

Reply to referee 1

The referee raised some useful comments and suggestions. We discuss her/his main points in the following sections.

The use of a Cobb-Douglas production function

In principle we agree with the referee that the use of Cobb-Douglas production function is probably not the best option for our artificial economy. We actually have in our agenda the task of exploring new solutions for modelling firms' production. However, we think that using Cobb-Douglas production function at the micro level, as in our case, is probably less subject to criticism than using it as aggregate macro production function. Actually, the relevant point is whether or not micro-production functions can be aggregated to give a macroeconomic relationship that reflects the underlying technology of the economy in some meaningful way, see e.g. Felipe and McCombie (2005). It is clear that using an aggregate production function that sums inputs and outputs of a disparate collection of industries is not realistic. However, in our model we do not have the problem of "aggregation" in this sense, because the aggregation arises from the process of interaction of the economic agents. Each firm simply uses its specific production function and in principle we could differentiate not only the parameters but also the type of production function for firms of different sectors. The point is, therefore, to understand if the factors transformation process at the level of a single firm can be efficiently described by a Cobb-Douglas function. We did not find clear evidence about it, a part from some early works (e.g. Houthakker (1955)); however, we consider the Cobb-Douglas function as acceptable approximation, especially for a paper that is not focused on the production process itself, but that aims at pointing out the qualitative dynamics of the credit market.

In any case, the attractive mathematical characteristics, see e.g. Labini (1995), for which the Cobb-Douglas production function was developed, are not so interesting to us. Our methodological approach does not need a strong mathematical manipulation, and therefore the historical reasons that led the Cobb-Douglas function to success are not an issue in our case. This means that we have no special reasons to defend it, and that we will drop it as soon as we will find a more realistic and reliable solution.

Homogeneous treatment of households

In our model households are active in the labor, goods and financial markets. They potentially own equity shares of Investments Goods Producers (IGP) firms, Consumer Goods Producer (CGP) firms, and banks, besides owning government bonds. The current version of the model only allows households to exchange CGP firms' shares in the financial market. The number of shares of banks and IGP firms owned by each household remain therefore constant during the simulation. The number of shares per households can be initialized according to any statistical distribution. We could of course decide that the number of shares are distributed according to a lognormal or to a fat tailed distribution, or that only a small percentage of the total households owns equity shares. In this sense, we could easily create a class of capitalists, as the referee suggests, and investigate the impact on our artificial economy. We thought that, for the specific purpose of the paper, an equal distribution of resources among households was the most neutral choice. We also think that it would be very interesting to initialize the system with more realistic distributions and study how this setting departs from our original configuration.

A part from the initialization phase, however, during the simulation the amount of equity shares owned by each household do vary and the model permits to consider income distribution dynamics. Indeed, both the labour and financial incomes evolve for each different household in a specific way, implying that the income distribution is itself a dynamic object in the system. Households' labour skills, stocks performances in the financial market, dividend payments and firms' bankruptcies are some of the elements that contribute to differentiate households' income and wealth during the simulation.

Simplistic modelling of the production of capital goods

Concerning this point, the referee is completely right. The capital goods market deserves a much more exhaustive treatment in the model. We are aware of this and we are currently examining how to improve the model from this point of view. On the other hand, the complexity of our framework is already high and we have to be very careful when introducing new interactions within the model. Anyways, this point is on the top of our research agenda.

Appropriateness of multi-agent modelling

Again, we agree with the referee, and we think that his suggestions are more that reasonable. We will modify our text accordingly.

Let us briefly comment some observation of the referee. We perfectly understand the danger that the agent-based approach may be regarded or even be used as a new way to apply microeconomics to macro. However, we would like to point out that this is not our attitude and that we are perfectly aware about the perils of reductionism and about the fallacy of composition. Indeed, our main focus is not much on individual behavior but on interactions and on structural relationships, i.e. the stock-flow consistency of the balance accounting that must

be fulfilled both at the individual and at the aggregate levels. Furthermore, the main contribution of the work is to show how relevant business cycles emerge at the aggregate level from the interactions within and among the credit and the production sectors of the artificial economy,

Finally, we thank the referee for spotting some misspellings that we have corrected in the text.

References

- Felipe, J., and McCombie, J. S. L. (2005). How Sound are the Foundations of the Aggregate Production Function? *Eastern Economic Journal*, 31(3): 467–488.
- Houthakker, H. S. (1955). The Pareto Distribution and the Cobb-Douglas Production Function in Activity Analysis. *The Review of Economic Studies*, 23(1): 27–31.
- Labini, P. S. (1995). Why the interpretation of the Cobb-Douglas production function must be radically changed. *Structural Change and Economic Dynamics*, 6(4): 485–504.