

INSTABILITIES AND CRISES

INSIGHTS FROM INTERACTING AGENT BASED MODELS

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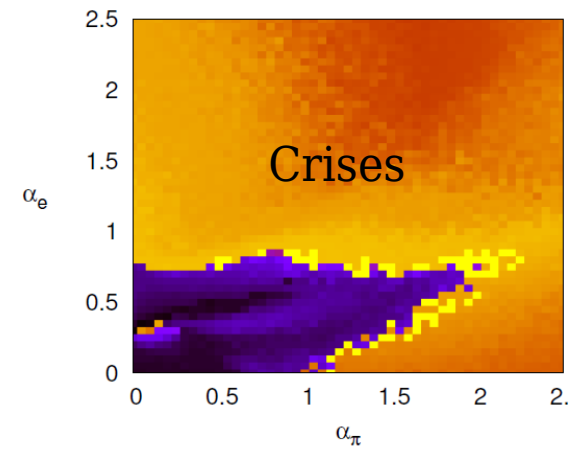
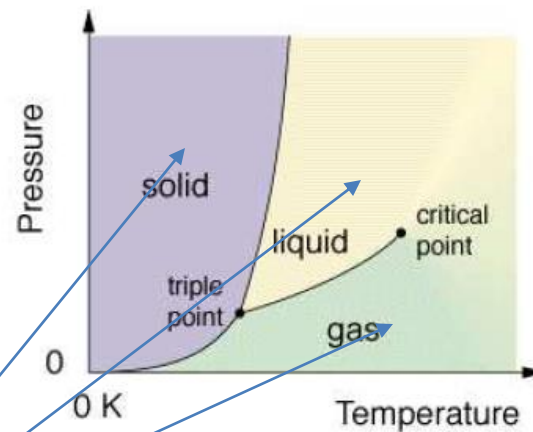
Emergent behaviour

- The Economy is a complex system, with a large number of interacting units, of different kinds (firms, households) and (very) different sizes
- The main point in Economics is precisely about organization, cooperation and coordination of these different micro-units
- Such coordination can breakdown leading to systemic crises
- Understanding these emergent properties is difficult: genuine *surprises* can appear when aggregating interacting micro-units
- Treating all units as a unique representative firm/household throws the baby with the bathwater

Micro-founded vs. Agent Based models

- Standard « micro-founded » models: a misnomer since we can just hope these models describe macro-behaviour, *as if* the representative household/firm were rational utility maximizers
- Non-rational behaviour and frictions of all kinds are difficult to integrate within standard models while keeping tractability
- Agent Based Models:
 - > Are very flexible (not constrained enough?)
 - > But « macro » is to a large extent robust against details
 - > Allow for non trivial emergent properties (e.g. phase transitions)

Emergent behaviour



- Within large swaths of parameters: robust macro behavior
- But close to “phase transitions”, slightly different micro rules/micro parameters can lead to very different macro-states: Sudden discontinuities (aka crises) can appear when a parameter is only slightly changed
- Because of heterogeneities and non-linearities, these emerging surprises are hard to anticipate. We need numerical simulations, aka “*telescopes for the mind*” (M. Buchanan)

Experimenting *in silico*



Fireflies flashing in unison

- Agent Based Models allow experiments “in silico” leading to scenarios that would be nearly impossible to imagine
- (Think for example of the spontaneous synchronization of fireflies. It took nearly 70 years to come up with an explanation!)
- ABMs allow to train our minds to grasp these collective phenomena/crises and to understand how they may come about

Experimenting *in silico*



Fireflies flashing in unison

- An intellectual exercise of genuine value: if we are not able to make sense of emergent phenomena within a world in which we set all the rules, how can we expect to be successful in the real world?
- Are there (or not) some “phases” where emergent properties are DSGE-like, separated by “phase transitions”/crises?
- Can one endow DSGE-like models with some ABM-like ingredients that allow non-trivial emergent phenomena?

A POC, stylized agent based model

- “Mark 0” - a Proof Of Concept ABM with plausible behavioural/*tatônnement* rules:
 - 1) Firms adjust workforce (= production), prices, and possibly wages in reaction to sales. Hiring/firing adjustment speeds may be different, with ratio **R**
 - 2) Households’ consumption budget = a fraction of their wealth. They favour firms with lower prices with some “intensity of choice”
 - 3) Firms default when debt exceeds a multiple **M** of total sales, and are replaced by new firms with some rate [Debt is shared between households & surviving firms]
 - 4) Fully “stock-flow consistent” [correct accounting]
- Min: 7 parameters; 5 turn out to be innocuous but 2 are crucial:

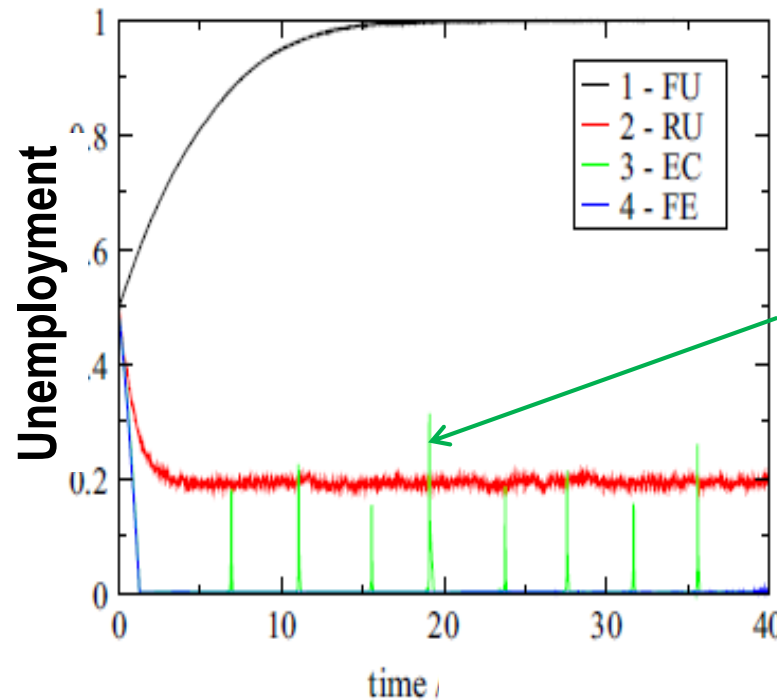
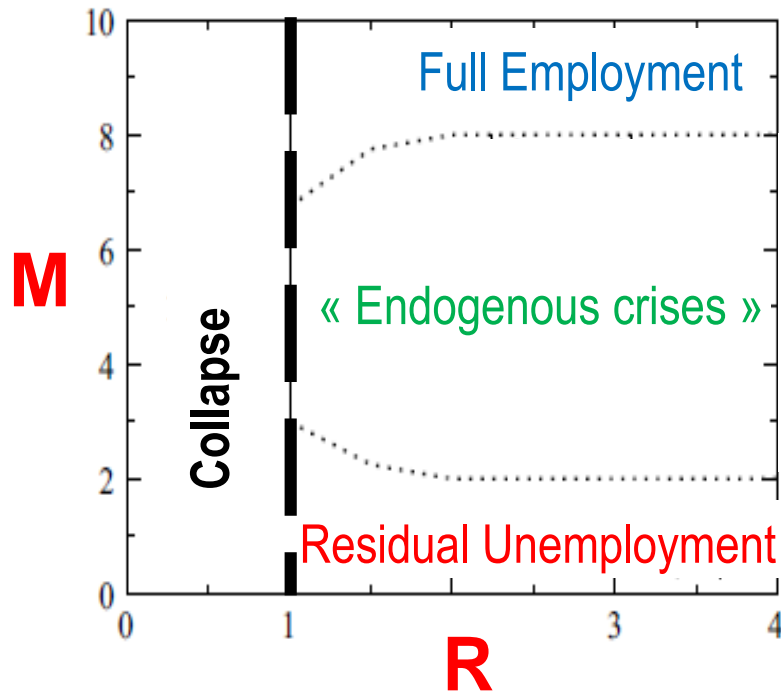
Ratio of hiring/firing adjustment rates (in reaction to sales)

Maximum debt-to-sales ratio before bankruptcy (i.e. leverage)

Tipping points in stylized agent based models

(with Gualdi, Tarzia, Zamponi)

⇒ Proof of Concept: a very robust qualitative phase diagram (w.r.t. many behavioural rules and parameters, e.g. fixed/variable wages, etc...)



Surprise: Quasi-periodic unemployment spikes without external shocks (??)

→ **R** Ratio of hiring/firing speed: if firms fire faster than they hire, the economy collapses

→ **M** Maximum level of indebtedness before bankruptcy: if too small, firms default “accidentally” leading to residual unemployment. As **M** grows, a curious phase with **unemployment spikes** sets in

An ABM/DSGE Hybrid

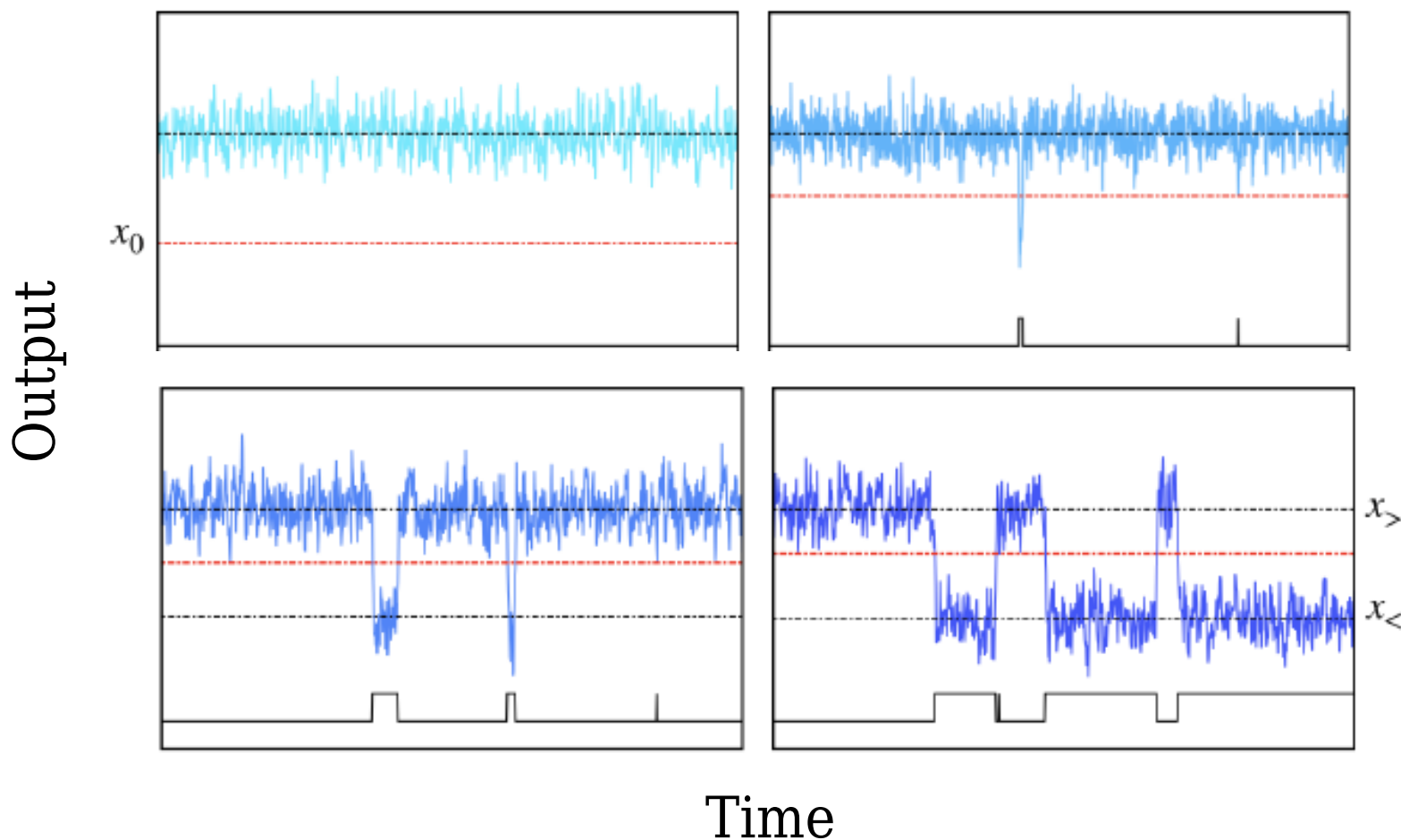
- ABM are still far from accepted in academic circles
- For all its shortcomings, DSGE is still the preferred framework, even by luminaries in the field*
- Can we somehow weld together the two approaches?
- An attempt: DSGE with heterogeneous agents, each with a consumption utility that depends on the previous average consumption level of others (“herding”)
- If others consume less, confidence is reduced and investment/consumption may collapse

*₉DSGEs make the right basic strategic choices and the current flaws can be addressed (Blanchard)

An ABM/DSGE Hybrid

(F. Morelli, M. Benzaquen, M. Tarzia, J.P. B.)

This confidence feedback loop can generate crises in such a DSGE framework!



Changing our modelling strategy

- ABM are spurned because they are hard (perhaps impossible) to calibrate, where as DGSE are routinely calibrated
- However, getting precise numbers out of a wrong model should not be considered helpful (e.g. recent value of optimal inflation rates within DSGE = 1.5%)
- We should abandon the « pretense of knowledge » and false sense of control and opt for a qualitative approach to phenomena, mechanisms, feedback loops, etc. - (cf. Keynes)
- By allowing one to make « what if » experiments, ABM are very useful to (i) build our intuition, (ii) teach our students « qualitative macroeconomics », and (iii) control the micro-macro connection

Main message



- Interactions/Externalities can lead to collective instabilities → « endogenous volatility », « small shocks, large business cycles » and unexpected crises, often disproportionate with real causes
- ABM are the perfect arena to develop these ideas