Reply to referee's report on 'Implicit microfoundations for macroeconomics'

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My thanks to the referee for taking the time to provide helpful comments and corrections. Below are my responses. Each bullet item corresponds to the original item in the referee's report.

- As requested, I have added a quantitative specification of 'sufficient' and 'insufficient' funds in the 'wage payment and firing rule'.
- The referee notes that my explanation of the possible cause of over-monopolization in the economy is not sufficiently clear. I have therefore added clarifying comments.
- I have included a reference to the event of a firm 'dying' in Section 2, as requested.
- The referee cites Fujiwara (2004) who reports that the distribution of liabilities of bankrupt Japanese firms in 1997 follows a power-law and that the magnitude of liabilities is correlated with firm size, measured either by 'sales right before bankruptcy' or 'number of employees'. The referee notes that my paper does not investigate the size of demised (bankrupt) firms and that 'in my opinion, the CSA model cannot replicate the power law distribution of demised firms'.

  The CSA model lacks any concept of debt but we can measure firm sizes during the month of a firm's demise, measured either by number of employees or sales revenue. I ran some small-scale simulations with 500 agents and collected data.

  Figure 1 plots the result when firm size is measured by sales revenue. The preliminary graphical analysis suggests that the distribution has a power-law tail.

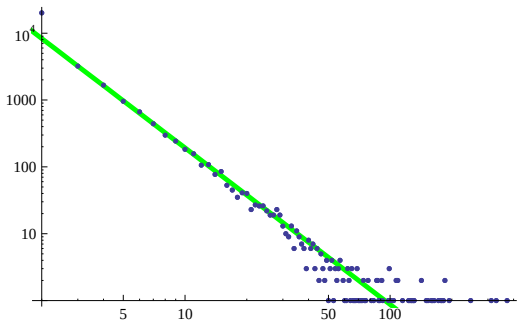

FIGURE 1. Frequency plot in log-log scale of firm size, measured by sales revenue, during the month of a firm's demise (bin size of 5). The straight line is a fitted Pareto distribution $P(x) \propto x^{-(\alpha+1)}$ with $\alpha = 1.3$.

Figure 2 plots the result when firm size is measured by number of employees. In this case also the distribution appears to have a power-law tail.

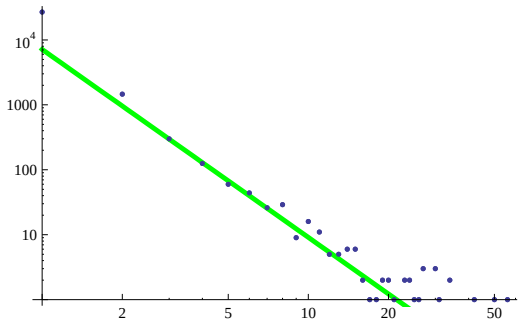

FIGURE 2. Frequency plot in log-log scale of firm size, measured by number of employees, prior to firm demise (bin size of 5). The straight line is a fitted Pareto distribution $P(x) \propto x^{-(\alpha+1)}$ with $\alpha = 1.9$.

So it appears that the CSA model is consistent with Fujiwara's empirical data, contrary to the referee's expectation.

Of course, it may have turned out otherwise. Any model must have explanatory limits. The more important point, I think, is not that the CSA model is consistent with the particular distributions reported by Fujiwara but that models of this type can explain the qualitative features of many macroeconomic distributions in a parsimonious manner. At first this might seem surprising. But if we consider each distribution examined in my paper (e.g., firm size, income distribution etc.) as a lower-dimensional projection of a single, higher-dimensional distribution over the basic ontology of the model (agents, their money holdings and employer-employee relations) then the results are less surprising. If the CSA model replicates, to some level of fidelity, the higher-dimensional distribution of the statistical equilibrium of actual capitalist economies then, of necessity, it will also reproduce any projections of it.

To discover that the CSA model is consistent with yet another empirical distribution is pleasing. But I have not added a new section on Fujiwara's data since it would lengthen the paper but not significantly enhance the main argument.

- The referee correctly points out that I do not investigate the rate at which new start-ups are formed in this model, so I have removed any reference to this rate from the paper.
- The referee notes that 'the distribution of sales revenue is not explained in the article'. However, in Section 3.5, I do state that this distribution has been variously reported as following a Laplace or Subbotin distribution. The CSA model is consistent with the empirical data in this case.
- The CSA model fails to replicate the distribution of GDP growth as reported by Lee et al. (1998) and Canning et al. (1998). As far as I can understand the referee therefore poses the question: is the cause of this discrepancy the definition of GDP used to generate the empirical data, or the definition used in the CSA model? In short, I do not know (although my suspicions were aroused since an earlier, less elegant, version of this model did replicate this distribution; see Wright (2005)). But the referee's observation does raise the general point that the mapping from model variables to empirical variables is rarely straightforward, especially when we consider the complexities of national income accounting. In this paper I deliberately keep things simple and do not dig too deep into the subtleties of the empirical data, for fear of defocusing the main argument. For example, much more

work needs to be done developing models of this type, particularly with respect to (i) removing some of the over-simplifications, (ii) model calibration and (iii) investigation of the replication of empirical time-series properties in addition to the distributional features of equilibrium states.

- My thanks to the referee for bringing this paper to my attention. I have added a reference as suggested.
- The plots in Figure 11(a) and Figure 12(a) are not rank size distributions but (unnormalized) complementary cumulative distribution functions (ccdfs). Once normalized they satisfy the conditions for a ccdf.
- I've ensured that the definition of the acronym 'ccdf' precedes its use.

References

Canning, D., Amaral, L. A. N., Lee, Y., Meyer, M. and Stanley, H. E.: 1998, Scaling the volatility of gdp growth rates, *Economics Letters* **60**, 335–341.

Fujiwara, Y.: 2004, Zipf law in firms bankruptcy, *Physica A* **337**(1–2), 219–230.

Lee, Y., Amaral, L. A. N., Canning, D., Meyer, M. and Stanley, H. E.: 1998, Universal features in the growth dynamics of complex organizations, *Physical Review Letters* **81**(15), 3275–3278.

Wright, I.: 2005, The social architecture of capitalism, *Physica A* **346**, 589–622.

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