decide to obey their norm in stage 2 (upper part) or not (lower part). If they do not obey the norm, they will retaliate the action of the BNTR's and play 1 if they meet a BNTE. Note that BNTRs always follow their norm because they have no incentive to disobey it.

Consider first the upper left cell A, where the BNTE follows this norm and offer  $l_1$  labor. A BNTE-individual has no incentive to disobey the norm iff the costs  $z_i > 1-p$  and a BNTR-individual has no incentive to play  $l_2$  iff  $du > 1-p$ . Thus these are the conditions for an equilibrium in the cell A. In this situation the BNTE's are worse off than the BNTR's and  $p$  increases. The situation B where both types play  $l_1$  and where the BNTE's violate the norm is an equilibrium if  $z_i < 1-p$  and  $du > 1-p$ . Here, the BNTR's are worse off than the BNTE's. The effect of this situation on  $p$  is ambiguous. The positive effect on  $p$  comes from the fact that the BNTE's do not follow their own norm while the BNTR's do. If the utility effect is larger then the economy returns to cell A with positive  $p$ . Otherwise  $p$  rises and the economy moves to F or H as soon as  $du < 1-p$ .

Two analogous equilibria can be found in the lower right cell. These equilibria emerge if  $du < 1-p$ .  $p$  increases in both equilibria. In the lower part H because the BNTE types violate their own norm, in the upper cell F because they are worse off than the BNTR's.

B and D are not equilibria because either the BNTE's are better off if they move to  $l_2$  or the BNTR's are better off if they move to  $l_1$ . The analogue reasoning applies to the cells E and G.

Therefore, if  $du < 1-p$ , one of the states in the upper left cell is the equilibrium. If not, one of the lower right states is. In both cases if the number of BNTR-believers,  $1-p$  is large enough, the BNTEs will disobey the norm. It rests to be shown that the economy never converges to the state where  $p=0$ . This is the case because in A and F  $1-p$  always increases with time because the BNTE's are worse off than the BNTR's. Thus, even if  $p$  would fall in cell C the economy could never converge to a situation with  $p=1$ . Q.E.D.

The proof of proposition 3 tells a sad story: One single BNTR mutant can shift behavior from the optimal coordinating norm BNTE to the suboptimal BNTR norm. Dependent on



the costs of disobedience,  $z$ , and on the utility differential  $du$  the economy passes different stages. First, the BNTR mutant deteriorates the situation for the BNTE's but the incentives are too weak for the workers to offer  $l_2$ . As  $p$  decreases, however, the incentives become stronger to offer  $l_2$ . Now two situations can emerge: either all the individuals offer  $l_2$  or the BNTE's disobey their proper rule. In the second case the economy either returns to A or it jumps to F or H if  $du < 1-p$ . In this latter case the BNTE's will start to abandon the rule and become BNTR's.  $p$  falls and the individuals will find themselves in the suboptimal equilibrium where they behave zero and offer  $l_2$ . A mutant of non-zero mass creates different patterns dependent on the cost  $z_i$ . The different feasible histories are depicted in figure 2.

#### **4. Conclusion and Extensions**

The analysis of two simple examples of economic and social behavior under existence of social norms has shown that social norms distort the economic equilibrium outcome if they link "correct social behavior" to economic activity. The initial endowment of an individual determines whether she benefits from such a social norm or not. Besides social heterogeneity can induce economic heterogeneity. In addition, we have seen that the evolution of norms can lead to evolutionarily stable suboptimal norms. On the other hand optimal norms can be evolutionarily instable.

There are a number of extensions and modifications of the above model which deserve examination. Social norms in this model are modeled similar to incentive mechanisms. Thus, one possible extension of the above model is to compare costs and benefits of a Pareto-improving social norm with those of other mechanisms. Such an analysis should consider the problem of the persistence of obsolete norms, the advantage of generality of norms, the costs of the establishment of norms and the institutional costs of the effective enforcement of incentive mechanisms.

The above framework also permits to examine additional channels that link social and economic phenomena. If, for example, individual preferences can be influenced by other individuals, e.g. through payments for propaganda or advertisement, then economic agents can influence parameters in the social part of the utility function in order to achieve economic goals.

A second link is given by the influence of the exercise of one activity on the ability to derive utility from a second activity in another sector. This technological interdependence is given if one activity affects the human capital that is connected to another activity. Certain forms of work, for example, affect the way people behave, even outside the workplace. This phenomenon is sometimes called *déformation professionnelle* (see Beck, Brater, Daheim (1974, chapter VII)). A lack of communication ability which in turn is the consequence of certain forms of work may feed back to the labor offer of individuals. Professional deformation can also create external effects when time with "deformed" persons is less enjoyable.

It may be useful to extend the above model in order to incorporate such additional links between social and economic actions.

## **Appendix**

### **Proof 2**

(i) Suppose that we have a SEE. All the workers work at least as much as in the case of the absence of a norm and given the real wage of the SEE because otherwise they could increase utility through a marginal increase of their labor-offer. The SEE-wage under BNTR cannot be the Walrasian wage because  $\Phi(l^w)=0$  and furthermore each worker can gain in the social game through a marginal increase in labor-offer and consumption. In the SEE, there is an equilibrium on the labor market. Consequently, there should be excess

demand on this market without a norm, given the SEE's real wage. The real wage must lie below the Walrasian real wage in order to create an excess demand in the absence of a norm.

(ii) Suppose that we have a SEE where all the workers offer the same amount of labor in stage one. Everybody follows the norm  $R$  in stage two. Therefore, if there is an equilibrium as described in (i), all workers behave 0 with respect to the other workers. The gain for a worker in the social game from increasing  $l_i$  is simply  $\gamma_i (N-1)$ . Any higher gain is excluded through the assumption that capitalists earn more than workers. A sufficient condition for the existence of an equilibrium with an identical labor offer is:  $\Phi(l_i^{eq}) = -\gamma_i(N-1)$  if  $l_i^{eq} < l_i^e$ . We know that in the Walrasian equilibrium  $\Phi(l^w) = 0$  and  $\Phi(0) > 0$ . There is only one Walrasian equilibrium. Consequently there cannot be a value of  $l^+$  in  $(0, l^w)$  so that  $\Phi(l^+) < 0$  because the utility function is continuous. Were this the case  $l$  would be less than  $l^w$  so that  $\Phi(l) = 0$  and this would be a second Walrasian equilibrium.

We now have either

- 1) a SEE where  $l$  lies in the open interval  $(l^w, l^e)$ , or
- 2) no equilibrium in this interval.

If 2) is true, then the situation where each worker offers  $l^e$  and  $w/p$  is a SEE because in this case all the workers are worse off, consuming less.

(iii) In a SEE, the real wage must lie below the unique Walrasian real wage. Thus, the utility of every worker is smaller than in the Walrasian equilibrium and the utility of capitalists is larger than in the Walrasian equilibrium. Additionally, in equilibrium there is no worker who is treated +1 by all the other workers because it is not possible that one single worker exists in equilibrium who works more than all the others. The reason is that in any SEE, each worker works at least as much as under the prevailing real wage in absence of a norm. The single rich worker is therefore better off if he works marginally

less. (iii) follows.

(iv) Capitalists consume more because the capital-offer is inelastic and the labor offer is higher in equilibrium. Q.E.D.

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Table 1: Social-utility of BNTE's and BNTR's

| BNTE\BNTR | $\ell_1$   | $\ell_2$  |
|-----------|--|---|
| $\ell_1$  | <b>A</b><br>u-utility of both players = $u_0$<br><br>BNTE's follow norm:<br><br>BNTR: $1 - (1 - p) * 1$<br>BNTE: $1 - (1 - p) * 2$ | <b>B</b><br><br>BNTE's follow norm<br><br>BNTR: $1 - (1 - p)$<br>BNTE: $1 - 4(1 - p)$   |
|           | <b>C</b><br><br>BNTE's do not follow norm:<br><br>BNTR: $1 - 1 = 0$<br>BNTE: $1 - (1 - p) - z_i$<br>$= p - z_i$                    | <b>D</b><br><br>BNTE's do not follow norm:<br><br>BNTR: $1 - 1 = 0$<br>BNTE: $1 - (1 - p) - z_i$<br>$= p - z_i$                             |
| $\ell_2$  | <b>E</b><br><br>BNTE's follow norm:<br><br>BNTR: $1 - (1 - p) = p$<br>BNTE: $1$  | <b>F</b><br>u-utility of both players = $u_0 + du$<br><br>BNTE follows norm<br><br>BNTR: $1 - (1 - p) * 1$<br>BNTE: $1 - (1 - p) * 2 - z_i$ |
|           | <b>G</b><br><br>BNTE's do not follow norm:<br><br>BNTR: $1 - (1 - p) = p$<br>BNTE: $1 - z_i$                                       | <b>H</b><br><br>BNTE does not follow norm:<br><br>BNTR: $1 - 1 = 0$<br>BNTE: $1 - (1 - p) - z_i$<br>$= p - z_i$                             |

Table 2: Feasible Histories

