

## Sensitivity analysis

Agent-based modelling often entails, as in our case, stochastic settings, and may generate rich and complex patterns. To investigate the uncertainty of the modelling results and how the uncertainty or variations of the model outputs can be attributed to various input variables, a sensitivity analysis needs to be conducted symmetrically (Ten Broeke et al., 2016). Given the limitations of the “behavioral Space” tool in NetLogo, we used RNetLogo, and its extended R packages, nlexperiment and nlrx, to execute a sensitivity analysis in R. We also used the tools to analyse and visualize the results in R.

Figure SA1 shows the parameters space of the four input variables: percentage of large firms (percentage\_of\_large\_firms), number of projects in a tick (Number\_of\_projects\_in\_1\_tick), maximum possible project size (PS\_Max), and the capital decay rate (DR). We set different value-ranges for these variables. For example, PS\_Max takes integer values from 1 to 6, with an interval of 1; percentage\_of\_large\_firms takes values from 0.01 to 0.10, with 0.01 as interval. Then we run the model for all possible combinations of values, with 100 repetitions for each combination. Accounting for all the combinations, we had 360,000 runs.

The results we obtained were along expected lines, and support the robustness of our results. The correlations we have observed between input and output variables can be explained by logic and mechanisms within the model code. Figure SA2, Figure SA3, Figure SA4 show how the input variables shape the variation of the output variables: total pollution, total financial capital, and total knowledge capital. We see that the variable number of projects in a tick has a positive effect on the total pollution – meaning more innovation projects may actually lead to the higher total pollution. This is because more innovation projects lead to more firms surviving and growing in the simulation (not shown in these graphs). The average pollution per firm, however, may decrease. Secondly, we see that the variable maximum possible project size has a negative effect on knowledge and financial capital. This can be explained by the mechanism of agents committing capital to projects. When there are more partners within a project, more capital is committed. However, these projects need not succeed. With failed projects, agents lose the committed capital. With more agents being part of failed projects, more capital is lost from the cluster. Finally, we see that knowledge and financial capital are negatively correlated with the decay rate, which is not surprising since the capital stocks decrease by higher amounts each time-step, at higher decay rates.

### **Figure captions**

- Figure SA1: The parameters space of the input variables for the sensitivity analysis: percentage of large firms (percentage\_of\_large\_firms), number of projects in a tick (Number\_of\_projects\_in\_1\_tick), Maximum possible project size (PS\_Max), and the capital decay rate (DR).
- Figure SA2: Sensitivity analysis for total pollution. The red line is a linear trend line.

- Figure SA3: Sensitivity analysis for financial capital. The red line is a linear trend line.
- Figure SA4: Sensitivity analysis for knowledge capital. The red line is a linear trend line.