Financially-constrained firms and technological development: an Agent-Based Model

TESI PER LA CERTIFICAZIONE FINALE DELLA

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Torino, 01/07/2016

Motivation

- Technological development is the main driver of growth
- Financial stability affects output
- Key fact: only financially robust firms perform innovation
- Feedback between financial conditions of the market and technological development
- Make a simple Agent-Based Model to explore it

Why interdisciplinary?

- Economy as a complex system
- Collection of entities whose collective behavior cannot be directly inferred from the individual behavior
- Anderson (1972)
- Complexity economics: bounded rationality, heterogeneity, out-of-equilibrium, interactions
- An example: Agent-Based Models

Related literature

- Endogenous growth: Romer (1990), Aghion and Howitt (1992), Grossman and Helpman (1991), Dosi et al. (2010).

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- Financial accelerator: Greenwald and Stiglitz (1993), Bernanke et al. (1996), Delli Gatti et al. (2005, 2010, 2012)

Overview

- Model
- No tech development
- Switching on tech development

Production and costs

- *N* firms denoted by *i*; time *t*, discrete

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- Equity (net worth, own capital): $A(i,t)$
- Planned quantity: $\widetilde{Q}(i,t) = \alpha A(i,t)^{\beta} > 0$
- Technology $\gamma(i,t)$, capital $K(i,t)$
- Production function: $Q(i,t) = (\gamma(i,t)K(i,t))^{\delta}$
- Perfect credit markets: $Q(i,t) \equiv \widetilde{Q}(i,t)$

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- Costs: $C(i,t) = gK(i,t) + RD(i,t)$

Market mechanism

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- Nominal revenues: $Y(i,t) = P(i,t)Q(i,t)$
- Profits: $\Pi(i,t) = Y(i,t) - C(i,t)$
- Update: $A(i,t+1) = A(i,t) + \Pi(i,t)$

Technological development

- States: robust (RB), fragile (FR), bankrupt

$$\mathbb{P}\{A(i,t+1) < 0\} = \mathbb{P}\{A(i,t)+\Pi(i,t) < 0\}$$

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$$\mathbb{P}\{A(i,t+1) < 0\} = \mathbb{P}\{A(i,t) + \Pi(i,t) < 0\}$$

- RB firms spend fraction ν of revenues on R&D
- Innovation: $\gamma(i,t+1) = (1 + \zeta(rd(i,t)))\gamma(i,t)$

- FR firms engage in imitation

Wrap-up

- Production financially constrained
- Stylized market mechanism with shocks
- State update
- Innovation and imitation
- Exit and entry

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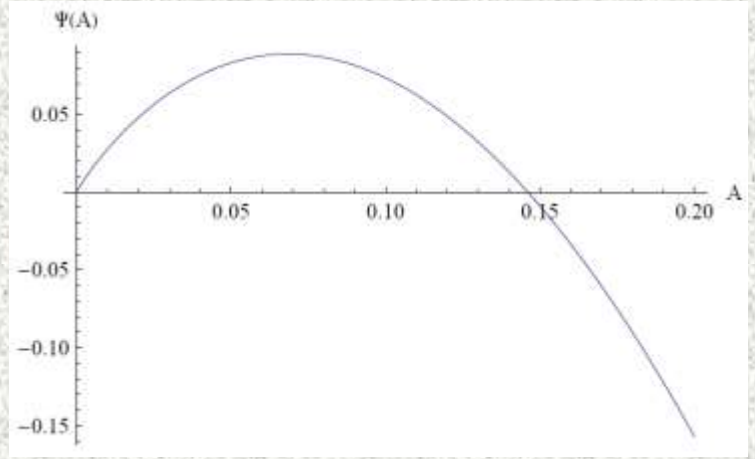
Baseline case

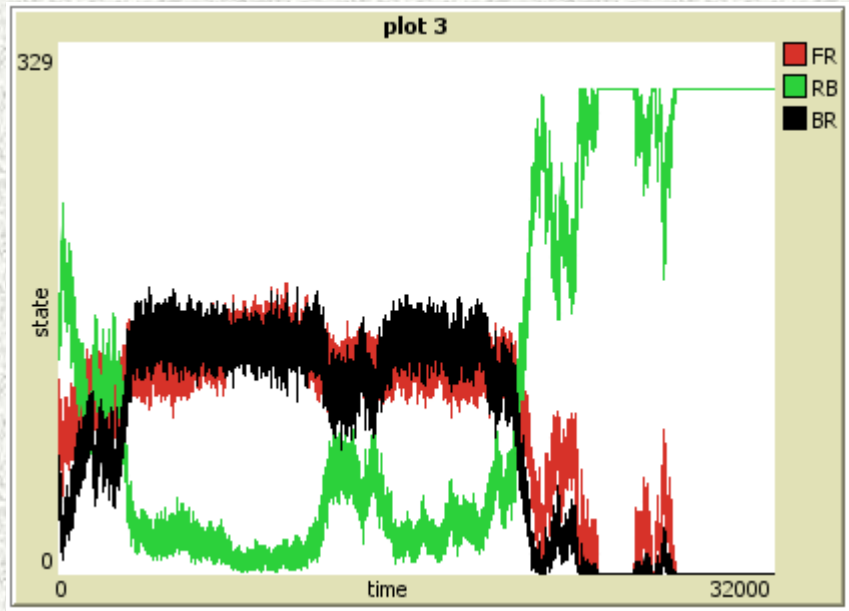
- Fixed technology: $\gamma(i,t) = \gamma$
- Constant price: $P(t) = P$
- Deterministic dynamics: $u(i,t) = 1$

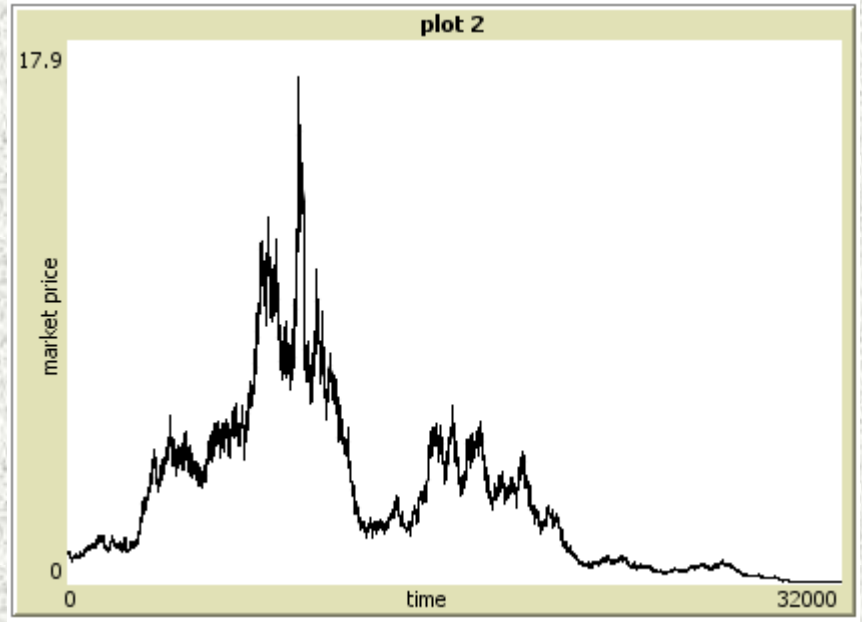


$$A^{\star} = \left[\frac{\gamma P}{g}\alpha^{1-1/\delta}\right]^{\frac{\delta}{\delta-\beta}}$$

$$\Psi(A_{RB}) = 1 + u_0 P \alpha A_{RB}^{\beta-1} - \frac{g\alpha^{1/\delta}}{\gamma} A_{RB}^{\beta/\delta-1} = 0$$

Price evolution





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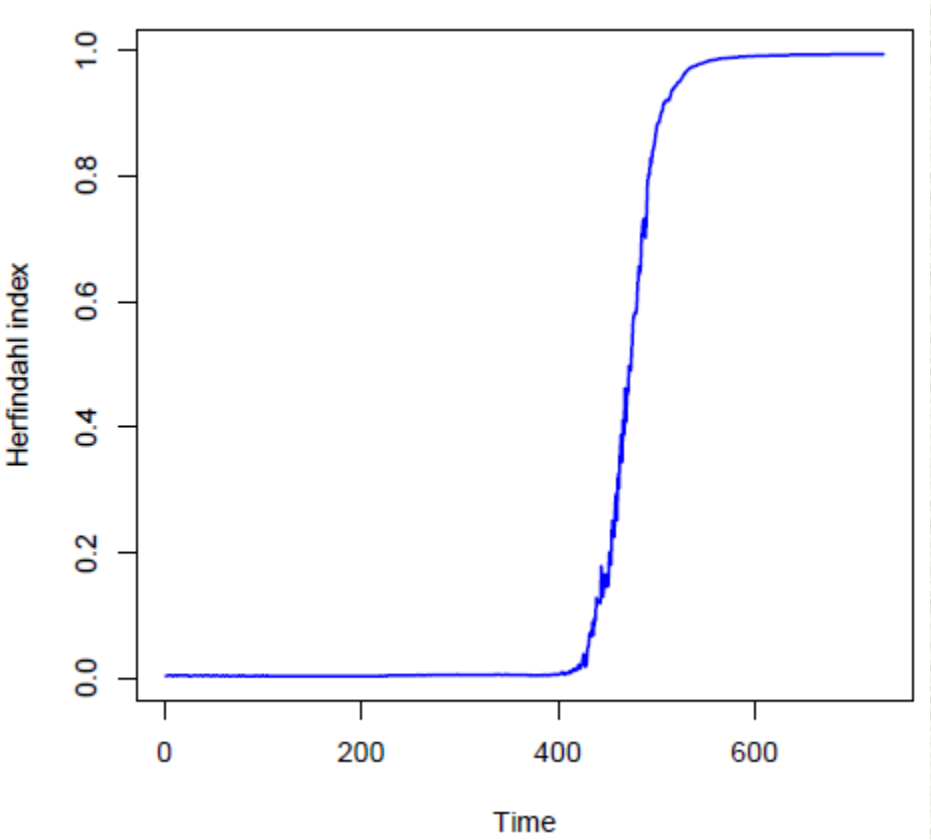
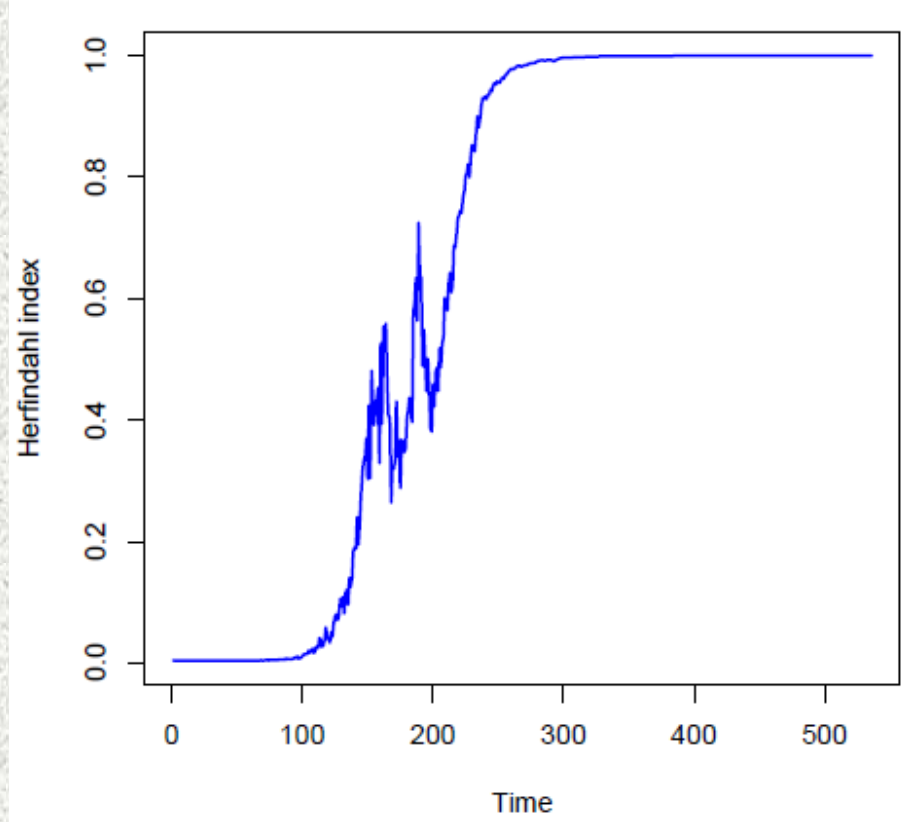
Relevant quantities

- Feedback effects between the credit constraints and the interplay between innovation and imitation.
- Prevalent state: RB or FR
- Herfindhal index:

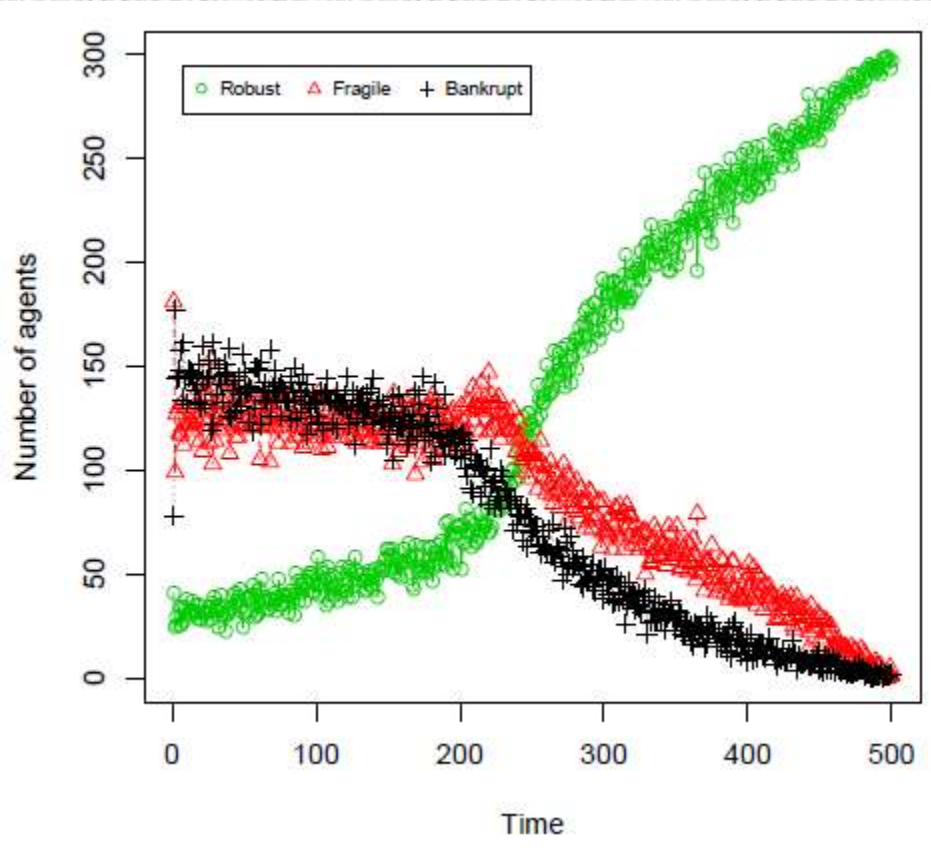
$$H = \sum_{i=1}^{N} s_i^2, \quad s_i = \frac{Q(i,t)}{Q(t)}$$

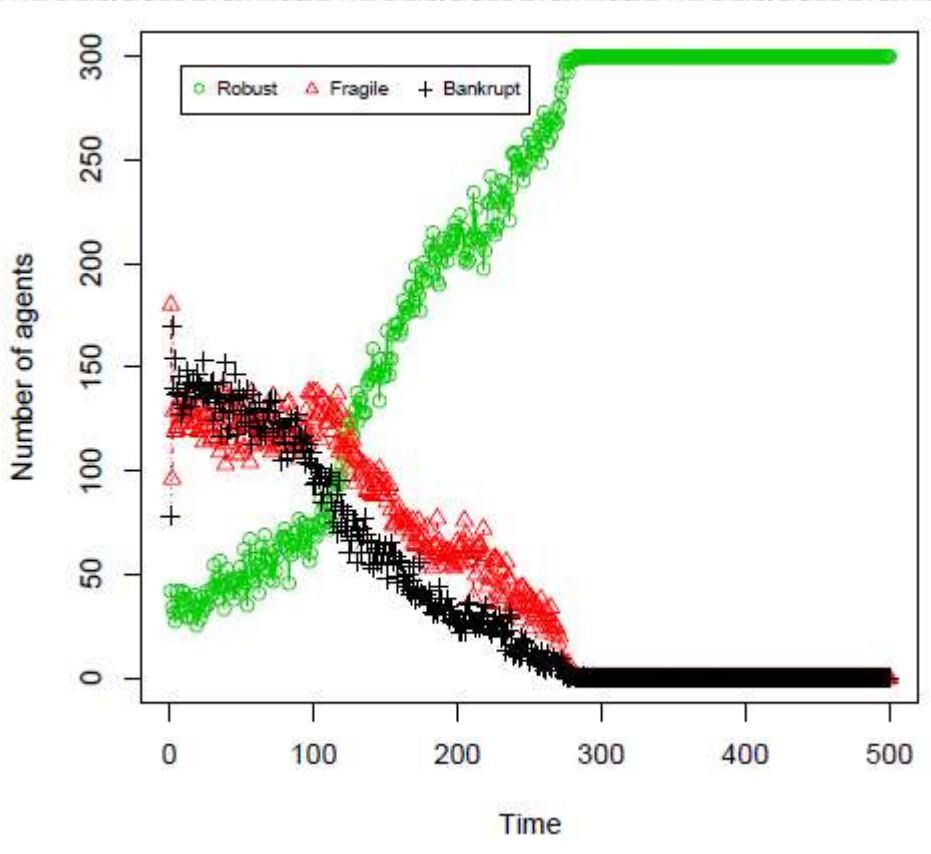
RB markets become concentrated sooner





Concentrated markets become RB later





Conclusions

- Technological development makes the market (more) robust
- Ceteris paribus, a robust market with technological development becomes concentrated sooner
- Ceteris paribus, a market where innovation is more common than imitation becomes robust sooner

Thank you for your attention!