8. DYNAMICS OF SOCIAL TOLERANCE ON CORRUPTION: AN ECONOMIC INTERACTION PERSPECTIVE

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Abstract

The dynamics of social tolerance on corruption have been analyzed based on the dynamic economic-interaction model of social tolerance between two groups which was recently proposed by Cerqueti et al. (2013). The evolution properties of social tolerance on corruption, such as the steady states, unequal distribution of aggregate wealth, and the necessary condition of achieving full tolerance have also been discussed. We show that dynamics of social tolerance on corruption can be greatly influenced by the distribution of aggregate wealth between corrupt officials and ordinary members of the society, which may contribute as original insights to the application of the dynamic economic-interaction model proposed by Cerqueti et al. An unequal distribution of aggregate wealth between corrupt officials and ordinary members of society is determined quite naturally in the framework of replicator dynamics.

Keywords: economic interaction model; social tolerance; corruption
JEL Classification: C70, D71

1. Introduction

Social tolerance, which is increasingly recognized as an important influence factor of economic growth, attracted more and more attention over the last decade (Akerlof and Kranton, 2000; Berggren and Elinder, 2012; Shi and Peng, 2014). It has been suggested that social tolerance leads to many potentially important consequences, including technological and economic performance (Florida and Gates, 2001; Berggren and Nilsson, 2013), population growth (Becchetti *et al*., 2010), and social development (Bjørnskov, 2004). The discussion on tolerance at the individual level reveals that economic reasoning can offer original and unique insights into the determinants of tolerance (Corneo and Jeanne, 2009),

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and many social phenomena related to tolerance can be explained by economic models (Garofalo *et al*., 2010; Muldoon *et al*., 2012).

Recently, a dynamic economic interactions model of social tolerance between two groups has been studied by Cerqueti *et al.* (2013). In the present work, we set up a simple model, which is a natural continuation and application of the Cerqueti-Correani-Garofalo model, to describe the evolution properties of social tolerance on corruption. We demonstrate that unequal distribution of aggregate wealth between corrupt officials and ordinary members of society is inevitable in economic interactions, and the corrupt official sustains a continuous social penalty which results from the intolerant social reaction of ordinary citizens adverse to the corrupt official. After analyzing the steady states, unequal distribution of aggregate wealth, and the necessary condition of achieving full tolerance, the social penalty to corrupt officials can be derived naturally from the dynamic economic interactions model. Our results deepen the understanding of the relationship between corruption and social attitudes to corruption (Hauk and Saez, 2002; Correani, 2005).

2. Dynamics of Social Tolerance on Corruption

We use an evolutionary game model of social tolerance similar to Cerqueti *et al.* (2013) to give more insights. We consider that these corrupt officials form a differentiated group of economic agents which recorded as group 1 with the population N_1 when their corrupt behaviors are detected, while the ordinary members of society form another differentiated group which recorded as group 2 with the population N_2. The total population of the society is $N = N_1 + N_2$, and both N_1 and N_2 are assumed to be changeless with time and large enough. Each economic agent in group 2 can be tolerant or intolerant towards the agents in group 1. We indicate that x_2 and $\hat{x}_2$ be the share of tolerant and intolerant agents in group 2 respectively, with $x_2 + \hat{x}_2 = 1$ and $x_2, \hat{x}_2 \in [0,1]$. Thus, x_2 and $\hat{x}_2$ reflect the level of social hostility to corruption. We use the assumption that two agents interact after being randomly matched, producing aggregate wealth R in unit time, and the agent in group i shares $\delta_{ij} R$ when he interact with the agent in group j, and $\delta_{ij} + \delta_{ji} = 1$, for each $i, j = 1,2$. The social tolerance influences the net gain of each agent in three cases:

1. For the case that the two agents in the economic interaction are of the same group, each of them obtains $R/2$ irrespective of their real attitude is whether tolerance or not, and $\delta_{ii} = 1/2$.

2. For the case that the two agents are of different group and the agent in group 2 is tolerance, the agent in group 1 obtains $\delta_{12} R$, while the agent in group 2 suffers (Cerqueti *et al.*, 2013) a psychological cost $\alpha = R/2$ and a social cost $\beta(1 - x_2)$ with the exception of $\delta_{21} R$. The parameter β is greater than zero, and a higher β leads to a higher social costs,

so the parameter β describes the social reaction of intolerant agents in group 2 adverse to the agents of the group 1.

3. For the case that the two agents are of different group and the agent in group 2 is intolerant, which rules out any interaction between them, there is no wealth produced, and each of them obtains 0.

The evolutionary dynamics of social tolerance can be modeled by the theory of replicators, and the evolution of tolerant population in group 2 can be described by

$$\dot{x}_2 = x_2 \hat{x}_2 (E[x_2] - E[\hat{x}_2]) \tag{1}$$

where: $E[x_2]$ and $E[\hat{x}_2]$ are the expected net gain of tolerant and intolerant individuals in group 2 respectively, and can be calculated by using the following expression:

$$E[x_2] = \frac{(P_{x_2 x_2} + P_{x_2 \hat{x}_2})R}{2} + [(\delta_{21} - 1/2)R - \beta \hat{x}_2] P_{x_2 N_1}$$

$$E[\hat{x}_2] = (P_{\hat{x}_2 x_2} + P_{\hat{x}_2 \hat{x}_2})R / 2 \tag{2}$$

with $P_{x_2 N_1}$ the probability for a tolerant agent of group 2 matches an agent of group 1, $P_{x_2 x_2}$ the probability for a tolerant agent of group 2 matches a tolerant agent of group 2, $P_{x_2 \hat{x}_2}$ the probability for a tolerant agent of group 2 matches an intolerant agent of group 2, $P_{\hat{x}_2 x_2}$ the probability for an intolerant agent of group 2 meets a tolerant agent of group 2, and $P_{\hat{x}_2 \hat{x}_2}$ the probability for an intolerant agent of group 2 interacts with an intolerant agent of group 2. Considering the randomly match, in which all the agents in these groups have the same probability to be selected, we can obtain $P_{x_2 N_1}$, $P_{x_2 x_2}$, $P_{x_2 \hat{x}_2}$, $P_{\hat{x}_2 x_2}$, and $P_{\hat{x}_2 \hat{x}_2}$ as follows:

$$P_{x_2 N_1} = \frac{N_1}{N-1}, \quad P_{x_2 x_2} = \frac{x_2 N_2 - 1}{N-1}, \quad P_{x_2 \hat{x}_2} = \frac{\hat{x}_2 N_2}{N-1},$$

$$P_{\hat{x}_2 x_2} = \frac{x_2 N_2}{N-1}, \quad P_{\hat{x}_2 \hat{x}_2} = \frac{\hat{x}_2 N_2 - 1}{N-1}.$$

Given the above probabilities we can obtain a differential equation which describes the evolution of tolerant population in group 2:

$$\dot{x}_2 = \frac{N_1 x_2 \hat{x}_2}{N-1} [(\delta_{21} - 1/2)R - \beta(1 - x_2)]. \tag{3}$$

This differential equation gives a description of the evolutionary dynamics of social tolerance on corruption, and in what follows, we will discuss some main points, and show that how the corrupt official sustains a social penalty compared to the ordinary member of society.

In general, the steady states of the dynamical system are $x_2 = 0$, $x_2 = 1$, and $x_2 = 1 - \Omega / \beta$, with $\Omega = (\delta_{21} - 1/2)R$. It should be noticed that the steady state $x_2 = 1 - \Omega / \beta$ can exist when $\Omega > 0$. These steady states have precise economic and social meanings: the steady state $x_2 = 0$ depict the situation that group 2 is wholly populated by intolerant agents while steady state $x_2 = 1$ depict the situation that group 2 is wholly populated by tolerant agents. The steady state $x_2 = 1 - \Omega / \beta$ depict the situation that group 2 is mixed by both tolerant and intolerant agents, which determined by the psychological cost and the distribution of aggregate wealth.

Proposition 1. The necessary condition in order that tolerance spreads in group 2 is $\delta_{21} > 1/2$.

Proof. To verify the stability of steady state $x_2 = 1$, we write $x_2 = 1 - \delta x_2$ with δx_2 a small quantity, viz. $0 \le \delta x_2 << 1$, thus the evolution equation 3 can be reduced to

$$\delta \dot{x}_2 = -\frac{N_1 \delta x_2 (1 - \delta x_2)}{N - 1} (\Omega - \beta \delta x_2) \quad (4)$$

After ignore higher-order small quantity of δx_2, we obtain

$$\delta \dot{x}_2 = -\frac{N_1 \Omega \delta x_2}{N - 1} \quad (5)$$

and the solution

$$\delta x_2 = \exp\left(-\frac{N_1 \Omega}{N - 1} t\right) \quad (6)$$

So the necessary condition in order that tolerance spreads in group 2 is $\Omega > 0$, which ensures that $\delta x_i \to 0$ for $t \to \infty$. Simplification of inequalities $\Omega > 0$ leads to $\delta_{21} > 1/2$. □

Remark 1. $\Omega < 0$ rules out not only the steady state $x_2 = 1$ but also the steady state $x_2 = 1 - \Omega / \beta$ which can exist when $\Omega > 0$, so the final steady state is $x_2 = 0$ in this case.

Remark 2. In general, corrupt officials desire to integrate into society, and favor a society with high tolerance which allows economic interactions between corrupt officials and ordinary members of society. However, the corrupt officials must make concession in the distribution of aggregate wealth, that is, the corrupt officials share less than the ordinary members of society. Such an unequal distribution of aggregate wealth between corrupt officials and ordinary members of society is inevitable in economic interactions according to Proposition 1.

Proposition 2. A sufficient condition in order that tolerance spreads in group 2 at any starting point x_2^0 is $\delta_{21} > 1/2 + \beta / R$.

Proof. $(\delta_{21} - 1/2)R - \beta(1 - x_2) > 0$, which can be reduced as $x_2 > 1 - \Omega / \beta$, ensures $\dot{x}_2 > 0$. Note that $x_2 \in [0,1]$, so $1 - \Omega / \beta < 0$, which ensures $\dot{x}_2 > 0$ for any x_2, gives a sufficient condition of achieving full tolerance at any starting point. Simplification of inequalities $1 - \Omega / \beta < 0$ leads to $\delta_{21} > 1/2 + \beta / R$.

Remark 1. In a society with low social cost, viz. $\beta / R << 1/2$, the distribution of aggregate wealth is relatively fair, and there are frequent economic interactions between corrupt officials and ordinary members of society. However, things are quite different if $\beta \geq R/2$. In this case, $\delta_{21} > 1$, and an agent of group 2 may reject the economic interaction with corrupt officials even if she shares the whole aggregate wealth.

A corrupt official and an ordinary member of society produce aggregate wealth R in unit time. To sufficient ensure social tolerance, the corrupt official shares $R/2 - \beta$ while the ordinary member of society shares $R/2 + \beta$. So the corrupt official sustains a social penalty 2β (the difference between $R/2 - \beta$ and $R/2 + \beta$) in unit time compared to the ordinary member of society.

3. Policy

Government favors a society with low corruption. Improving the officials' annual salary can obviously reduce corruption at some level, which confirms the intuitively clear idea (Aidt, 2003) that the official is more likely to accept corruption if the job is not earning more (compared with the average annual salary in the society). Usually, the implementation of improving the officials' annual salary is not easy due to the income of the government (Cracau and Franz, 2013). Sufficiently high one-off penalty of government can reduce corruption in theory, however, rarely be applied and enforced in reality (Becker and Stigler, 1974).

According to proposition 1 and 2, with the exception of the one-off penalty of government, corruption is great affected by the level of social hostility to corruption: the official sustains a continuous social penalty 2β except the one-off penalties of government because their behavior is disapproved by members of society and treated as dishonesty lasts for a long time. Such a continuous social penalty is a function of time and β, while has little to do with the specific details of corruption since members of society care only whether the official is corrupt. Corruption is more likely to occur in a society with full tolerance due to the absence of the social penalty. A society, in which everyone has a zero tolerance against corruption, should be less vulnerable to corruption. The social cost parameter β which can be controlled via cultural method, such as cultural differentiation and cultural integration (Cerqueti *et al*., 2013). From a policy perspective, the main implication of this finding is that controlling the continuous penalty of society provides an additional approach for reducing corruption. In reality, a government which aims to reduce corruption should reform economic and political institutions to strengthen the credit record, meanwhile, value honesty and cultural differentiation (Cerqueti *et al*., 2013; Shi and Pan, 2016) should be part of the agenda.

4. Conclusions

In this work, we present an analysis of the dynamics of social tolerance on corruption from an economic-interaction perspective. We set up a simple model, which is a natural continuation and application of the Cerqueti-Correani-Garofalo model, to describe the evolution properties of social tolerance on corruption. We discuss the steady states, unequal distribution of aggregate wealth, and the necessary condition of achieving full tolerance, and show that social tolerance on corruption plays an important role in the unequal distribution of aggregate wealth between corrupt officials and ordinary members of the society. The corrupt officials must make concession in the distribution of aggregate wealth, and such an unequal distribution of aggregate wealth between corrupt officials and ordinary members of society is inevitable in economic interactions.

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