# Exploration over parameters in the ABM model

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## Table of contents



### Executions

The ABM has been explored over four parameters: $\beta$, $g$, $k$ and $w$. Also the $\eta$ has been considered to obtain results for a monopolistic market ($\eta > 0.25$) and perfect competition ($\eta \approx 0$). The parameters appear in the ABM as:

- $k$ is the capital intensity
- $w$ is the real wage
- $g$ is the bankruptcy cost
- $\beta$ is the skewness
- $\eta$ is the inverse of the elasticity of demand ($1/\varepsilon$)

For each combination of those parameters, the model has been run 10 times using a Montecarlo method. So a total of 3250 executions of the model have been done:

```
parameters_not_eta = {
   'beta': [0.02, 0.03, 0.04, 0.05],
   'g': [1.0, 1.1, 1.2],
   'k': [1.0, 1.1, 1.2],
   'w': [0.5, 0.6, 0.7]
}
eta = {
   'eta': [0.0001, 0.1, 0.3]
}
```

Many of those executions are not representative of a realistic system with crisis, as the example in Figure 1. So the first purge done was those models in which the Spearman's rank correlation coefficient was higher than 0.99, discarding a total of 2047:

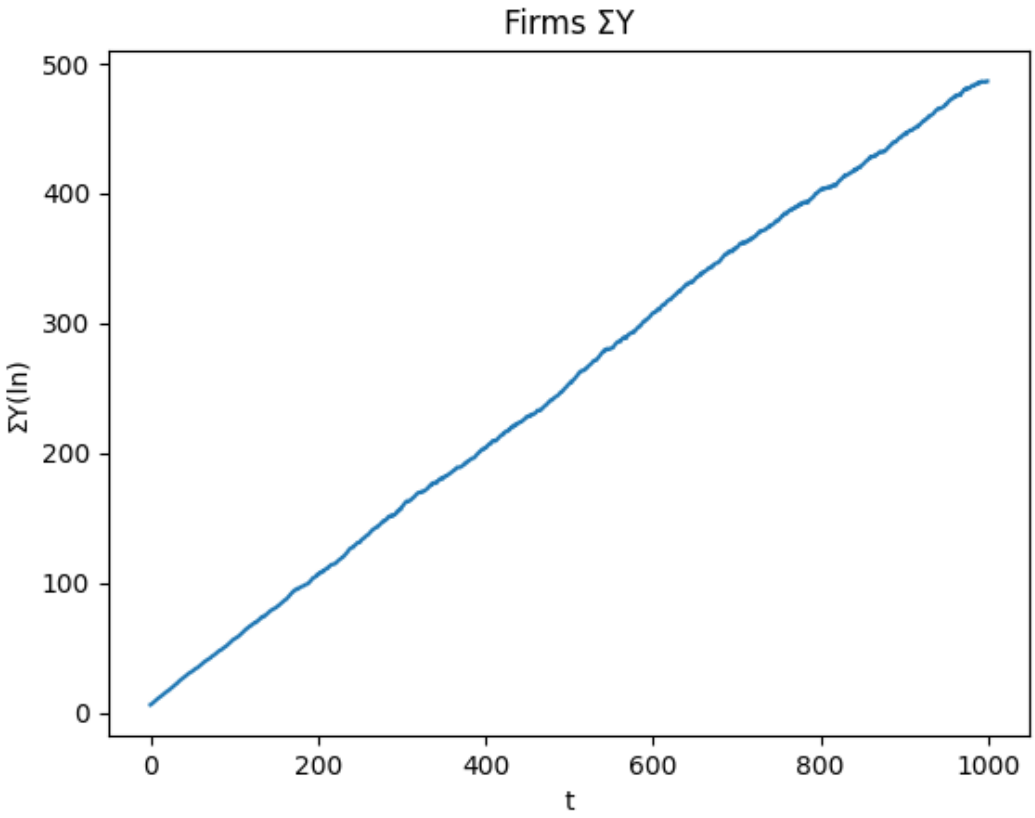


Figure 1: The Spearkman's rank correlation of this GDP over time is 0.9999

Also even if the Spearman's rank correlation is below the limit of 0.99, some of the executions show an evolution of ups and downs in GDP only at the last third of the ticks (t>666), as in Figure 2. We classify them also as useless models, and we discard them also (192 in total) , so with this new discarded items, we have only 1001 executions of models.

With all these, we should also consider what to do with those models where a majority of executions are not valid. That is, when the capacity of the selected combination of parameters to success is unlikely, as it happens with the GDP of model with parameters $\beta = 0.02$, $g = 1.0$, $k = 1.1$ $w = 0.6$ and $\eta = 0.3$. The GDP of nine of them has no up and downs, as shown in Figure 3, and the only one we can consider correct, Figure 4, can be discarded? We though so. The decumulative distribution function (DDF) with this parametrized models is shown in Figure 5. The data considers the values of the ten executions of the Montecarlo simulation,

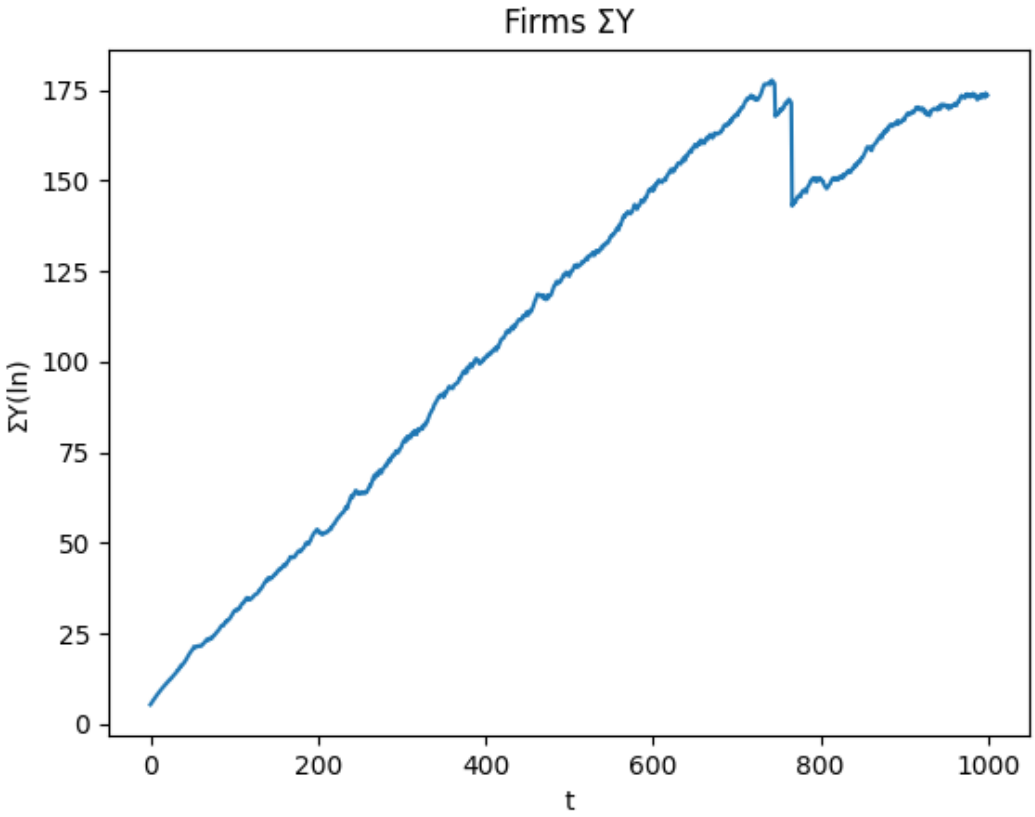


Figure 2: The Spearkman's rank correlation of this GDP over time is 0.9617757977757978, but 0.9998987703872105 considering only t=[0..666].

the nine with no ups and downs and also the only one successful. More of these could be understood reading Grilli, Tedeschi, and Gallegati (2014), but in this case we tend to discard completely the combination of parameters because of DDF and data indicates that market is not realistic.

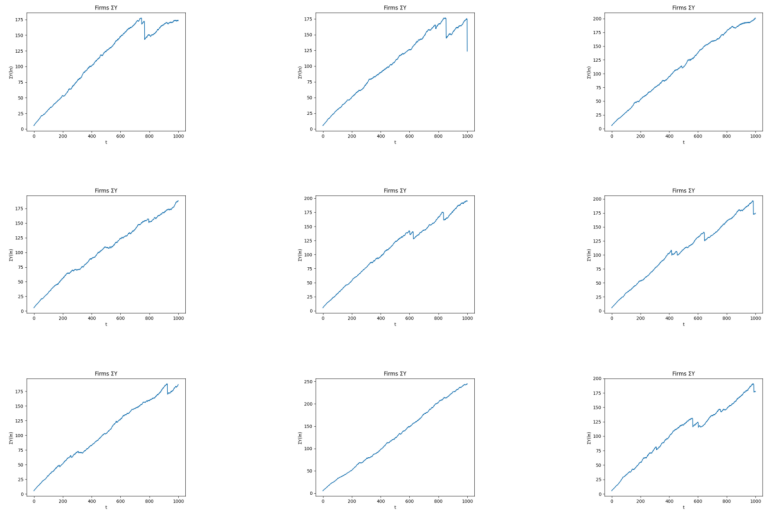

Figure 3: GDP of the executions of beta=0.02, g=1.0, k=1.1 w=0.6 and eta=0.3

## GDP in valid models

If we now pay attention to the parameters that have more executions with a reasonable number of ups and downs (green) in Figure 6 an initial approximation could be:

- $w = 0.7$ surely (or at least 0.6)
- $k =$ \$ [1.0 …1.1 ] \$, but not 1.2
- $g$ not conclusive
- not conclusive
- is the inverse of the elasticity of demand (1/ ). Not to be determined.

Let's analyze the GDP: considering the same colors we have seen in Figure 6 we can depict the combinations of parameters with better success, but using the size of the balloon for bad debt size for the bank sector (logarithm) and Z-position for average GDP of firms (also logarithm). These results could be found in Figure 7. To explain it: - Bigger average GDP is obtained with models with poor behaviour, but at cost of a bigger amount of bank bad debt. - Few main GDP is representative of the models we identified as good, but also with less bank risk.

Let's fix now $w$ as 0.7 and try to determine something more conclusive about $k$, *beta* and $g$. To do it, let's focus now on the mean number of bankruptcies by each model, using the

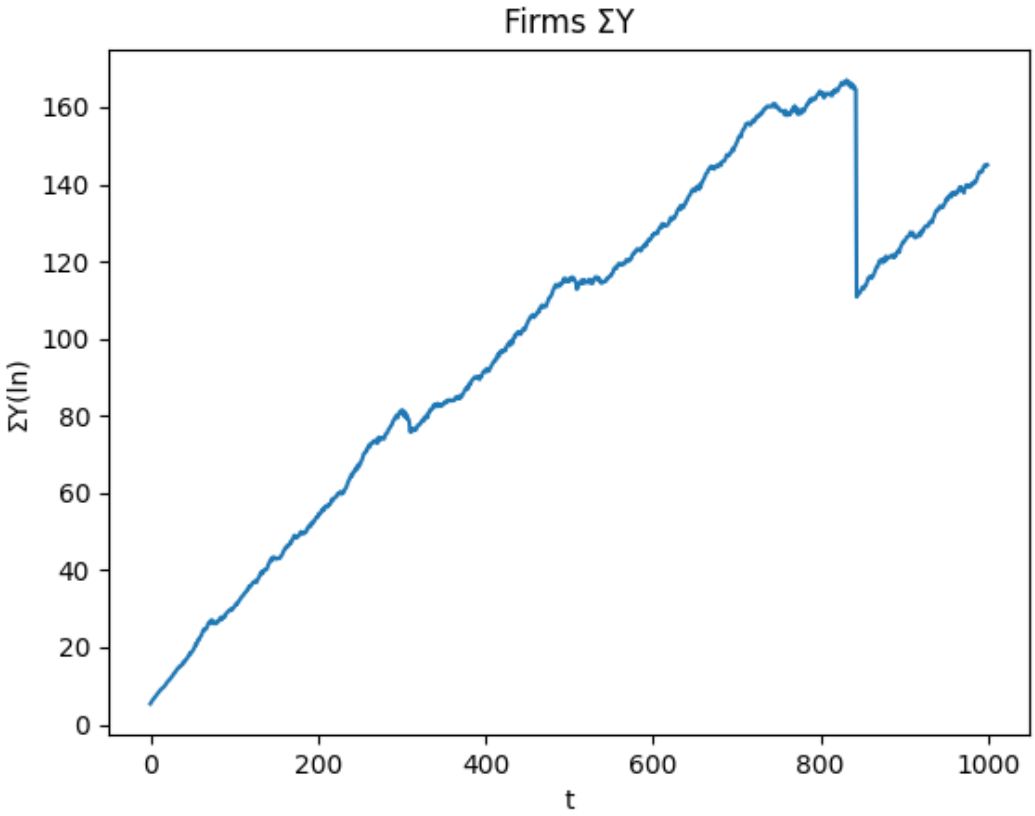


Figure 4: The Spearkman's rank correlation of this GDP over time is 0.9617757977757978, but 0.9998987703872105 considering only t=[0..666].

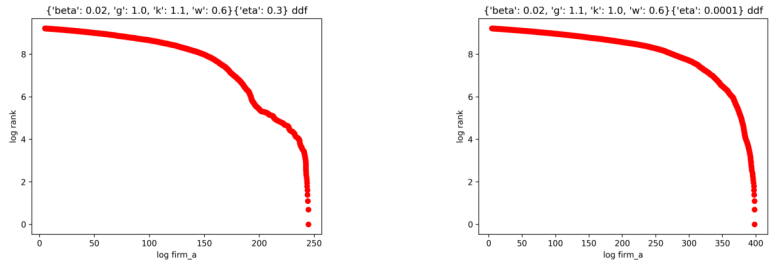


Figure 5: DDF of a model very unlikely to success (left) and the good expected form of a model with better performance (right)

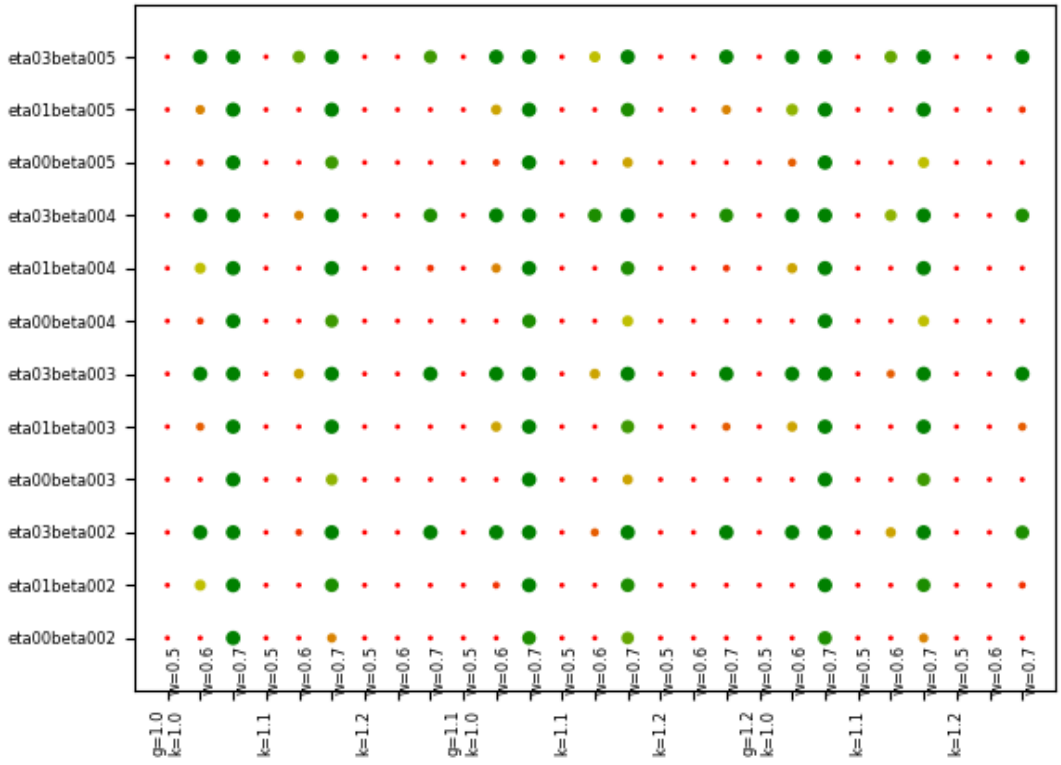


Figure 6: Greener colors are for combinations with more executions considerated correct

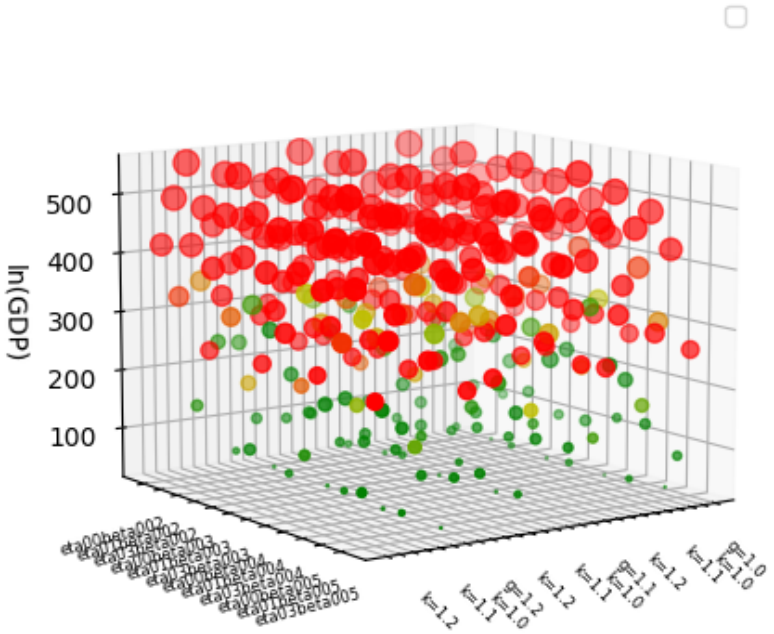


Figure 7: Using the same colors as before, size of point is related with bad debt, and axis Z represents the logarithm of GDP

10 executions from Montecarlo of each model, and also the standard deviation from the mea (Figure 8), differencing now between $\eta = 0.0001$ (perfect competition or PC), $\eta = 0.1$ (MIXED) and $\eta = 0.3$ (monopolistic competition MC):

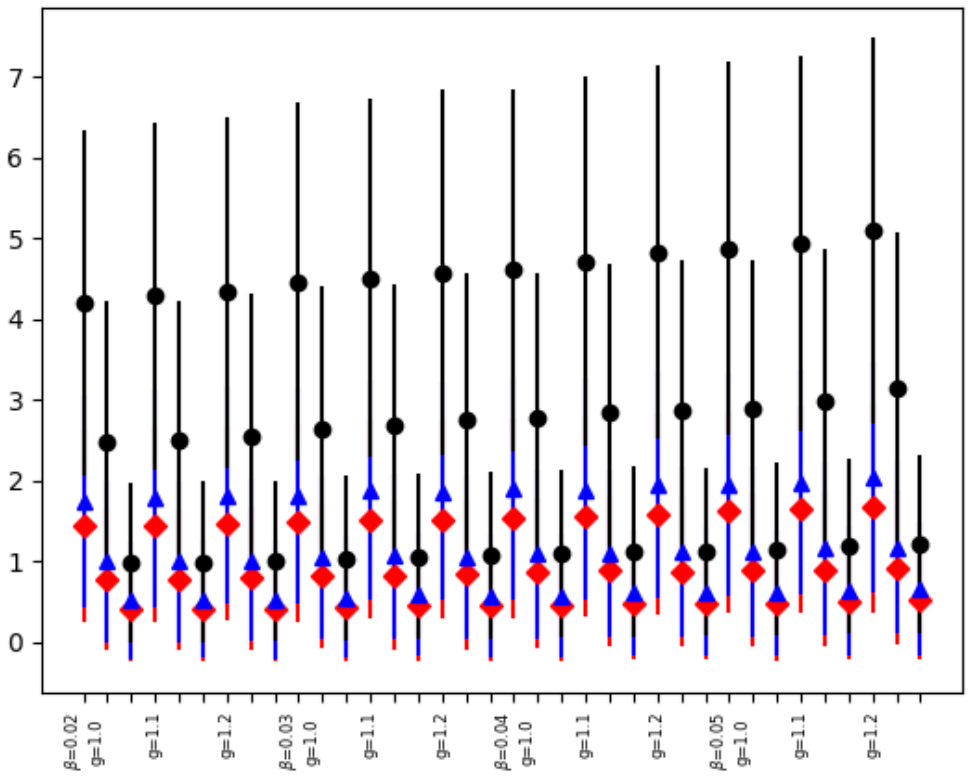


Figure 8: Mean of bankruptcies for the different parameters (PC in red :black_circle:, MIXED in blue and MC in black). Each three consecutive values are for k = [1.0, 1.1, 1.2]

So almost no impact in the model due to variations in $g$. For $\beta$, few bankruptcies are when the value is 0.02, In respect of $k$, the plot shows its three results for $ [ 1.0, 1.1, 1.2 ] $ by grouping by each three. The few failures are when $k = 1.2$. So in conclusion, the best fit is obtained with:

- $k = 1.2$
- $\beta = 0.02$
- $w = 0.7$

Grilli, Ruggero, Gabriele Tedeschi, and Mauro Gallegati. 2014. "Markets Connectivity and Financial Contagion." *Journal of Economic Interaction and Coordination* 10 (March).

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