

How fair is an equitable distribution?

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Abstract

Envy is a rather complex and irrational emotion. In general, it is very difficult to obtain a measure of this feeling, but in an economical context envy becomes an observable which can be measured. When various individuals compare their possessions, envy arises due to the inequality of their different allocations of commodities and different preferences. In this paper, we show that an equitable distribution of goods does not guarantee a state of fairness between agents and in general that envy cannot be controlled by tuning the distribution of goods.

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1. Introduction

Envy is commonly defined as a feeling with a negative character that affects the social relationships making it rather complicated to define and, therefore, to measure. In economics, this envy relation can be established as a phenomenon that emerges after interpersonal comparisons between agents. From this point of view, envy can be considered as an economical observable that can be measured. We have developed a model where we analyze the emergence of envy in a network of agents when there is allocation of goods. Each agent has a list with individual preferences in mind that restricts his/her choices. The satisfaction level at the end of the allocation process is measured according to the restrictions imposed by their preferences. This model could be applied in behavioral economics [1,2] and potentially in physics, in particular measurement problems, which are related to conditional probabilities [3,4].

Previous investigations about similar systems are based on the development of a single model that describes the dynamics between agents as the dynamics of a network where the agents are located on its nodes [5,6]. An equivalent concept has been used by Donangelo et al. to model a network of trading agents as an interaction rule. Here the exchange between agents consists of goods as well as information that can be quantified [7]. On the other hand, interpersonal relations have been studied in markets with a finite number of agents and a finite number of goods in economics without production, see e.g. Schmeidler et al. [11]. This paper exhibits a

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fundamental definition of fairness, depending on some trading properties of the agents and prices, without considering the quality of goods or a fairness index.

Our motivation is to investigate interpersonal relations between the agents and to understand how the market motivates the evolution of these relations. We do not model envy as a network of trading agents interacting via envy relations, but we analyze the behavior of the agents as a function of parameters of allocation and the form in which agents compare their goods. Because emotions cannot be defined in a unique way, we develop a model that uses envy as a factor that modifies the conformation of a network based on information exchange. This information exchange is determined by the amount of envy. We suppose that a unidirectional exchange of information (each agent only observes his/her neighbors) is made through perfect channels, i.e., there is no noise or some other disruption in the transmission of information between agents. The existence of these channels ensures perfect comparisons, supposing that each agent has access to the content of information, i.e., the kind and number of goods assigned to other agents. This situation can be imagined as a group of agents with webcams, i.e., instruments to observe what other agents have, making them able to compare their actual situation with the situation of the other agents whom they can watch.

A maximized allocation, a situation in which each agent is reaching the best state with his/her endowment (see e.g. Ref. [8]), is called ‘pareto’ efficient. Otherwise, the individuals search for a larger allocation with a larger welfare, motivated by the possibility to get a larger utility level reflected in their interpersonal comparisons. Given the diffuse definition of the notion of envy, we present some fundamental concepts and theory from an economical point of view in Section 2. In Section 3, we explain the fundamental schemes and ideas in the formulation of our model. In Section 4, we propose our main results. Section 5 is devoted to the main conclusions obtained in this investigation.

2. Fundamental economical concepts

In economics, the first concept of equity, as no-envy, is due to Foley [9], introducing the concept of envy-free allocations: an allocation is equitable (or envy-free) if no agent prefers the bundle of another agent to his own. In this case we can say there is a situation with fairness defined as no-envy.

The simplest problem of fairness is that of dividing a homogeneous commodity among a set of agents with equal claims on it. In this case, equal division (or equal income situation) is clearly the appropriate solution. If we want to have efficiency of this type of allocation and preserve its property of symmetry, the concept of fairness must be redefined. We define this equilibrium state as the moment when each person chooses the most preferred bundle in his/her budget set, and the choices exhaust the available supply.

An allocation is fair if it is envy-free and efficient [10]. An allocation in a walrasian equilibrium with equal income is fair in this sense, but the converse no longer holds at all. A walrasian equilibrium is defined as a state where the aggregate excess demand (sum of all individual demands minus sum of all individual supplies) is equal to zero. So, if a bundle B'_i is preferred by agent i to the bundle B_i he/she currently possesses then the excess demand which is different from zero. Hence, when the agents have equal initial endowments and equal possibilities in the market, they can easily reach their maximum utility getting a fair trade [11].

A distribution of goods is said to be envy-free when no one prefers anyone else’s bundle of resources to his/her own. The suggestion here is that envy is not the psychological motivation for the concern with equality, but rather that, where a distribution in fact produces envy, this is a reason to doubt the fairness of the distribution. But envy in this context is a technical term for any situation in which someone prefers another’s bundles of goods, and does not refer to the emotional syndrome with which this envy is concerned.

3. Model

For the construction of our model, we need three basic elements: the first one is a set of various goods of K different kinds located in a depot. For each kind k of goods, a specific number $G(k)$ of goods exists. Our second element is a set of agents. There are N agents in our model. Each agent i has a preference list P_i of his/her preferred goods. This preference list P_i can be coded as a permutation of the numbers $1, \dots, K$ with $P_i(1)$ being the good being most important for agent i , $P_i(2)$ being the good second important, and so on. The third element is a set of individual ‘baskets’ B_i in which the agents can deposit their goods after picking them up

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