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The co-evolution of reciprocity-based wage offers and effort choices

Philipp Schliffke *

University of Hamburg, Department of Economics, Von-Melle-Park 5, 20146 Hamburg, Germany

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ABSTRACT

I study the evolution of reciprocity in a gift-exchange game. In equilibrium, wage offers induce maximal effort but there is strong inequity in favor of the workers. The result suggests that norm-based efficiency wages may be unstable over time.

1. Introduction

Theories of social preferences based on reciprocity explain a positive wage–effort relation in the gift-exchange game frequently observed in experiments (e.g. Fehr et al., 1997, 2007). But when and why does reciprocal behavior evolve? And, is it persistent? A natural explanation would be that reciprocity yields superior payoffs in an evolutionary context. Accordingly, I study the evolution of reciprocity in a gift-exchange game.

Previous works have revealed that the ability to discriminate between different player types is crucial for the evolutionary success of other-regarding preferences (e.g. Güth and Kliemt (1994) and Herold and Kuzmics (2009)). Applying the reciprocity model introduced by Falk and Fischbacher (2006), Berninghaus et al. (2007) have shown that an infinitely large reciprocal inclination associated with fair-split offers is stable in the ultimatum game but behavior corresponding to money-maximization is successful in the dictator game.

Contrasting the ultimatum game, second mover choices in the gift-exchange game are associated with positive rather than negative reciprocity. Similar to the dictator game, workers make quasi-dictatorial decisions but they need the employers to trust them. Another characteristic is that there may be two equilibrium wages, either high ones inducing high effort or low ones inducing low effort. On an a priori basis, it is unclear which kind of behavior will be evolutionary successful. Further, contrasting the standard one-population approach, the situation calls for a multi-population model since it appears unlikely that employers and workers frequently switch positions.

The paper proceeds as follows: Section 2 discusses the gift-exchange game and reviews Falk–Fischbacher preferences and the reciprocity equilibrium for the game. In Sections 3 and 4, the evolution of reciprocity parameters is studied. Section 5 concludes.

2. Reciprocity equilibrium in the gift-exchange game

Using the specification by Falk and Fischbacher (2006), the gift-exchange game Γ is a two-player sequential game with an employer (E) who moves first offering a wage w to the worker (W). Given that the worker accepts the offer, the wage is paid and the worker chooses an effort level e. Pecuniary payoffs are given as $\pi_E = ve - w$ and $\pi_W = w - c(e)$. For simplicity, assume that $w \in [0, 1]$, $e \in [0, 1]$, and $v = 1$. Further, let $c(e) = \alpha e^2$ with $\alpha \leq \frac{1}{4}$. Once the wage is paid, the worker has full discretion over the final outcome. If payoffs are equal to utility, $u(\pi) = \pi$, the unique subgame perfect equilibrium of the game is $e^* = 0$, $w^* = 0$.

Now assume that pecuniary payoffs do not equal utility. Rather, players hold Falk and Fischbacher (2006) preferences for

* Tel.: +49 40 42838 4630; fax: +49 40 42838 6713.
E-mail address: philipp.schliffke@wiso.uni-hamburg.de.

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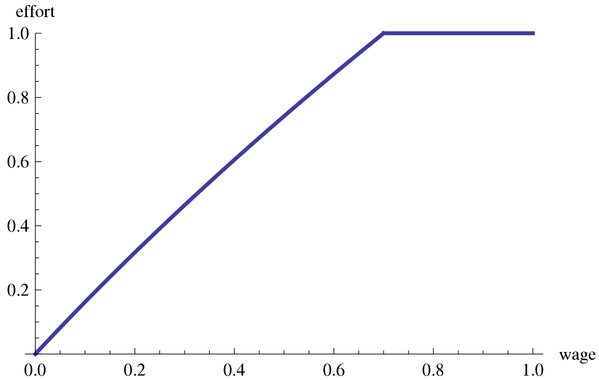

Fig. 1. $e^*(w)$ with $\rho_W = 2$.

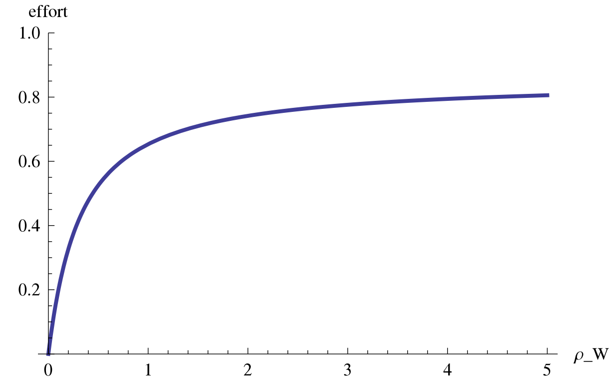

Fig. 2. $e^*(\rho_W)$ with $w = .5$.

reciprocity.[1] Agent i's utility is defined by:

$$u_i(f) \equiv \pi_i(f) + \rho_i \varphi_{ji}(n)\sigma_{ij}(n, f). \tag{1}$$

Utility is the sum of pecuniary reward at terminal node f, $\pi_i(f)$, and reciprocity utility $\varphi_{ji}(n)\sigma_{ij}(n, f)$ scaled with the individual reciprocity parameter $\rho_i \in \mathbb{R}_+$. The *kindness term* $\varphi_{ji}(n)$ evaluates the kindness by j toward i at non-terminal node n by comparing the expected payoffs for both players. Whenever i expects to get more (less) than j, player j's action is considered as kind (unkind). In addition, overall kindness depends on the intentions behind j's (un-)kindness. If, for example, player j is unkind but has no alternative to be less unkind, then the unkindness is considered as unintentional and the difference of expected payoffs is multiplied with the *outcome concern parameter* $\epsilon_i \in [0, 1]$.[2] The second component of reciprocal utility is the *reciprocation term* $\sigma_{ij}(n)$ capturing the impact of i's decision in n on j's final payoff.

The reciprocity equilibrium for the gift-exchange game is provided in Falk and Fischbacher (1998). Whenever the reciprocity parameter of the worker is zero, $\rho_W = 0$, then $e^* = 0$, $w^* = 0$ is the unique reciprocity equilibrium. Whenever $\rho_W > 0$, the optimal effort decision satisfies

$$e^* = \min\left[1, \frac{-2\alpha - \rho_W + \sqrt{(2\alpha + \rho_W)^2 + 8\alpha\rho_W^2 w}}{2\alpha\rho_W}\right]. \tag{2}$$

Figs. 1 and 2 illustrate the behavior of the workers ($\alpha = .2$).

Since the worker can always assure an equal split but typically receives more than the employer, he judges the employer as kind and effort increases in w and ρ_W. Note that except for very low levels of ρ_W, effort will be equal to 1 for wages less than 1.

With regard to first-mover behavior, let $\bar{w}(\alpha, \rho_W) = \frac{1+\alpha}{2} + \frac{\alpha}{\rho_W}$ be the minimal wage that ensures an effort choice of 1. Moreover, let $\tilde{w}(\alpha, \rho_E, \rho_W)$ be the wage offer if w, e are not restricted to $w, e \leq 1$ but restrict $w^* \in [0, 1]$.[3] Then, there is always an equilibrium given by

$$w^* = \min\left[\bar{w}(\alpha, \rho_W), \tilde{w}(\alpha, \rho_E, \rho_W)\right]. \tag{3}$$

Since the expected pecuniary payoff of the employer is smaller than the one of the worker, the employer judges the worker as unkind. Whenever the worker provides an effort of 1, however, the worker has no chance to be less unkind. In such cases, the employer

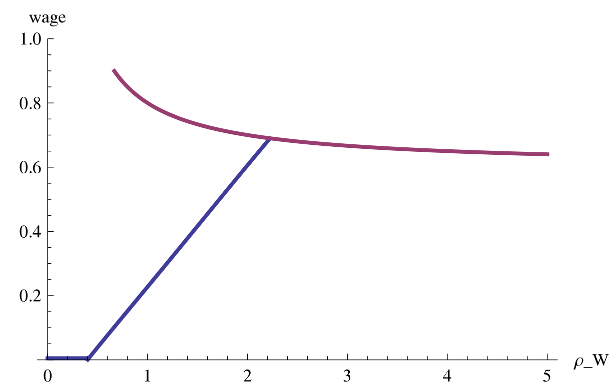

Fig. 3. $w^*(\rho_W)$ with $\rho_E = 3$.

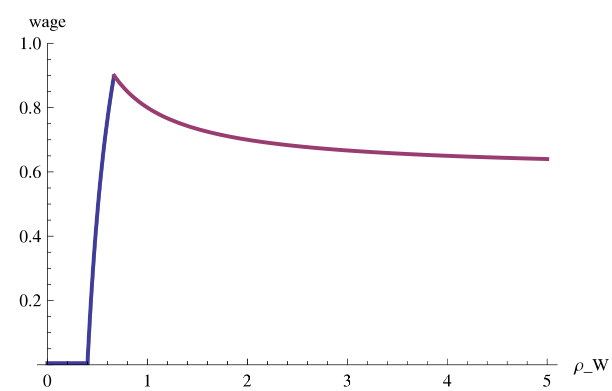

Fig. 4. $w^*(\rho_W)$ with $\rho_E = 0$.

judges the unkindness as unintentional and with a sufficiently low ϵ_E, the employer nevertheless offers a comparably high wage. Formally, if $\bar{w}(\alpha, \rho_W) \leq 1$ and if

$$\epsilon_E \rho_E \leq \frac{\rho_W(-\rho_W + 2\alpha + 2\alpha\rho_W)}{2\alpha(-2\alpha - \rho_W + 2\alpha\rho_W)},$$

then $w^* = \bar{w}(\alpha, \rho_W)$. (4)

Figs. 3 and 4 illustrate the behavior of the employer ($\alpha = .2$).

Wage offers $\bar{w}(\alpha, \rho_W)$ are decreasing in ρ_W since workers with a higher reciprocal inclination provide the maximal effort for lower wages. For very low ρ_W, a zero wage is offered but beyond a threshold, wage offers $\tilde{w}(\alpha, \rho_E, \rho_W)$ strictly increase in ρ_W. If the reciprocal inclination of the employer is larger than zero, equilibrium wage offers may depend on ϵ_E (upper and lower branch in Fig. 3). If the reciprocal inclination of the employer is zero, only one equilibrium can exist (Fig. 4). Note that $\tilde{w}(\alpha, \rho_E, \rho_W)$ is strictly decreasing in ρ_E. This is due to the fact that the employer judges the worker as unkind.

1 The model is based on psychological game theory, see Geanakoplos et al. (1989), and combines outcome-based approaches to other-regarding preferences, like Fehr and Schmidt (1999), with intention-based models, like Rabin (1993).

2 For an exact and formal definition of all terms, see Falk and Fischbacher (1998, 2006).

3 The exact expression $\tilde{w}(\alpha, \rho_E, \rho_W)$ is provided in Appendix.