Simulating the evolution of financial sophistication

Abstract: The influence of money creation and its role in allowing the optimization of pricing of goods and in promoting credit is a key matter in economics. The goal of this work is to use computational tools to simulate societies of different levels of financial development in order to gain a better understanding of the underlying dynamics of these economic processes. We show that computer simulation of simple economic agents can generate a dynamic that resembles real life features of known economic system that price goods; that the use of money as a mean to improve commercial exchange has no effect on the macroeconomic variables studied, but that the type and nature of financial instruments affects the economic dynamics; that the presence of credit produces large improvements of aggregate economic variables; and that bottom-up regulation of prices by itself does not produce inflation and achieves the greatest aggregate wealth. Price fixing might improve a particular economic variable but causes large distortions, even in very simple economies. This exercise shows that simulations may help us in understanding general basic economic processes.

Introduction

Assuming the economic environment as a multidimensional hyperspace in which economic consequences of human action are represented, and the exchange as a way to promote social processes; then money does not appear suddenly in the economy, but as the result of pre-existing values. This is clearly the case with certain objects that assume a monetary function. In this sense, we define money as the purest expression of the concept of the economic value.

Money is then more than a simple economic concept: it is an abstraction of a social relationship that only exists in societies; societies in which private property, agents’ independence, and individual responsibility for the risks they face, is present (Wray, 1996).

Following Giddens (1994), money is a token, a kind of abstraction that acts like a medium of exchange and which assumes some knowledge and trust granted on it from the ones who use it. Obviously, the use of money eases transactions because it is a well-known abstraction, which summarizes -at the moment of its acceptance- the whole group of elements that support it. For the above mentioned, as token, money is an appropriate tool in systems of growing complexity.

Theoretically speaking, in economic orthodoxy, the central function of money is to be a medium of payment; therefore it is no more than ‘a veil ‘ in the economic world, an element that only facilitates the exchange. On the contrary, post-Keynesians and Circuitists, emphasize money as being generated through the credit process and its performance as token, being then, decisive in the economy.

It is difficult to specify what money is or which asset can be considered as money, because money is usually defined by its functions. Those who emphasize the credit
process point out that what we call money is in permanent change, in continuous flow through the economy, and no predictable relationship among the quantity of money and the behavior of economic agents exists. Thus, the velocity of circulation of money is not constant, but volatile and essentially unpredictable. Following Gurley and Shaw (1960), we may say that the continuous financial innovations induce a growing credit readiness and an increase of the velocity of monetary circulation.

Different levels of sophistication or financial depth are known to exist, that go from systems based on barter, going through those of self-financing, simple intermediation, until arriving to systems of complex intermediation, characterized by an active management of assets and equities with external sources. In the sophistication process, the financial innovation generates cost reductions as well as a diversification of risks, increasing the level of liquidity. On the other hand this process has proved to be crisis prone.

The influence of money creation is a key matter in economics, and it is for this reason that our goal here is to develop a computational tool that allows us to simulate societies of different levels of financial sophistication, with different number and kind of agent, favoring a better knowledge of economic processes. Most studies of the impact of money supply on the real variables and on utility use representative agent economies, often under perfect foresight. With such a framework, however, the use of fiat money as a medium of exchange cannot be endogenously explained. A few papers consider an economy where fiat money is intrinsically necessary for exchange, due to the local structure of interaction among agents, showing interesting transitory and permanent impact of local or global injections of money on the dynamics of exchanged quantities, prices, and individual welfares, and the mechanisms that explain this evolution (Manolova, Lai Tong and Deissenberg (2003). Here we extend this agents based simulation approach to explore further the dynamic working of money and prices.

**Sociodynamica: An overview of the model**

We chose the agent based computer simulation Sociodynamica as it has been previously used to study the effect of altruism and altruistic punishment on aggregate wealth accumulation in artificial societies (Jaffe 2002a,b, 2004a, b), the effect of division of labor on a economy (Jaffe 2002b), and the effect of shame on social cohesion (Jaffe 2007). The model simulates a continuous two-dimensional toroidal world (500 x 400 pixels), which contains patches of food and minerals, through which different types of agents wander with Brownian motion, each at its proper speed (DM in Table 1, ranging from 0-30 pixels / time step). We refer to Brownian motion here to the fact that the direction of movement was determined randomly each time step along the two dimensional grid.

Each agent has to eat food in order to survive. They can get food either by collecting it from the food patches if they happen to wander over them, or by getting it from other agents through commercial (barter or purchase) or altruistic interactions. Possession of minerals by agents, which could be also acquired by direct collection from the landscape or through inter-agent exchange, reduces the odds of being affected by catastrophes that occur randomly in time and affected agents randomly.
Agents have a simple memory of the last commercial transaction. The simulations tests for the survival abilities of agents and their capacity to accumulate wealth under variable circumstances. The virtual society can be programmed to have different levels of interaction. A first level simulates interactions with the environment, where agents collected food and/or minerals. A second level simulates the interchange of goods between agents in different economic scenarios.

Exchange of excess food for minerals, or vice versa, can be made by barter, using money but with fixed prices for each commodity, or using money with prices fixed by the micro-level perception of supply or demand. Agents were specialized in one of three tasks, collecting food, collecting minerals and exchanging goods.

Social interactions

Agents moved in random directions each time step. Each time an agent met another at a distance smaller than 20 pixels, an exchange could occurred. There were different scenarios where interactions could happen:

A. Barter Economy: Trading goods through barter & fixed prices. Food was exchanged for minerals according the following relation: 2 food units/ 1 mineral unit. Agents were given an amount of money (3 units) that was not used, serving as a control reference for the money amount for further comparisons (see below).

B. Monetary Economy 1: Trading goods using money & fixed prices. Agents were given three units of money. The exchange of goods occurred using money, so that agents could accumulate goods or money when selling their excess of goods. All transactions occurred at a set price for each good.

C. Monetary Economy 2: Trading goods using money & free prices. Agents were given three units of money. The exchange of goods occurred using money, so that agents could accumulate goods or money when selling their excess of goods. An initial price for each good (food = 1, mineral = 2) is assigned initially to each agent. When an agent wanted to sell a good, without finding a buyer in a given time-step, he decreased the price of that good for the next time-step in one unit of price. A buyer not finding a seller of a given good in a given time-step increased the price of that good for the next time step in one unit of price. The previous dynamic pretends to resemble the impact of scarcity on price setting in a perfect competition market.

D. Financial Economy 1: Financing trade & fixed prices. Traders could provide credit to buyers or buy commodities with credit. Prices in this simulation where set and fixed arbitrarily.

E. Financial Economy 2: Traders could provide credit to buyers or buy commodities with credit. Prices in the simulated economy where assigned by the market in the same way as in MONETARY ECONOMY 2.
An additional constraint for the interchange was that no agent treaded food if it had less than 2 units in reserve, guaranteeing its future survival for at least 4 time steps.

**Results and Conclusions**

The results of Sociodynamica are in complete agreement with those of Epstein and Axtel 1996. That is, Sociodynamica supports the conclusions of Epstein and Axtel but allows for deeper explorations of economic interactions and their macroeconomic consequences.

This exercise shows that computer simulation of simple economic agents can generate a non-linear dynamics that resembles real life features of known economic system. For example, results show two important lessons:

1. Price fixing has important macroeconomic effects even in very simple economies. It is remarkable that simulations of economies with fixed prices and economies in which prices are established by the market in a free supply-demand game, do not produce the same results. In the first case, the establishment of prices at levels outside of market impedes a great number of transactions that could arise if transactions were able to be established by agreement among the parts. Without pretending to deny the utility of some price controls during short periods and under specific circumstances, the results show the importance, even in simple scenarios, of the free market favoring heterogeneous pricing, which could be related eventually to wealth creation.

2. The use of money in itself is not enough to promote or motivate trade. It is the emergence of credit - and of further financial sophistication - that allows the emergence of qualitative differences in the dynamical behavior of the economy.

This report shows that the effect of fixing prices and of financial instruments on any kind of economy can be studied experimentally in virtual environments. As the results obtained here were certainly dependent on the specific assumptions adopted, we do not pretend to extrapolate them any further nor draw any theoretical conclusion from them. We want to use the results to exemplify the feasibility of using simulations to study basic economic phenomena in the context of evolutionary complex systems (Beinhocker 2006).

This research showed that these models, besides having a potential in experimental economics, are a fantastic tool to make complex phenomena visible to human understanding and thus, if properly adapted, in didactic games for teaching economics at any level and for policy analysis purposes.

**VI. References.**


http://jasss.soc.surrey.ac.uk/5/3/3.html


