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PUNISHMENT MAKES LARGE-SCALE MARKETS POSSIBLE

Summary: In this paper we discuss some experimental results which go against predictions of game theory and show how those results can be explained by incorporating norms into economic explanations. We justify the claim that norms are responsible for cooperative behavior. Finally, using evolutionary game theory and computer simulations we investigate the evolutionary stability of some simple strategies governing cooperation and show the importance of punishment for the persistence of cooperative strategies.

Key words: evolutionary game theory, computer simulations, cooperation, norms, punishment.

1. Introduction

Cooperation is one of those factors of human behavior that made civilization possible – it played and plays a basic role from the construction of Egyptian pyramids to shopping at a local store. Wherever human interactions exceed one's own family and parties involved become anonymous to each other, a question arises: what makes it possible that they cooperate? It seems that the answer is: norms.

In this article we would like to show how and which norms make cooperation possible. To do so, we use the framework of evolutionary game theory. First though, we describe some problems that are encountered by classic game theory when used to explain human economic behavior without appealing to norms.

2. Non-selfish behavior in the Ultimatum Game and the Dictator Game

In economics, explanations of individuals' economic behaviour usually invoke their utility function. According to the theory, given a set of actions, an individual will choose the action where the outcome maximizes its expected utility. Not much is assumed of the utility function: it is monotonic, continuous, and quasi-concave. In case of several possible but uncertain outcomes of an action, an expected utility of this action is a sum of utilities of particular outcomes weighted by their probabilities;

in a more complicated version, risk aversion and risk seeking are introduced. When other agents are introduced, an individual takes their possible actions under consideration when choosing his or her own strategy. A model of his or her behaviour in such circumstances is provided by game theory. One of the axioms of game theory uses is the selfishness-axiom – an assumption that agents try to maximize their own gains and expect others to do the same.

This model represents a foundation for the rational choice theory and was used to explain a wide variety of human behaviour – from choosing an educational pathway to committing crimes [Becker 1964; 1968]. While the use of the rational choice theory branched out from economics to other social sciences, some problems emerged in the very core of the field the theory was aiming to model.

In the Ultimatum Game (UG) there are two players, the proposer and the responder, who are anonymous to each other. The proposer is provided with some amount of money, a portion of which he or she can offer to the responder. The responder can either accept the divisionin this case the money is divided accordingly – or reject it, which results in both players leaving with nothing. According to rational choice theory, the best strategy for the proposer would be offering a very low but non-zero share to the responder, and the best strategy for the responder would be accepting any positive offer. Thus, under the assumption that maximizing utility in this game means maximizing income, the equilibrium seems to be pretty obvious. And how do real people behave?

Proposers usually offer 40%-50% of the initial amount, and the responders often reject offers below 30% [Camerer 2003, p. 43]. That seems to indicate peoples' economic behaviour is driven at least by both maximizing income and conforming to an equity norm, and that people would rather give up their monetary gains than transgress this norm [Cameron 1999]. In the Dictator Game (DG) – a game similar to UG but where the responder cannot reject the offer – the mean offer for the responder is 20%-30%, and the mode is usually 0%. That means the proposers in the UG are aware that when the offer is too low, it can be rejected. However, the positive mean payoff for the responder in the DG indicates that economic behavior is partially driven by considering the welfare of others, not only their possible response to the agent's strategy (as the responder cannot reject the offer). Those results are not a direct threat to rational choice theory, they just call for extending the utility function over the distribution of payoffs among all participants.[1] However, in this case the devil was indeed in the details.

Subjects used in those experiments came from Europe, USA, and Asia [Camerer 2003].That made plausible the claim that a preference for justice is universal – that it is a part of human nature. But actually all of the subjects came from industrialized countries and most of them were undergraduate students. A study conducted by the Cross-cultural Ultimatum Game Research Group [Henrich *et al*. 2005] showed

[1] For an example of a formalism fitting those results see Bethwaite, Tompkinson [1996].

that the results of those experiments were dramatically overgeneralized.[2] Henrich and his colleagues conducted experiments (mostly UGs, but also DGs, and public goods games) in fifteen small-scale societies. The mean offers in those UGs ranged from 26% to 58% – both below and above those of participants from industrialized countries. We would like to describe the two most extreme cases from this study.

Proposers from the Machiguenga tribe offered on average 26% of the sum to share, and the most frequent offer was 15% (second most frequent: 25%). Although more than 75% of their offers were below 30%, only one offer out of 21 was rejected. On the other hand, proposers from Au and Gnau tribe offered on average 43% and 38% of the sum respectively, with modes of 30% and 40%, but what is interesting is that proposers often offered more than 50% of the sum and responders often rejected such high offers. Now, the first case just fits the classical theory better; however, the second case does not make sense either in the light of the selfishness axiom or a preference for justice. The authors provide a model explaining their experimental results.

3. The role of norms

Henrich *et al*. [2010] described the investigated tribes in two dimensions: payoffs to cooperation (PC) and aggregated market integration (AMI). PC measures the degree of cooperation with non-immediate kin. Thus, tribes ranked very high in PC are those where extrafamilial cooperative institutions are present – in other words, whose members' lives depend on cooperation with large groups of non-kin. Tribes whose members are economically independent at the family level are very low in PC. The AMI index was combined from three more basic indexes: market integration (how often people engage in market exchange), sociopolitical complexity (how much decision making occurs above the family level) and settlement size. PC and AMI together account for 47% (adjusted R^2) of the variance when predicting mean UG offers.

In the case of the Machiguenga tribe, its members do not cooperate, share, or exchange goods with people outside their own family. They neither demonstrate fear of social sanctions, nor care about the opinion of people in other families. For a long time they did not even have last names – there was no need to use them. All this shows that the Machiguenga do not have institutions governing economic interactions with strangers, their PC and AMI are low, and so are the offers in UGs.

In the most interesting case of the Au and Gnautribes, Henrich et al. provide a detailed explanation: "In these societies, accepting gifts, even unsolicited ones, implies a strong obligation to reciprocate at some future time. Unrepaid debts accumulate, and place the receiver in a subordinate status. Further, the giver may

[2] Actually, a practice of generalizing results of experiments where students from industrialized countries, especially USA, are used is a common practice in social sciences. For a meta-analysis showing how unrepresentative those samples might be, see Henrich *et al*. [2010].

demand repayment at times or in forms (e.g., political alliances) not to the receiver's liking, but the receiver is still strongly obliged to respond. As a consequence, excessively large gifts, especially unsolicited ones, will frequently be refused. Together, this suggests that as a result of growing up in such societies, individuals may have acquired values, preferences, or expectations that explain both high offers and the rejection of high offers in a one-shot game" [Henrich *et al*. 2005, p. 811].

Thus, Henrich *et al*.'s results cannot be explained by a utility function involving only an agent's payoff, a preference for equity, and envy.[3] Those preferences are governed by norms and if norms are not taken into account, no general model is possible. In such a model, norms fulfillment would have to be an argument in the utility function. As the authors put it, "norms such as 'treat strangers equitably' thus become valued goals in themselves, and not simply because they lead to the attainment of other valued goals" [Henrich *et al*. 2005, p. 813].

An additional argument for the importance of culture in economic behaviour comes from a study with a somewhat different subject and a different outcome. The game that was played was again the Ultimatum Game, but Jensen, Call, and Tomasello [2007] chose chimpanzees for the responders. In a UG designed in a way that monkeys could play it, the experimenters have shown that although game theory does not do a good job in predicting human behavior in this game, it succeeds in the case of chimpanzee-responders.[4] Assuming that monkeys do not have institutions governing sharing goods,[5] those two results together suggest that norms rather than some universal, maybe even innate mechanisms are responsible for human non-selfish behaviour in the Ultimatum Games and therefore plausibly in the market exchange.

So, there is no problem with the game theory formalism – it is universal enough to include the influence of norms on agents' possible strategies. If an agent considers transgressing a norm where doing so implies some emotional costs (and thus decreases his or her utility), the consequences of transgressing a norm can be accounted by reducing the payoffs for the strategy transgressing the norm. One can introduce the same modification when violating a norm leads other agents to punish the violator. Finally, if a norm is so deeply imprinted that an agent does not even consider transgressing it, strategies not conforming to the norm can be simply removed from the game. The actual problem is how big the payoffs modification should be or which strategies should be dismissed. And that, as Henrich *et al*. [2010] showed, can be addressed only empirically by studying norms governing social interactions in particular societies.

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[3] For the possible role of envy in UGs see Kirchsteiger [1994].

[4] On the other hand, it is not the case that non-human animals always act selfishly. Masserman, Wechkin, Terris [1964] showed that at least some rhesus monkeys prefer not to get food if it is associated with suffering of their conspecific. However, this preference is explained not by a norm but by an innate reaction to distress in others.

[5] Which after all is not such an implausible idea. See Tomasello [2009, p. 61] for a description of chimpanzees engaging in group hunting of red colobus monkeys in Tai Forest in Ivory Coast.

So, norms influence economic behavior. Henrich and his colleagues showed how norms shape economic life of the tribes they studied, sometimes – as in case of Au and Gnau – in very surprising ways. Needless to say, free markets in contemporary industrialized societies would not be possible without a huge array of norms. One does not only need highly formalized norms governing institutions like banks, monetary authorities, ministries of finance, companies, and trusts. What is more important is that a simple act of buying groceries at a local store would not be possible without norms either. Only due to a norm can a buyer and a seller trust each other during a transaction even though they might never meet again. In terms of the classical game theory such a transaction is a simple example of the prisoner's dilemma. The parties, when rational, would try to swindle each other and therefore spend resources on trying to avoid being swindled – they would count the money carefully, check the quality of the object of the transaction, the seller would use his or her own scale to weigh the commodities, and so on. However, in real life that is usually not the case.

Because norms make contemporary large-scale markets with an enormous number of anonymous agents and one-time interactions possible, explaining their origin, expansion, and persistence would help in understanding the very existence of such economies. But how can one study norms?

4. An evolutionary model of cooperative norms

Although norms are one of the reasons that game theory does not provide an accurate account of many examples of economic behaviour, ironically the game theory is a good framework for studying norms themselves. Here we would like to present an example of this approach: a study of cooperative norms, and particularly conditions under which they could spread. Cooperative norms are crucial for large-scale economies as they underlie an agent's choice of cooperating, instead of defecting, in one-time anonymous interactions of a form of the prisoner's dilemma.

The model we use in this study is designed according to principles of evolutionary game theory. The main difference between classic game theory and evolutionary game theory is that in the latter one:

a) agents do not choose their strategies but come equipped with a strategy that they use in all their interactions;

b) after a number of turns where agents interact with each other, they reproduce. The fertility rate is proportional to agents' fitness – their summary payoff.

Hence, the more often an agent equipped with a particular strategy wins his or her matches (gets a payoff higher than the agents that he or she interacts with), the more frequent that strategy is in the next generation.

Is evolutionary game theory a good tool to study norms? That is, do the conditions (a) and (b) accurately describe the spreading of norms? We think – accurately enough. A justification for that claim is provided by Sripada and Stich's framework for the psychology of norms [2006]. The authors note that no human community has been found whose members do not conform to norms. However, there are very few norms (if any) that are universal.[6] That suggests that the human ability to invent, follow, spread, and acquire norms is innate but norms themselves are not. And if norms are not innate, there must exist an acquisition mechanism that allows humans to recognize and internalize them. For our current purpose, it is enough to assume that most norms are learned in childhood from a child's closest environment, especially from parents and close kin. Needless to say, those very norms also guide parents' behaviour. Hence, the higher parents' fitness is (in comparison to agents equipped with other norms), the more children that they can raise, and the more tokens of those norms are present in the next generation. This story would justify (b).

Whether (a) is plausible depends on a few factors. Firstly, the stronger intrinsic motivation a norm elicits, the harder it is for an agent to transgress it. If this motivation is strong enough, the agent will not even consider changing his or her strategy. Secondly and more importantly, changing one's strategy in response to the strategies of others sometimes might be a single complex strategy itself. For example, instead of considering an agent who always cooperates or always defects, one can consider an agent who cooperates with agents who cooperated the last turn, and defects agents who defected the last turn. That is, not only norms "always cooperate!" or "always defect!" are possible but also more complex ones, for example, "cooperate with cooperators and defect defectors!". Thirdly, in the case of complying with a norm for instrumental reasons – because an agent believes it helps him or her reach his or her goals – he or she needs some reasons to change that belief. Encountering a few situations where the strategy does not work might not be a reason strong enough – after all, conforming to that norm usually helped him or her, his or her parents, and his or her grandparents in the past! And as we have already mentioned, the results of UGs and DGs, both when played by Western undergraduates and members of small-scale societies, confirm (a).

Having said that, we can move to the details of the model. Each turn consists of four phases. In the cooperation phase, the population of *n* agents is randomly divided into pairs in which they play the prisoner's dilemma:

		Player *b*	
		Cooperate	Defect
Player *a*	Cooperate	R, R	S, T
	Defect	T, S	P, P

Comment: The payoffs obey: T > R > P > S and 2R > T + S.

Figure 1. The prisoner's dilemma

Source: Hoffman [2001, p. 102].

6 The most obvious candidates – norms prohibiting murder or theft – actually do not serve as good examples as different actions are considered as murder or theft in different cultures. Murder means impermissible killing someone and theft means impermissible taking one's property. But circumstances under which killing someone is not permissible, as well as the conditions under which taking someone's property is impermissible significantly vary across cultures.

Each agent has one strategy that he or she employs in every match. However, when the strategy prescribes cooperation there is a probability *e* of defecting by mistake. However, agents do not cooperate by mistake.[7] In the next phase, the punishment phase, each agent has a possibility to punish another agent randomly chosen from the population. An agent can be punished only if he or she defected the last turn. An agent can punish only if his or her strategy prescribes him or her to do so. Again, there is a chance *e* that such an agent will fail to punish the defector with whom he or she she is paired during that phase. Punishment is costly for both the punisher and the defector – it decreases the defector's fitness by *p* and the punisher's fitness by *k*. However, it is worse (in terms of fitness) to be punished than to punish ($p>k$).

Then, there are two additional phases: the moralist phase I and the moralist phase II. During the first one, agents can punish other agents who had a chance to punish a defector (paired with one during the punishment phase) but failed. During the second one, agents can punish the ones who did not punish an agent in the previous phase (that is, a non-punisher) although they could have done it. Again, in both phases each agent can punish another one randomly chosen, and the probability of a failure is *e*.

Turns – consisting of those four phases – are repeated *t* times before are production phase occurs. In this phase the population is replaced with a new one, where the number of agents equipped with a particular strategy is proportional to the total fitness of agents using that strategy in the old population. To keep the game simple, the overall number of agents (almost) does not change as only the frequencies of the strategies are of interest here.[8] Together, *t* turns and a reproduction phase make one cycle.

The strategies that we implemented in this model have been taken from [Boyd, Richerson 1992]:

– a defector: never cooperates, never punishes,
– an easy-going: always cooperates, never punishes,
– a punisher: always cooperates, punishes those who did not cooperate (non-cooperators),
– a moralist: always cooperates, punishes non-cooperators, those who did not punish non-cooperators although they had a chance (non-punishers$^{(1)}$), and those who did not punish non-punishers$^{(1)}$ when they had an opportunity (non-punishers$^{(2)}$).

We used a slightly different moralist strategy than the one proposed by Boyd and Richerson [1992]. Their moralists punish defectors and non-punishers if they failed

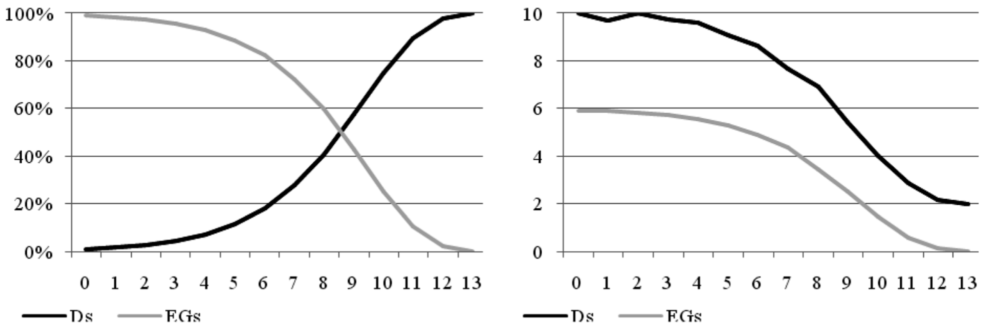
[7] It is nicely described by Henrich and Boyd [2001, p. 82]: "This makes sense because, in the real world, people may intend to cooperate but fail to for some reason. For example, a friend who plans to help you move may forget to show up or have car trouble en route. Defectors, however, are unlikely to mistakenly show up on moving day and start carrying boxes".

[8] Some changes may occur due to rounding float numbers.

to cooperate/punish since the last time they were punished (or since the beginning of the cycle). This version is problematic, because it requires agents to broadcast the information about some details of the history of their interactions. Specifically, on this view, a moralist can find out that the other player defected five turns ago even if she cooperated for the last four. That raises a question whether in large-scale anonymous market interactions such information about agents' past is available. We do not think so. Moreover, in comparison to the moralist strategy, other strategies are very unsophisticated. If allowing for the moralist strategy, Boyd and Richerson [1992] should have introduced other strategies that also use information about players' past.

5. The simulations

We have implemented our model and tested strategies' evolutionary stability using computer simulation.[9] A strategy is evolutionary stable if and only if a population of agents using this strategy cannot be invaded by a smaller group of agents using any other strategy. In other words, no new and initially rare strategy can spread in this population. How successful (in terms of average fitness) a strategy is in a homogenous population does not predict whether it will not be invaded by a different strategy even if this alien strategy is less successful in its own homogenous population.



Comment: The left graph represents the change in the number of agents in the population, the right one represents agents' mean payoffs. This is a sample simulation – for each example in the study, we have run several simulations with similar values of the parameters and we obtained similar results.

Figure 2. Defectors and easy-going agents

Source: authors' own work.

Take a population of defectors (Ds) and easy-going agents (EGs). The simulation was run for $R = 6$, $S = 0$, $T = 10$, $P = 2$, $p = 7$, $k = 2$, $e = 0.01$, and $t = 20$ (if not indicated

[9] The source code in C# is available on: www.xphi-europe.org/tomaszwysocki/punishers.zip.

otherwise, in the rest of the simulations the parameters' values are the same). In homogenous populations a mean fitness of Ds in one turn is $\mu_D = 2$ and mean fitness of EGs ($n_{EA} = 100$) is $\mu_{EA} = 5.9$ (it is lower than $R = 6$ due to failures by a mistake). However, if 3 Ds enter a population of 300 EGs, they invade quickly, decreasing both EGs' and their own fitness. Hence, a flourishing culture of cooperative EGs can be quickly devastated by very few D mutants.

There is a way to defend a cooperative strategy against defectors – punishment. A population of punishers (Ps) cannot be invaded by defectors if only the punishments are efficient: not too expensive for the punisher but costly for the one that is punished. For a population of 300 agents where there are 100 Ds and 200 Ps, the punishers kept their dominant position.

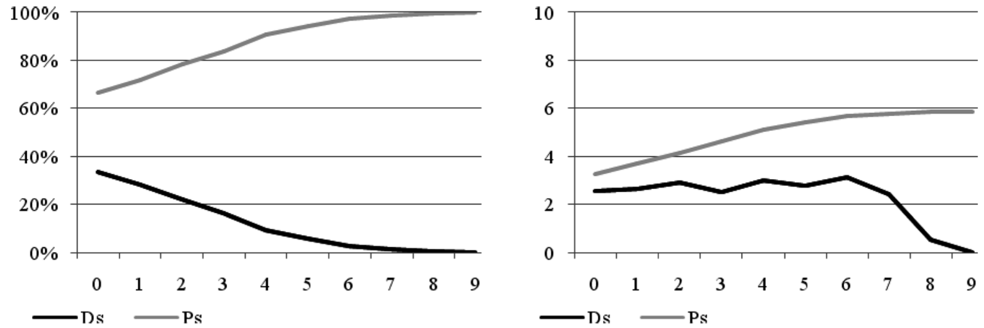


Figure 3. A population of punishers resisting an invasion of defectors.

Source: authors' own work.

Actually, when the punishments are really efficient ($p = 1$, $k = 9$), a smaller group of Ps can invade a bigger group of Ds ($n_P = 100$, $n_D = 150$):

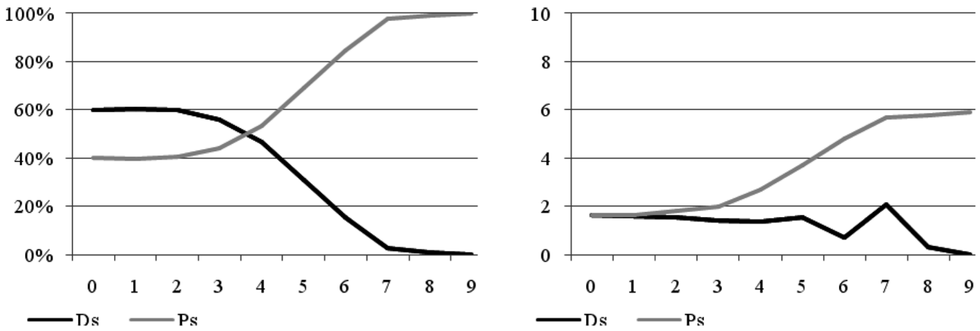


Figure 4. A population of defectors invaded by punishers

Source: authors' own work.

However, this time a homogenous population of punishers can be invaded by EGs. The reason for that is that in a mixed population of Ps and EGs, agents defect only due to a mistake. Such agents do not have to be punished to sustain cooperation in the population but Ps do punish them. Therefore, Ps' fitness is on average lower than EGs' fitness and eventually the easy-going strategy spreads in the population. This process is very slow. For $e = 0.05$, $t = 100$, $n_P = 100$, $n_{EG} = 80$ it took EGs more than 130 cycles to invade Ps.

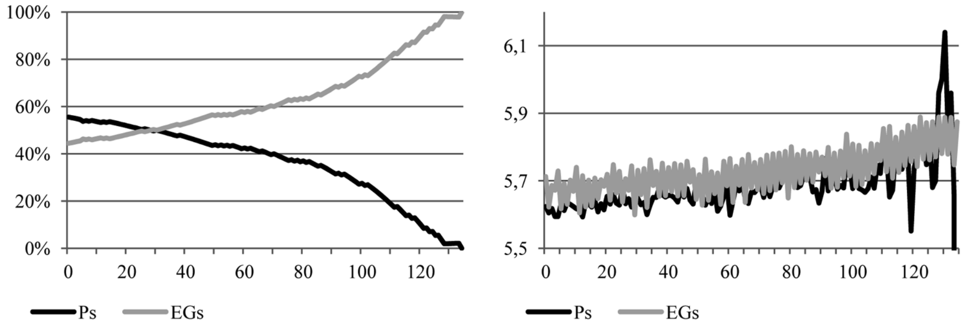


Figure 5. A population of punishers invaded by easy-going agents

Source: authors' own work.

And after the population is invaded by EGs, it becomes prone to defectors' invasion, as in the first case described here. As Hoffmann puts it, "[f]or any pure strategy *s*, it is always possible to envisage a distinct alternative strategy which in any number displays indistinguishable behavior in an s-population but can be triggered into differential behavior patterns by a third strategy. Since agents following such a strategy receive payoffs identical to those of indigenous players, it may randomly spread in the population though a process known as drift and eventually open the door for the invasion of a third strategy" [Hoffmann 2001, p. 102].

Boyd and Richerson introduced a strategy – the moralist strategy – that, under a particular condition, is immune to this effect. A moralist (M) punishes not only those who failed to cooperate, but also those who failed to punish non-cooperators or non-punishers. When defectors try to invade moralists, the situation reassembles defectors in a punishers' population – the invaders die out as punishment decreases their average fitness more than punishing decreases Ms' fitness.

The idea behind the moralist strategy is that Ms can also resist invasion from easy-going agents. It is supposed to be so because "[w]hen M is common, rare individuals deviating from Mare punished; otherwise, they have no effect on the behavior of the group. Thus, as long as being punished by all the other members of the group is sufficiently costly compared to the individual benefits of not behaving according to M, M will be evolutionarily stable" [Boyd, Richerson 1992, p. 177].

Agents who do not punish those who (even mistakenly) fail to cooperate or punish are identified as non-moralists and punished.

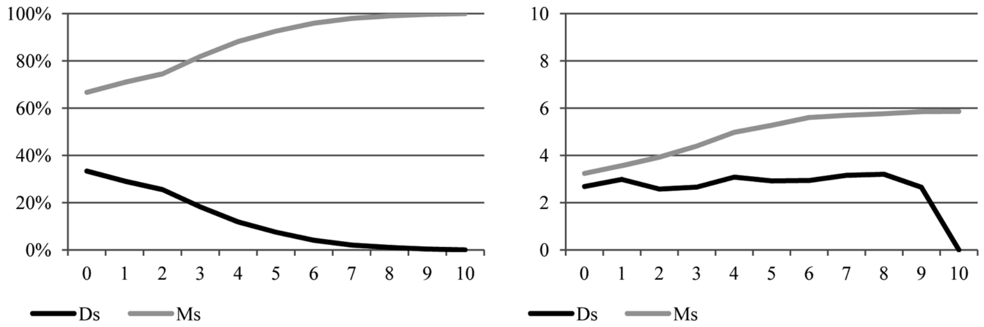


Figure 6. A population of moralists resisting an invasion of defectors

Source: authors' own work.

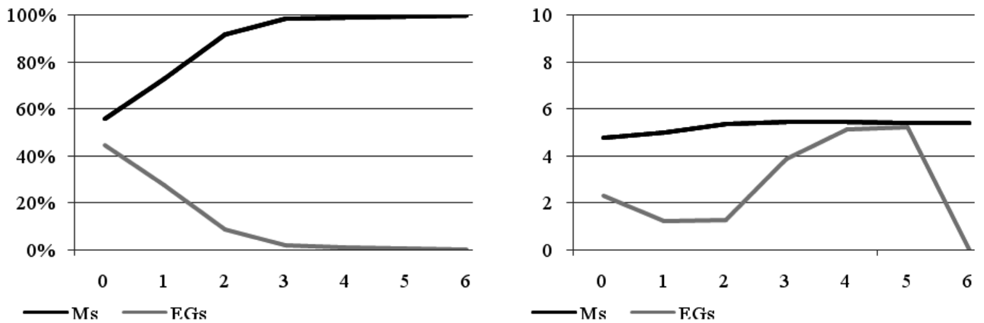


Figure 7. A population of moralists resisting an invasion of easy-going agents

Source: authors' own work.

Our simulations did confirm those predictions (see Figure 7). A population of moralists resists invasion by easy-going agents. Moreover, invading easy-going agents died out in very few – seven – cycles (for comparison, the values of the parameters were the same as in the simulation of EGs invading a Ps' population). The strategy is so efficient that actually it lets Ms invade EGs ($n_M = 50$, $n_{EG} = 100$; this time default values of the parameters were used):

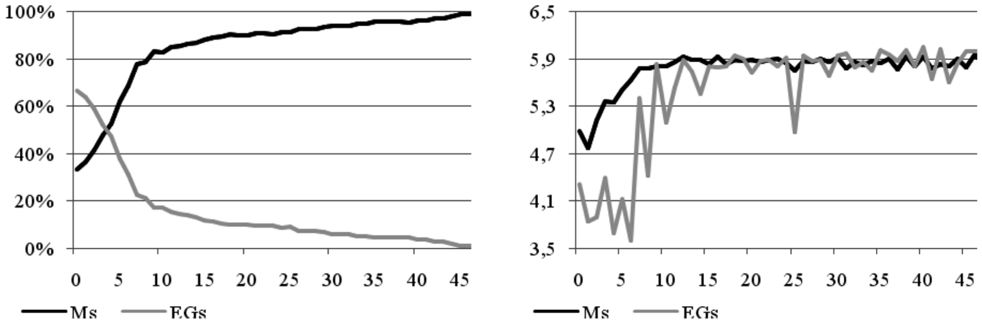


Figure 8. Moralists invading a population of easy-going agents

Source: authors' own work.

Moralists are also able to resist punishers' invasion ($n_P = 30$, $n_M = 100$):

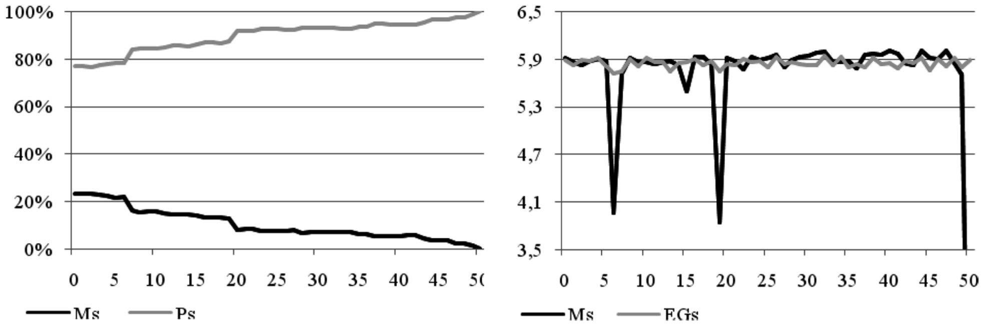


Figure 9. Moralists' population resisting an invasion of punishers

Source: authors' own work.

However, as we said, moralists can distinguish themselves from other agents only due to the fact that agents make errors. When an agent fails to cooperate due to a mistake, moralists can punish those agents who do not punish this erroneous agent. If there were no errors, there would be no difference between moralists, punishers, and easy-going agents when no one defects (see Figure 9, *nP* = 80, *nEGs* = 100, *nM* = 120, *e* = 0).

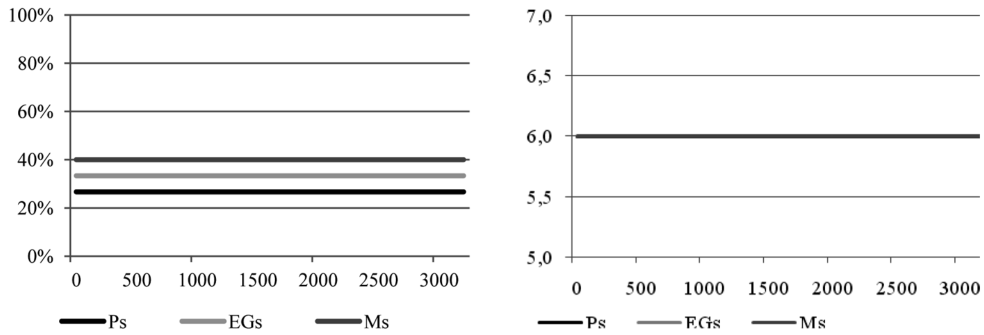


Figure 10. An equilibrium coexistence of moralists, punishers, and easy-going agents (agents do not defect mistakenly: $e = 0$)

Source: authors' own work.

Thus, Boyd and Richerson's [1992] conclusions were maintained. Moreover, the assumptions needed for the moralist strategy that we proposed are weak (no information on the history of agents' interactions is required), but still the strategy seems to be evolutionary stable. We believe that information about agents' past is not accessible in large-scale groups. If it is the case, our proposal provides a better explanation for why cooperative norms are present in modern industrialized societies. In essence, this exemplifies how cooperation might be defended against defectors in times where there was neither law nor institutions enforcing it.

6. Conclusions and further studies

If correct, our analysis confirms the previous results that punishment is necessary for preserving cooperation in a population. Not only agents need to cooperate – they also have to punish those who do not cooperate and who do not punish non-cooperators. We used an assumption that agents' strategies are coded as norms which is very plausible given norms' cross-cultural variety, the way that they are transmitted and the way that they influence human behaviour. Our simulations also confirmed an interesting and definitely not obvious claim that punishing individuals who mistakenly defected allows cooperative norms to persist.

In our further studies on cooperative norms, we would like to investigate more complex strategies, especially by introducing agents' reputation and capability to recognize partners' norms.[10]

[10] For an analysis of the role of reputation see Fehr [2004] and Panchanathan, Boyd [2004]. For the role of ethnic boundary markers in the evolution of norms see McElreath, Boyd, Richerson [2003].

References

Becker G., *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*, University of Chicago Press, Chicago 1964.

Becker G., *Crime and punishment: An economic approach*, The Journal of Political Economy 1968, Vol. 76, No. 2, pp. 169-217.

Bethwaite J., Tompkinson P., *The ultimatum game and non-selfish utility functions*, Journal of Economic Psychology 1996, Vol. 17, No. 2, pp. 259-271.

Boyd R., Richerson P., *Punishment allows the evolution of cooperation (or anything else) in sizable groups*, Ethology and Sociobiology 1992, Vol. 13, No. 3, pp. 171-195.

Camerer C., *Behavioral Game Theory: Experiments in Strategic Interaction*, Princeton University Press, Princeton 2003.

Cameron L., *Raising the stakes in the Ultimatum Game: Experimental evidence from Indonesia*, Economic Inquiry 1999, Vol. 37, No. 1, pp. 47-59.

Carruthers P., Laurence S., Stich S., *The Innate Mind: Culture and Cognition*, Oxford University Press, New York 2006.

Fehr E., *Don't lose your reputation*, Nature 2004, Vol. 432 (7016), pp. 499-500.

Fischer I., *The emergence of reactive strategies in simulated heterogeneous populations*, *T*heory and Decision 2003, Vol. 55, No. 4, pp. 289-314.

Henrich J., Boyd R., *Weak conformist transmission can stabilize costly enforcement of norms in cooperative dilemmas*, Journal of Theoretical Biology 2001, Vol. 208, No. 1, pp. 79-89.

Henrich J. *et al*., "Economic man" in cross-cultural perspective: Behavioral experiments in 15 small-scale societies, *Behavioral and Brain Sciences* 2005, Vol. 28, pp. 795-855.

Henrich J., Heine S.J., Norenzayan A., *The weirdest people of the world?*, Behavioral and Brain Sciences 2010, Vol. 33, pp. 1-75.

Hoffmann R., *The ecology of cooperation*, Theory and Decision 2001, Vol. 50, No. 2, pp. 101-118.

Jensen K., Call J., Tomasello M., *Chimpanzees are rational maximizers in an ultimatum game*, Science 2007, Vol. 318, pp. 107-109.

Kirchsteiger G., *The role of envy in ultimatum games*, Journal of Economic Behavior and Organization 1994, Vol. 25, pp. 373-389.

Masserman J.H., Wechkin S., Terris W., "*Altruistic*" *behavior in rhesus monkeys*, American Journal of Psychiatry 1964, Vol. 121, pp. 584-585.

McElreath R., Boyd R., Richerson P., *Shared norms can lead to the evolution of ethnic markers*, Current Anthropology 2003, Vol. 44, No. 1, pp. 123-29.

Panchanathan K., Boyd R., *Indirect reciprocity can stabilize cooperation without the second-order free rider problem*, Nature 2004, Vol. 432 (7016), pp. 499-502.

Sripada C., Stich S., *A Framework for the Psychology of Norms*, [in:] P. Carruthers (ed.), *The Innate Mind: Volume 2: Culture and Cognition*, Oxford University Press, New York 2006.

Tomasello M., *Why We Cooperate*, Boston Review, Cambridge, MA/London, England 2009.

KARY UMOŻLIWIAJĄ WYMIANĘ RYNKOWĄ

Streszczenie: W publikacji omawiamy eksperymenty, których wyniki okazały się sprzeczne z przewidywaniem teorii gier oraz staramy się pokazać, że można je wyjaśnić przez odwołanie do norm kulturowych. Uzasadniamy, dlaczego za zachowania zorientowane na współpracę odpowiadają normy, a następnie przy pomocy ewolucyjnej teorii gier i symulacji komputerowych badamy stabilność ewolucyjną pewnych prostych strategii rządzących współpracą.

Słowa kluczowe: ewolucyjna teoria gier, symulacje komputerowe, współpraca, normy, kary.