APPENDIX 2 Convergence analysis

The goal of the convergence analysis was to estimate how many replications of the model are required to generate model outputs that are not significantly influenced by stochasticity within the model. We refer to this number of replications as r^*. In our case, the quantity of interest is $P(CC \succ Ins)^{shock}$. We expect that this probability will vary considerably with both T_{shock} and T_{assess}. Hence, we choose $r^* = \max\left(r^*_{T_{shock},T_{assess}}\right), \forall (T_{shock}, T_{assess})$ over $T_{shock} \in \{5,10,20\}$ and $T_{assess} \in \{1,3,5,7,9,11,13\}$.

Our approach for estimating each $r^*_{T_{shock},T_{assess}}$was as follows:

1. Run a large number of model replications (1000).
2. Assume the estimated $P(CC \succ Ins)^{shock}$ over these replications ($\hat{X}_{1000}$) is the "true" value.
3. For each $r \in \{1, \ldots, 1000\}$, calculate the absolute error (AE) from the true value. For example, $AE_{50} = |\ \hat{X}_{1000} - \hat{X}_{50}\ |$, where $\hat{X}_{50}$ represents $P(CC \succ Ins)^{shock}$ calculated over the first 50 replications.
4. Choose r^* as the number of replications at which the absolute error in the estimated probability falls below 5%, i.e., $r^* = argmax_n(AE_n > 0.05)$.

The threshold of 5% was chosen as we do not require highly precise estimates of $P(CC \succ Ins)$ for our assessment. We acknowledge that our approach is relatively ad-hoc and not formally statistically grounded. However, it captures the essence of what we desire: estimates of $P(CC \succ Ins)$ that are robust to within-model stochasticity. We considered using the approach presented in Abreu and Ralha (2018), but the coefficient of variation (i.e., the standard deviation of $P(CC \succ Ins)$ divided by the mean) is unstable with estimates near zero. Additionally, we considered the approach presented in Law (2008) (pg. 502), but because our model is not computationally intensive it was feasible to run a large number of simulations and calculate $\hat{X}_n\ \forall n$ and we adopted the approach described above.

The results indicate that $r^* = 188$ is sufficient (Figure A2.1). To be conservative, we run the model at least 300 times for all experiments. For some figures we used a higher number of replications to improve visual clarity.

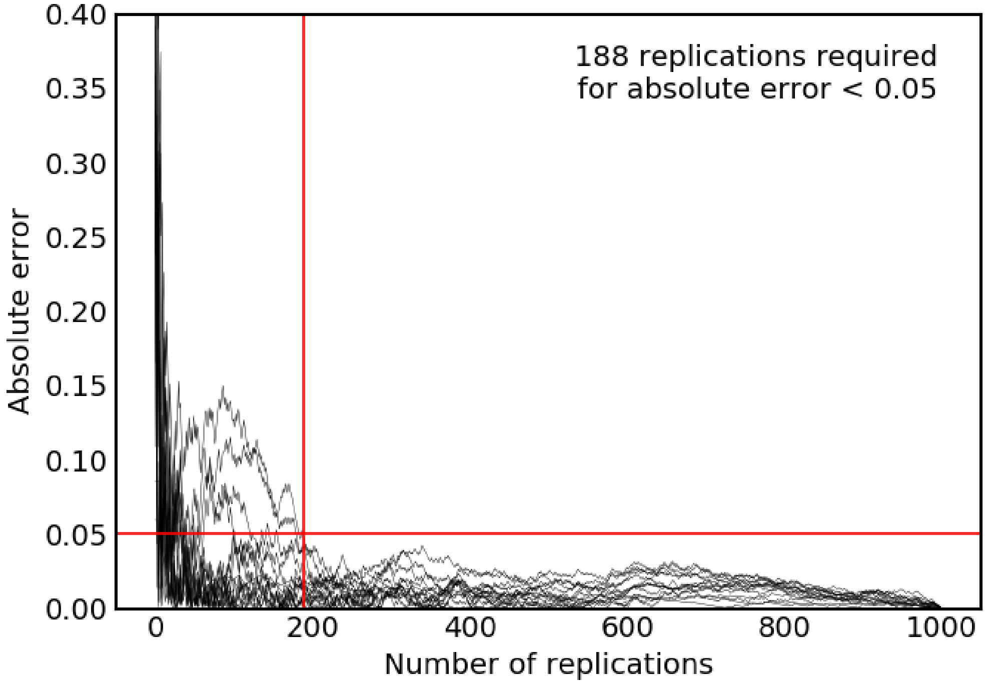

Figure A2.1: Absolute error in the estimate of $P(CC \succ ins)$ as the number of model replications is increased. Each black line represents a unique (T_{shock}, T_{assess}). The red lines show the point at which the absolute error falls below 0.05 for all (T_{shock}, T_{assess}).

References

Abreu, C. G., and C. G. Ralha. 2018. An empirical workflow to integrate uncertainty and sensitivity analysis to evaluate agent-based simulation outputs. *Environmental Modelling & Software* 107:281–297.

Law, A. M. 2008. *Simulation modeling and analysis, Fourth Edition*. McGraw-Hill New York.