Evolutionary Justification of Plagiarism

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This paper provides evolutionary game theoretic model of plagiarism. The paper finds the relationship between author effort, publication value, and the frequency of plagiarism. There are two types of equilibria. Plagiarist-free equilibria are neutrally stable. The only evolutionary stable state is characterized by a positive share of plagiarists.

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1. Introduction

Plagiarism is a form of scientific misconduct. The number of scientific retractions caused by plagiarism has shown an increasing trend in recent decades (Fang et. al. 2012; Steen et. al. 2013). Among 3,247 scientists surveyed anonymously in the United States, 1.4% admitted to plagiarism (Martinson et.al. 2005). In many other countries, the rate of plagiarism is even higher (Fang et. al. 2012; Zhang, Grieneisen 2013).

There are several papers on the economics of plagiarism. Quandt (2012) developed the aggregate demand for plagiarism modeling a plagiarism detection process. Arce et. al. (2008) provided a game with incomplete information about an editor's preferred response to a case of plagiarism that captures key features of the submission process. Haeussler et.al. (2014) modeled unethical behavior in the context of information sharing among competing academic researchers. Hoover (2006) developed a game-theoretic model of author-plagiarist interaction. The model shows that current incentives in the profession result in plagiarism.

Plagiarism appears to be an inherently social and interactive phenomenon, with both incentives and punishment for plagiarizing coming from one's scientific peers. Thus, one of the most significant incentives for plagiarism appears to be the growing pressure to publish (Necker 2014) as the key to recognition and survival in the increasingly competitive and hostile environment of one's scientific community. In fact, these general features and the very appeal to 'publish or perish' prompt to rethink plagiarism in evolutionary terms.

This paper provides an evolutionary model of author-plagiarist interaction. The model captures plagiarism as a group phenomenon, following the evolutionary patterns of imitation, and inheritance. In fact, the identity of players is not stable: the same player can be an author or a plagiarist in different time periods. Players inherit norms from their colleagues. There is no pure equilibrium. Only a small fraction of papers is plagiarized.

2. Model

This section develops an evolutionary model. There is a population of adaptive agents. There are two possible strategies, the Author and the Plagiarist. All agents are randomly paired in each period. Following Hoover's (2006) model we define P - publication value, E – the Author's effort to publish paper, e – the Plagiarist's effort to create the work ($E>e$), δ - loss of citations (because the Plagiarist's paper has a certain number of citations). Table 1 describes all

possible interactions. The Author-Plagiarist cell is obtained from Hoover's model solution for the case when the Author chooses not to fight to establish the case for plagiarism. The Author-Author cell corresponds to Hoover's model payoffs in the case of the Plagiarist who abstains from plagiarizing. The Plagiarist-Plagiarist cell is equal to zero.

Table 1. Plagiarism game. Row's Payoffs.

	Plagiarist	Author
Plagiarist	0	P-e
Author	P-E-δ	P-E

An evolutionarily stable strategy (ESS) in a scientific community guarantees that no other strategy could invade the population of scholars. Because *P-e>P-E* and *P-E-δ>0* there is no ESS with pure Author or Plagiarist strategies. Polymorphic population in which x is a share of authors is ESS if the expected payoff to being an Author

$$x \cdot (P - E) + (1 - x) \cdot (\mathrm{P} - \mathrm{E} - \delta)$$

is equal to the expected payoff to being an Plagiarist

$$x \cdot (\mathrm{P} - \mathrm{e}) + (1 - x) \cdot 0.$$

Equilibrium share of Authors is

$$x^* = 1 - \frac{\mathrm{E} - \mathrm{e}}{\mathrm{P} - \mathrm{e} - \delta}.$$

The share of Authors thus decreases with respect to Author effort. The same follows from empirical literature (Fang et. al. 2012; Zhang, Grieneisen 2013). Because Author effort is higher in non-English-language countries, the equilibrium share of Authors is higher in English-language countries.

The journal impact factor is a good proxy for publication value. Steen et al (2013) found that there is a negative correlation between impact factor and the number of plagiarism cases. In our model, the share of Authors increases with respect to the publication value which explains this empirical observation.

2.1 Generalization

Let P'=P-e and E'=E-e be normalized values of publication and author's effort. Let us introduce an additional strategy Author-Fighter. Author-Fighter represents an idea of collective punishment of plagiarists. The punishment of Plagiarists depends on the share of Author-Fighters.

Table 2. Plagiarism game. Row's Payoffs.

Share		Plagiarist	Author	Author-Fighter
γ=1-α-β	Plagiarist	0	P'	P'(1- β)
α	Author	P'-E'-δ	P'-E'	P'-E'
β	Author-Fighter	P'-E'-δ(1-β)	P'-E'	P'-E'

From Table 2 replicator dynamics equations are derived

$$\frac{d\alpha}{dt} = \alpha((\delta - P)(-1 + 2\alpha + 2\beta - 2\beta^2 - \alpha^2 - 2\alpha\beta + \alpha\beta^2 + \beta^3) + E(\alpha + \beta - 1));$$

$$\frac{d\beta}{dt} = \beta(-P(-1 + 2\alpha + 2\beta - 2\beta^2 - \alpha^2 - 2\alpha\beta + \alpha\beta^2 + \beta^3) + E(\alpha + \beta - 1) +$$
$$+\delta(-1 + 2\alpha + 3\beta - 3\beta^2 - \alpha^2 - 3\alpha\beta + \alpha\beta^2 + \beta^3));$$

$$\frac{d\gamma}{dt} = \gamma(-P(\alpha + \beta - \beta^2 - \alpha^2 - 2\alpha\beta + \alpha\beta^2 + \beta^3) + E(\alpha + \beta) +$$
$$+\delta(\alpha + \beta - 2\beta^2 - \alpha^2 - 2\alpha\beta + \alpha\beta^2 + \beta^3)).$$

Stable states are depicted in Fig. 1. Following Bowles (2006), I call stable states as Hobbesian and Rousseauian Equilibria. Hobbesian equilibrium is ESS with only Authors and Plagiarists. It is the case in scientific communities with low academic standards. Rousseauian Equilibria are NSS (Lyapunov neutrally stable state) with only Authors and Authors-Fighters. It is the case in scientific communities with high-academic standards. The population with Plagiarists and Authors-Fighters cannot be stable.

Rousseauian Equilibria is based on collective punishment of plagiarists. It is not ESS, but only NSS. It is hard to support it. Evolutionary drift disturbs the equilibrium. Taking into account stochastic events (evolutionary drift) in the long run the population would spend most of its time in the neighborhood of the Hobbesian equilibrium. Additional institutions such as group competition, second-order punishment (to punish Authors who tolerate Plagiarists), conformist cultural transmission (Bowles, 2006) are needed.

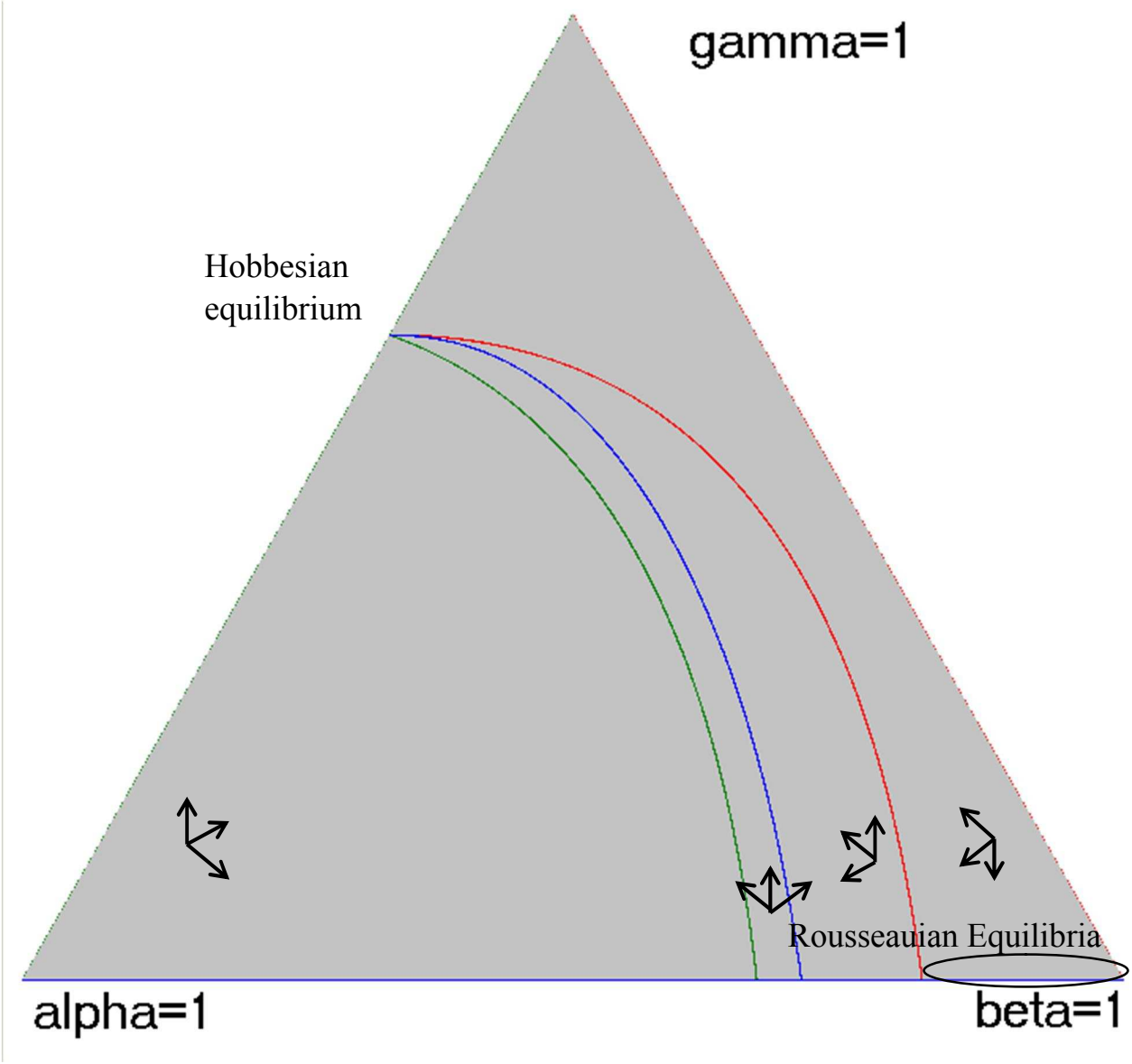

Figure 1. Phase plot for Plagiarism game (P'=4, E'=2, δ=1).

3. Conclusion

The paper explains the huge variation in frequencies of plagiarism cases in different countries, scientific communities. The crucial role in the fight against plagiarists is collective punishment. There exist equilibria without plagiarists, but they are only neutrally stable. There exists unique ESS, which is characterized by a positive share of plagiarists. A variety of frequencies of plagiarism can be explained by the difference in Author effort between non-English-language countries and English-language countries, and by difference in publication value.

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