Available online at www.sciencedirect.com
SCIENCE DIRECT®
Physica A 342 (2004) 186–192
PHYSICA A
www.elsevier.com/locate/physa

Correlation between risk aversion and wealth distribution

J.R. Iglesias[a,*], S. Gonçalves[a], G. Abramson[b], J.L. Vega[c]

[a] *Instituto de Física, Universidade Federal do Rio Grande do Sul, C.P. 15051, 91501-970 Porto Alegre RS, Brazil*
[b] *Centro Atómico Bariloche, Instituto Balseiro and CONICET, 8400 San Carlos de Bariloche, Argentina*
[c] *Banco Bilbao Vizcaya Argentaria, Via de los Poblados s/n, 28033 Madrid, Spain*

Received 4 November 2003; received in revised form 26 January 2004
Available online 17 May 2004

Abstract

Different models of capital exchange among economic agents have been recently proposed trying to explain the emergence of Pareto's wealth power-law distribution. One important factor to be considered is the existence of risk aversion. In this paper, we study a model where agents possess different levels of risk aversion, going from a uniform to a random distribution. In all cases the risk aversion level for a given agent is constant during the simulation. While for uniform and constant risk aversion the system self-organizes in a distribution that goes from an unfair "one takes all" distribution to a Gaussian one, a random risk aversion can produce distributions going from exponential to log-normal and power-law. Besides, interesting correlations between wealth and risk aversion are found.

PACS: 89.65.Gh; 89.75.Fb; 05.65.+b; 87.23.Ge

Keywords: Econophysics; Wealth distribution; Pareto's law; Risk aversion

Probably one of the most important contributions to the study of the distribution of personal income and wealth was made at the end of the XIXth century by Italian economist Vilfredo Pareto. In his book "Cours d'Economie Politique" [1], he presented the statistical analysis of the income distribution of different European regions and countries. He concluded that the income distribution follows a rather universal law,

* Corresponding author. Tel.: +55-51-3316-6466; fax: +55-51-3316-7286.
E-mail address: iglesias@if.ufrgs.br (J.R. Iglesias).

0378-4371/$ - see front matter
doi:10.1016/j.physa.2004.04.077

characterized by a logarithmic pattern, described by the formula: $\log N \propto \alpha \log w$, where N is the number of income earners with an income higher than w and the exponent α is named Pareto index. This income distribution is a power-law and Pareto determined the exponent to be $-1.9 \leqslant \alpha \leqslant -1.2$. Analysis of current economic data seems to indicate that Pareto's law is valid for the high income strata of society, while for middle and low income classes the distribution appears to be a log-normal (Gibrat) distribution. Data for Japan [2–4], the United Kingdom and the United States of America [5–7] confirm this idea. Also, we have verified from the 2002 Gross National Income (GNI) data of 179 countries [8], that the GNI of the richer countries can be fitted with a power-law, while for the poorest ones, the best fit is an exponential or log-normal distribution.

A great deal of effort has been devoted to obtain the power-law distribution of the wealthiest strata [9–15]. In previous articles we have proposed a Conservative Exchange Market Model (CEMM) [16,17] with extremal dynamics of the kind of self-organized criticality (SOC) theories [18,19]. The obtained distribution was a Gibbs-exponential type and the results were in good agreement with the distribution of some welfare states such as Sweden [20]. Other authors [10–12] have proposed models in which agents save a fraction of their capital, and only the rest may be exchanged. In the language of economics this *saved part of the resources* is a measure of the agent risk aversion. Following these ideas, we present here a family of models that combine the risk aversion ingredients with Monte Carlo dynamics and extremal dynamics. We found different interesting shapes for the wealth distribution, and in some particular cases a power-law profile is obtained.

Let us consider a set of economic agents characterized by a risk aversion factor $\beta(i)$, so that $[1-\beta(i)]$ is the percentage of wealth the i-agent is willing to risk. An agent with $\beta(i)=0$ is a radical one who risks all his assets while, on the other hand, $\beta(i)=1$ characterizes a totally conservative agent who simply does not play the game. The dynamics of the system is as follows: one chooses two partners that exchange resources; the choice of the two agents may be carried out using extremal dynamics as in previous calculations [16,17], or a Monte Carlo method as in Refs. [10–13]. In the first case we start by determining the site with the minimum wealth, and then we choose at random the other partner of the exchange. In the second case both agents are chosen at random. When considering the case of extremal—minimum—dynamics we model the situation where the poorest agent will try to do something to improve its situation, or else, some external regulator (the government, for example) will act in order to favor the handicapped. In that case one expects a more equitable wealth distribution. The second case is best adapted to represent a kind of stock market, where the transactions occur independently of the fortune of the agents. In both cases, we prescribe that no agent can win more than he puts at stake, so the value that will be exchange is the minimum value of the available resources of each agent, i.e., $\mathrm{d}w = \min[(1-\beta_1)w_1; (1-\beta_2)w_2]$. Finally, we introduce a probability $p \geqslant 0.5$ of favoring the poorer of the two partners, because *a stable society requires that the poor have an advantage in transactions with the wealthy and are protected by particular rights and marketing freedom* [12]. Increasing the probability of favoring the poorer agent is a way to simulate the action of the state or of some type of regulatory policy that tries to redistribute the resources