

REPLY TO REVIEWER 2

We thank the reviewer for her/his helpful comments and clarifications requests that surely help us to improve the paper. In the following, we reply in detail to all the issues raised by the reviewer. Whenever appropriate, new text, tables and additional explanations has been added in the article.

MAJOR REVISIONS

Additional references

The reviewer pointed out the need of more references to provide better support to the choices made about the decision making rules of agents. To meet his/her request we have added a few additional references where the reader can find the details and the empirical support of our modeling choices. In particular, we have cited the book by Silver et al. (1998) about production planning and inventory management, Fabiani et al (2006) for mark-up pricing behavior of firms, the Basel Committee on Banking Supervision official documentation on the minimal capital requirements for banks, and Saunders and Allen (2010) for more details about the probability of default estimation for firms.

Labor market

In order to satisfy the reviewer's request, a new paragraph has been added at the beginning of section 3 "Households" where one can find a better explanation about households' labor supply, the functioning of the labor market and the wage dynamics.

PART ADDED IN THE PAPER: "Each household can offer one unit of labor per month. The supply of labor is inelastic provided that the offered money wage is equal or higher than the reservation wage. Reservation wages are heterogeneous among households and are set to the latest received wage. If a household is unemployed, its reservation wage is decreased by a constant monthly rate up to a lower bound equal to the unemployment benefit.

The labor market is decentralized and demand and supply are matched on a pairwise basis. Firms seeking additional labor force post vacancies with a related money wage. Unemployed households actively search for new jobs by accessing to a random subset of the job vacancies and send job applications to those firms offering wages equal or higher than their reservation wage. Job applications are then ranked by firms according to applicants' skills. Firms send job offers to selected applicants and, if the offer is accepted (any household may receive more than one job offer and all offers are ranked by the household according to the attached wages), the household/worker is hired. If a firm is unsuccessful in hiring the number of worker required to fill its vacancies, it rises its wage offer by a constant rate and a second (and final) iteration of job posts/applications and offers among firms and households starts. If a firm is still unsuccessful in hiring the required number of workers, it raises the wage offer again but it has to wait the next month before entering the labor market again."

The evidence that employment remains high while production is already declining, as showed by Figure 2, is not explained by some rigidity in the labor market, but by the absence of new investments in physical capital, as showed in the corresponding time period by the bottom panel of Figure 1. Without new investments, the endowment of physical capital declines, then also production declines even in a persisting full employment scenario. The description in the paper has then been amended with the aim to provide a better explanation.

PART ADDED IN THE PAPER: "The reason of this evidence is that investments contract too much, due to the high interest rates (see Figure 1 in the corresponding time period) to adequately replace capital depreciation. Without new investments, the endowment of physical capital declines, then also production declines even in a persisting full employment scenario."

Simulations with an increased number of agents

To meet the referee's request we have performed a new set of simulations with an increased number of agents. The results, showed in Table 12, confirms the evidence observed in the previous setting, i.e. the occurrence of endogenous credit-fueled boom-bust cycles for high values of α .

Some comments about the new results have been added at the end of section 7.2 *“Finally, it is worth noting that the main results are robust with respect to an increase of the agents' number. In particular, we performed a new series of simulations with an enlarged set of agents, where the number of households has been raised to 5000 from the previous 2000, the number of firms is now 50 instead of 20, while the number of banks has been increased from 3 to 7. Table 12 presents the ensemble averages over 5 different random seeds of the relevant economic variables, as presented already in Table 6 for the previous agents' setting. The ensemble averages are reported both for the first 4 years (48 months) and for the whole period of 20 years (240 months). We can notice for high values of α (high leverage) the boom-bust cycle already observed in the previous setting, i.e., an initial credit-fueled boom in the high leverage case that however in the long-run transforms into a burst and an economic depression.”*

Investment goods sector

We agree that the modeling of the investment goods sector is too stylized and therefore is not adapt to capture important real world features. However, we would like to point out that the an accurate modeling of the supply chain is not the main aim of the study, which instead is more focused on the interplay between the credit and the real sectors of the economy, as one the main driver of business cycles. In this respect, the quite realistic modeling of the financing behavior of firms and of credit supply by banks seems to achieve this goal. Finally, the Eurace simulator is a work in progress and in this respect a more realistic modeling of the investment good sector is for sure at the top of our research agenda. With the statement “job production process”, we refer to “production on job” or better “production on demand”. To avoid misunderstanding we have substituted in the statement “job production process” with the statement “on-demand production”. We think that production on demand is a reasonable approximation for the investment goods sector. This assumption allow us to avoid taking into account inventories and, combined with the hypothesis of energy and raw materials as only production factors, allow us to simplify matters and to skip financing needs for investment goods producers.

Central Bank role

The Central Bank in the Eurace model has the key role of supplier of liquidity of last resort to the banking system. It is worth noting that there is no interbank market in the Eurace model and that the central bank is the only provider of liquidity to banks, alongside of course depositors, i.e. households and firms. The central bank, however as mentioned in the paper, can provide liquidity in infinite supply. This critical role is actually performed by central banks also in real economies and recent events have showed its relevance, in particular during crisis times. In normal conditions, banks get liquidity in the interbank market but, during the peak of a financial crisis, when credit markets freeze due to lack of confidence, like in the aftermath of Lehman Brothers collapse or in the ongoing Eurozone crisis, interbank markets cease to function and central banks need to step in, see e.g. the two long-term refinancing operations (LTRO) made recently by the ECB. For these reasons, we do not think that the way we have modeled the central bank lacks of generality and that the absence of an interbank market in the model is detrimental; this in particular because the scope of the model is the study of how the banking system affects the economy during a financial crisis.

The central bank in Eurace always accommodates the liquidity request by commercial banks as it usually applies in real operations made by central banks and as it is also documented by the

endogenous money theory, i.e. the theoretical framework we refer for credit market modeling (see the Introduction and references therein). We are of course aware that this central bank behavior strongly influences the model results; in fact, without a supplier of liquidity of last resort, the credit crunch and the consequent the fall of production and employment, we observe, would be much more severe. In this respect, again, we think that this central bank behavior represents quite well some of the actions undertaken by major central banks to stem the crisis, like the two recent mentioned LTROs made by the ECB.

Furthermore, it is worth noting that this central behavior prevents the bankruptcy of banks due to lack of liquidity. However, banks could in principle still fail because of insolvency, i.e. if their equity becomes negative. This actually may happen, in particular when a big borrower goes bankrupt and consequently there is a huge assets write-off on the side of bank, see e.g. the aggregate equity of the banking system in the bottom part of Figure 3 for the case $\alpha = 9$. In the present version of the Eurace model, however, there is no foreseen bailout mechanism for banks, therefore they are kept alive and functioning even if technically insolvent. Again, we do not think that this is an unrealistic assumption as these insolvent yet functioning banks represent the so-called “zombie banks”, i.e. financial institutions that are de facto insolvent but continue normal operations, yet without granting new loans and deleveraging their loan portfolio due to the Basel II constraints.

Finally, to reply to the specific reviewer’s request to increase the number of banks, it is worth noting that the new simulations performed with an increased number of agents, i.e., new number of agents, as shown by table 12, confirm the finding of previous results.

To better clarify the role of the central bank, we have enriched and hopefully improved section 6 “The Central Bank”.

PART ADDED IN THE PAPER:

“It is worth noting that there is no interbank market in the Eurace model and that the central bank is the only provider of liquidity to banks, alongside of course depositors, i.e. households and firms. This critical role is actually performed by central banks also in real economies and the ongoing global financial crisis started in 2007 has showed its relevance. The central bank in Eurace always accommodates any liquidity request by commercial banks as it usually applies in real world operations and as it is recognized by the endogenous money theory, i.e. the theoretical framework we refer for credit market modeling (see the Introduction and references therein). Therefore, commercial banks deal with liquidity excess or shortage by depositing or withdrawing money at the central bank. Without a supplier of liquidity of last resort, the observed credit crunch and the consequent the fall of production and employment would have been probably more severe.”

References

- Silver, E., Pyke D., and Peterson R. (1998). Inventory Management and Production Planning and Scheduling, John Wiley & Sons.
- Fabiani F., Druant M, Hernando I., Kwapil C., Landau B., Loupias C., Martins F., Matha F., Sabbatini R., Stahl H., and Stokman A. (2006). What firms’ surveys tell us about price-setting behavior in the Euro Area. International Journal of Central Banking 2(3): 1-45.
- Basel Committee on Banking Supervision (2006). International convergence of capital measurement and capital standards: A revised framework - comprehensive version, Technical report, BIS, <http://www.bis.org/publ/bcbs128.htm>.
- Saunders A and Allen L (2010) Credit Risk. Measurement In and Out of the Financial Crisis. Wiley