Stabilization Policies, Technological Diffusion and Economic Growth: An agent-based Analysis

Herbert Dawid, Philipp Harting,
Sander van der Hoog
(with Simon Gemkow, Michael Neugart)
Bielefeld University

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Overview

- Intro
- The Eurace@Unibi Model
- Business Cycle Mechanisms and Stylized Facts
- Effects of Fiscal Stabilization Policy
- Conclusions

Motivation

- Controversial discussion in the literature concerning the long term effects of stabilization policies (see e.g. Priesmeier & Stähler, 2011):
  - Schumpeter hypothesis of creative destruction: Positive relationship of volatility and output.
  - 'Learning by doing' hypothesis: Negative relationship between volatility and growth.
- Majority of theoretical studies makes *ex-ante* choices to follow one of the two hypotheses.
- Concentration on growth rate effects typically blacks out distributional effects of stabilization policies.

This paper..

- considers the effect of fiscal stabilization policy in a model capturing the endogenous dynamics of the technological frontier, of the diffusion of technologies and of the learning by doing effects.
- separates the effects of stabilization policies under endogenous and exogenous technological frontier dynamics.
- analyses the effects for firms with different properties, in particular firm size.

The Eurace@Unibi Model

- Closed macroeconomic Agent-Based model substantially extending the model developed during the EU-funded project EURACE (2006-2009).

- **Overall Objective of the EURACE Project:**
  - Develop an agent-based simulation platform that is suitable for (macro)economic analysis and the evaluation of the effect of economic policy measures.

Main features of the Eurace@Unibi model

- Agents: Firms, Households, Banks, (Central Bank)

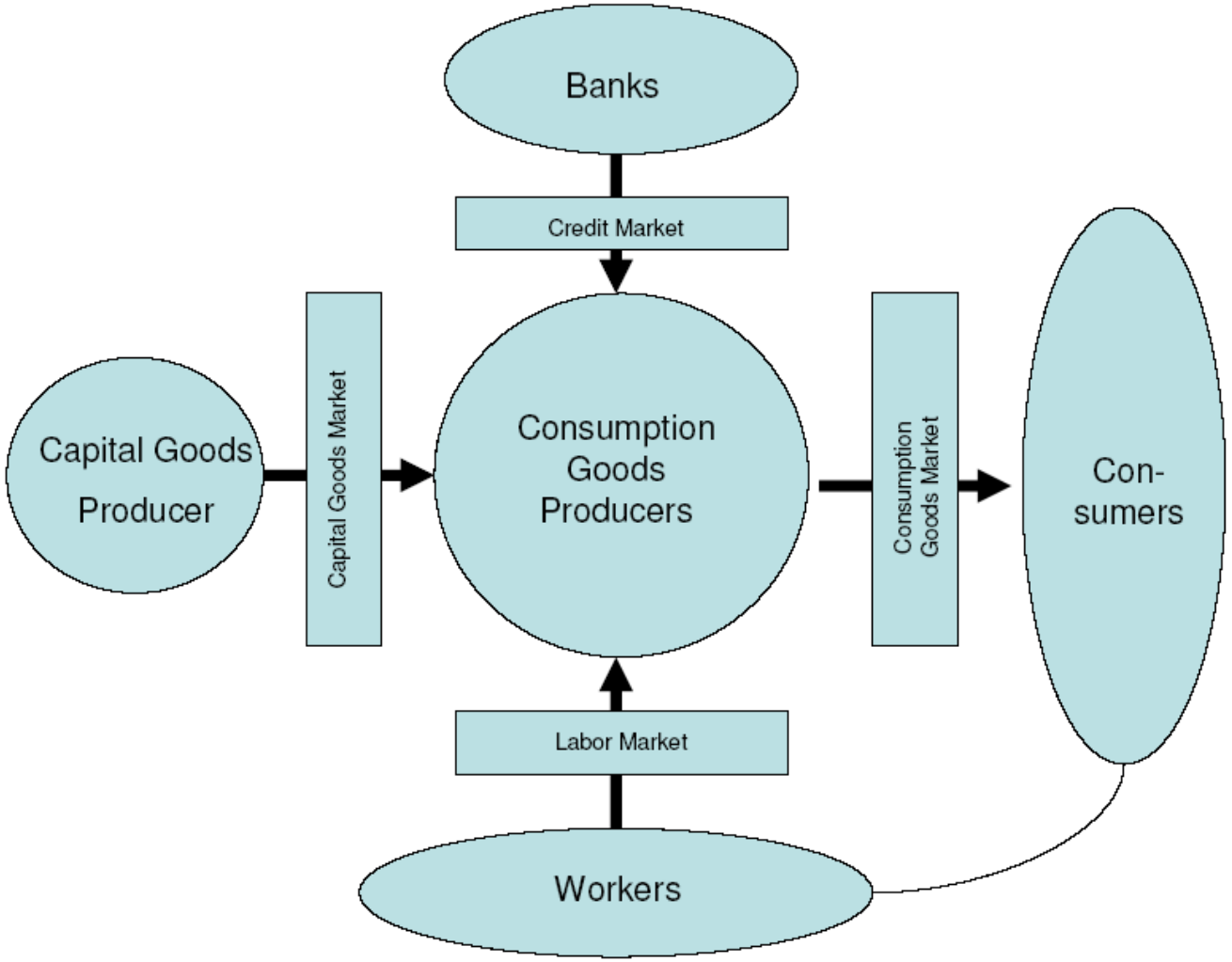
- Description of crucial aspects of the dynamic interplay between
  - labor markets (skill dynamics, (spatial) labor flows)
  - industry evolution (productivity change, technology diffusion)
  - credit markets (credit rationing, total debt dynamics)
  - consumption.

- Networks and geographical structure
  - Regions located on grid, agents assigned to regions
  - Distribution of agents and their characteristics might differ between regions

Main features of the Eurace@unibi model

- Strong micro-foundation of agents' behavior, basing decision rules on
  - relevant management literature
  - consumer behavior literature
  - experiments (ideally)
- Asynchronous decision making of individuals

Overview over the EURACE Model



The Model: Consumption Goods

- Consumption goods are produced using (vintage structured) capital and labor.

- Complementarity between quality of investment goods and level of specific skills of workers
  - Productivity of a given technology level is only fully exploited if workers in the firm have sufficiently high specific skills.

The Model: Consumption Goods

- If capital stock is not fully used, oldest vintages are made inactive first.

- Actual productivity of each vintage is determined by the (minimum of the) quality of the vintage and average skills of the firm's employees.

$$Q_{it} = \sum_{V=1}^{V_{\max}} \min\left[K_{i,t}^{V}, \max\left[0, L_{i,t} - \sum_{k=V+1}^{V_{\max}} K_{i,t}^{k} \right] \right] \min\left[A^{V}, B_{i,t} \right]$$

Technological Change and Diffusion

- Investment good producer (IGP) offers a range of investment goods with different quality (vintages), which are supplied at differentiated prices.
- New vintages with improved quality are added to the product range following stochastic innovation cycles.
- Innovation success probability depends on R&D effort of investment good producer.
- R&D effort is proportional to revenues of the IGP (Geroski & Walters, 1995).

Skill Dynamics

- Specific skills of workers increase due to learning by doing if they are employed:

$$b_{w,t+1} = b_{w,t} + \chi(b_w^{gen})\max[(A_{it} - b_{w,t}),0]$$

- $\chi(b_w^{gen})$: learning speed depending on general skill of worker

- (Local) knowledge flows and spillovers through the labor market.
  - Workers transfer specific skills when changing employer.

Technology Diffusion and Vintage Choice

- Diffusion of new technologies depends on the investment activities of consumption goods producers (CGP) and their vintage choice.

- When investing a CPG chooses a vintage according to a logit choice model based on estimated future productivity of the vintage over a planning horizon (depends on the skills of the firm's employees; see Piva & Vivarelli, 2009).

Consumption Goods Market

- Consumption goods producers offer (and store) goods at market outlets (‚*malls*‘) at posted prices.
- Once every year CGPs adjust prices (based on profit oriented pricing rules reyling on *simulated purchase surveys, see Nagle & Hogan, 2006*)

  -> endogenous mark-ups.
- Once every month CGPs decide on quantities to be delivered to the mall (based on standard OM heuristics relying on estimates of the demand distribution)

Consumption Goods Market

- When visiting a mall a consumer collects randomly selected information about prices and inventories of producers serving that mall. Purchasing decision is modelled using a logit approach.

-> intensity of competition between CGPs is governed by intensity of choice parameter of consumers

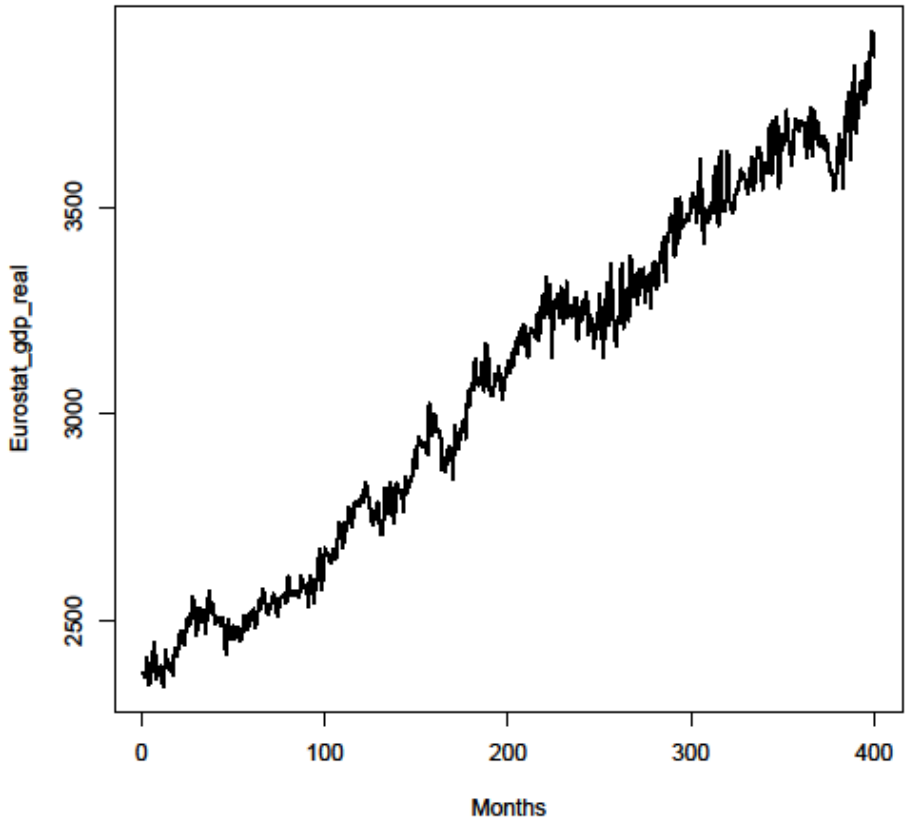
Government

- Collects income tax
- Pays out unemployment benefits
- Might implement policies affecting fiscal and general economic conditions:
  - stabilizing fiscal policies inducing net income smoothing of HHs over time
  - changing commuting costs
  - altering general skill distributions
  - changing regulations for banks

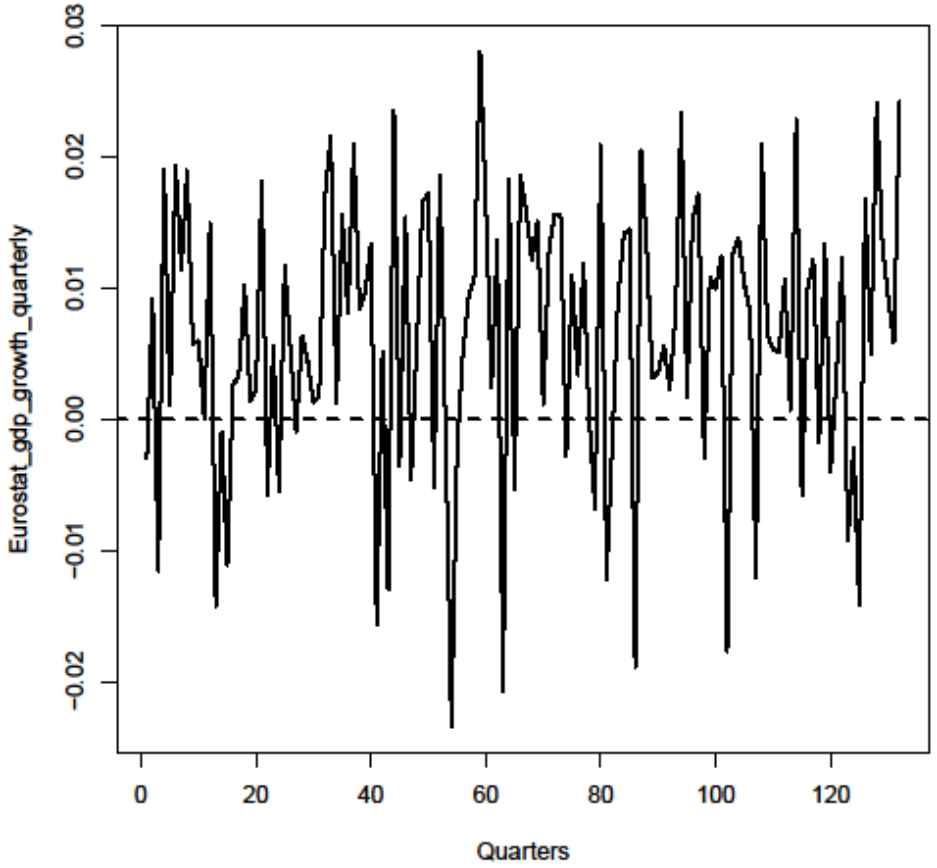
Some Technical Issues

- Macroeconomic indicators like GDP, Price-Indices,… are generated by aggregation over individual agents corresponding to procedures of (national) statistical offices (‚EUROSTAT Agent‘)
- Closedness of the model is ensured through the use of balance sheets for all agents.
- The Model is implemented in FLAME (Flexible Large Scale Modelling Environment)

Some Dynamic Properties and Stylized Facts



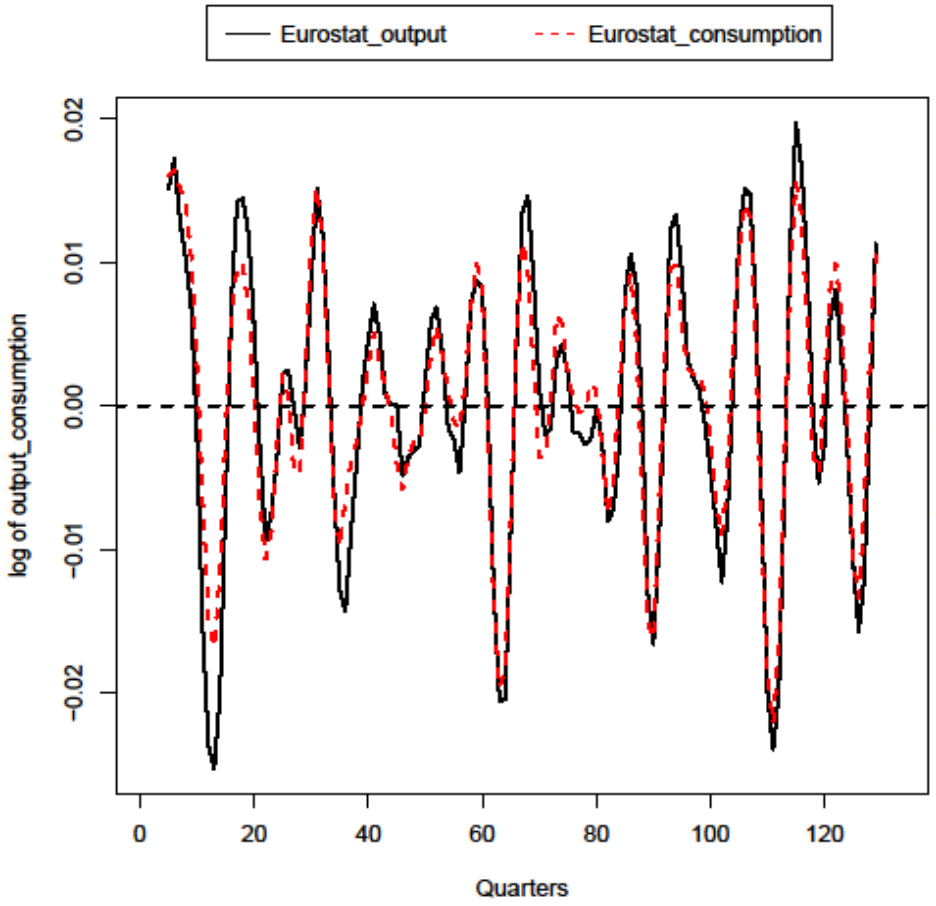
GDP



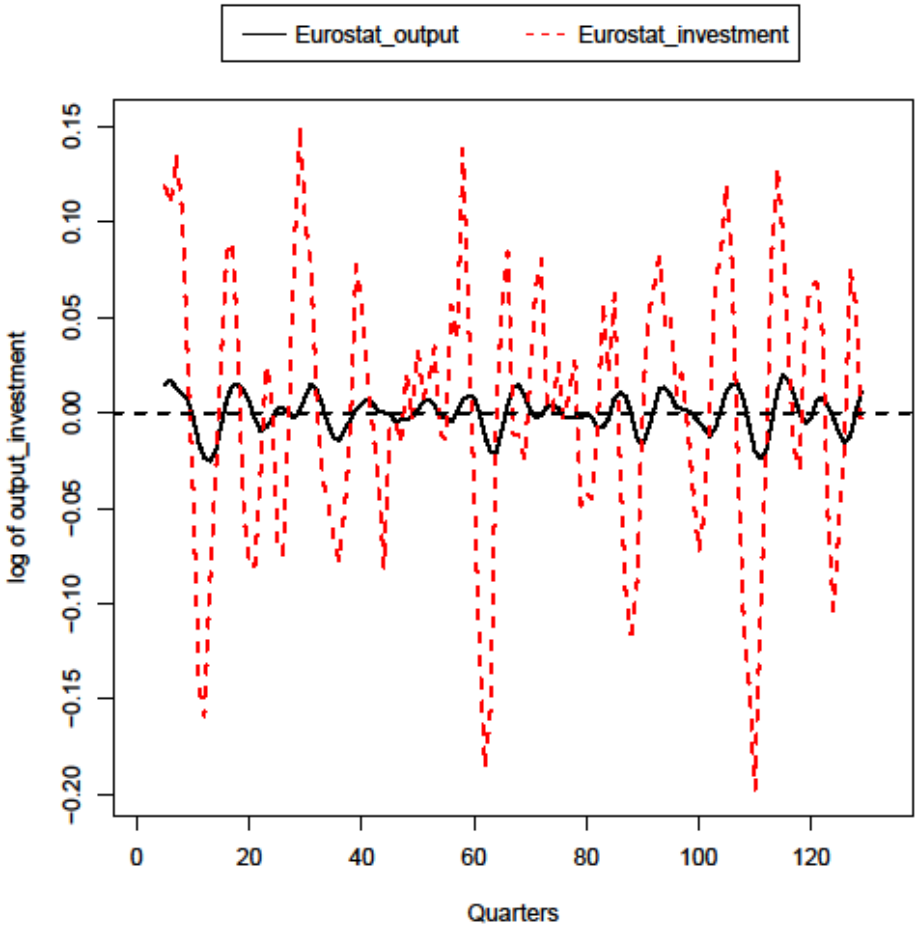
GDP Growth

Dynamic Properties and Stylized Facts

Bandpass filtered:

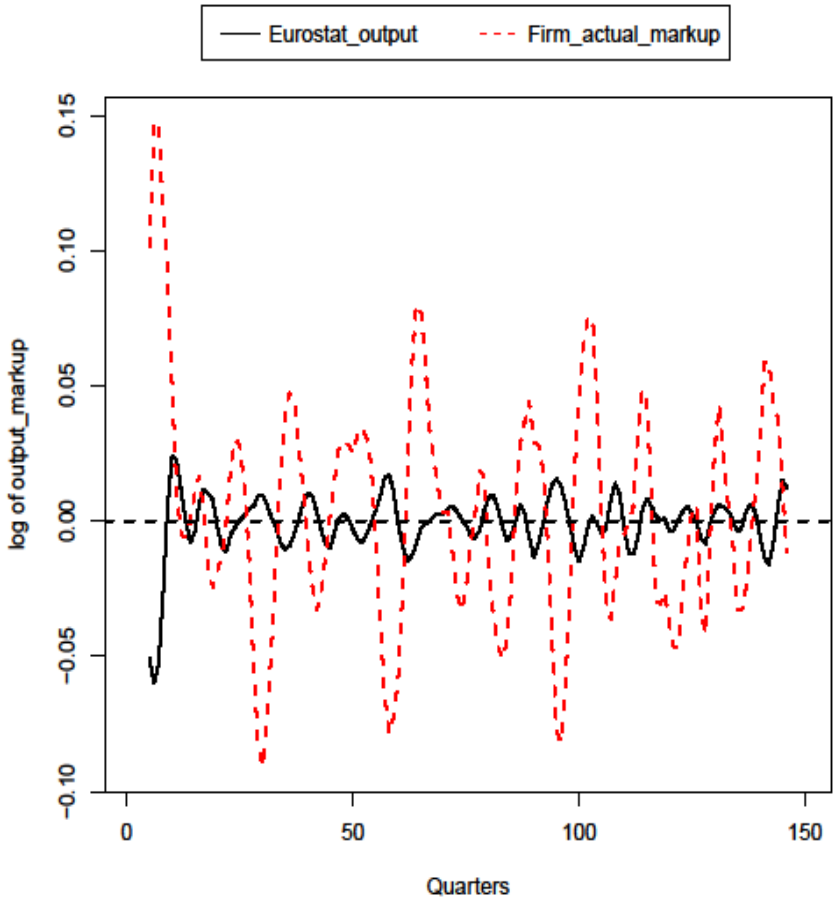


Output/Consumption

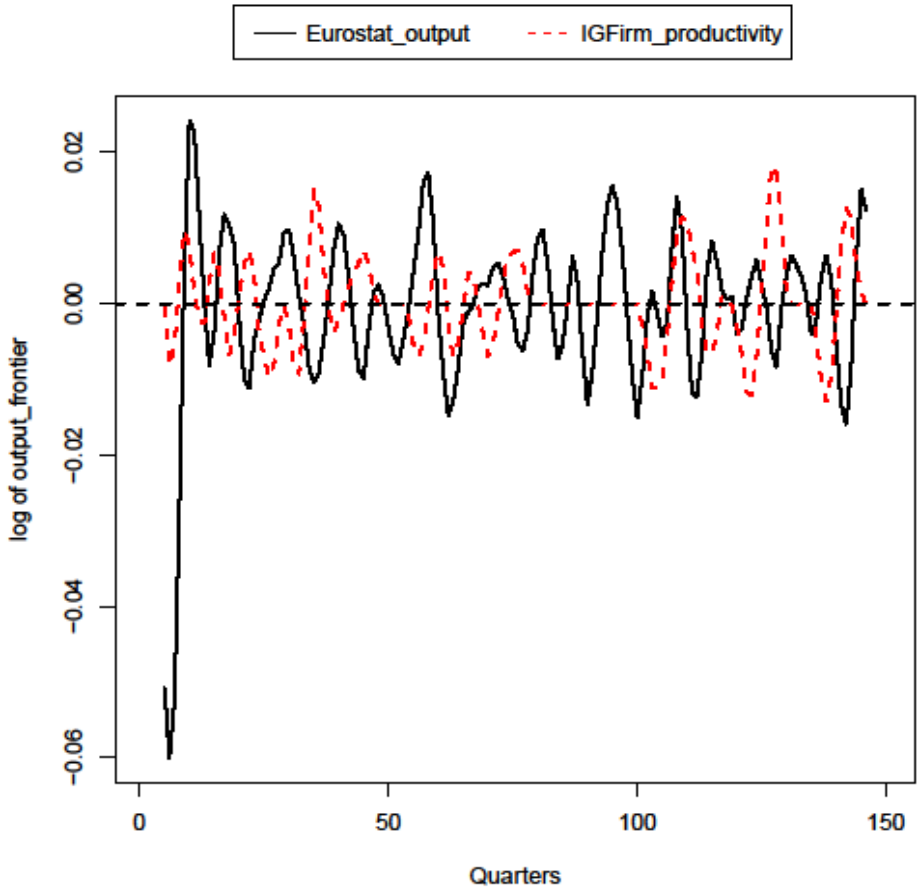


Output/Investment

Dynamic Properties and Stylized Facts

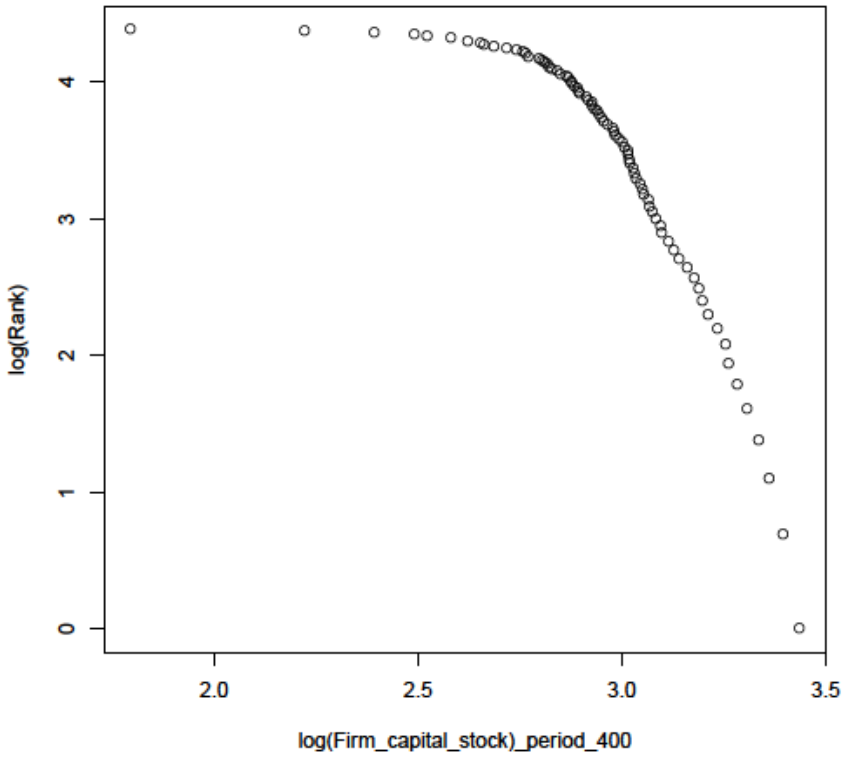


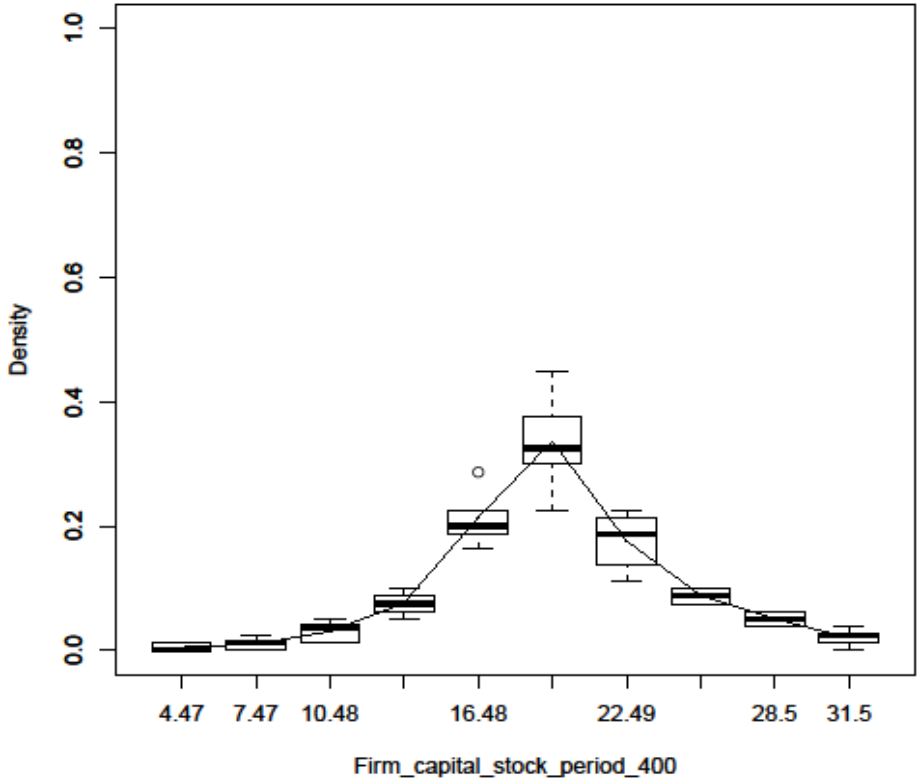
Output/Markup



Output/Technological Frontier

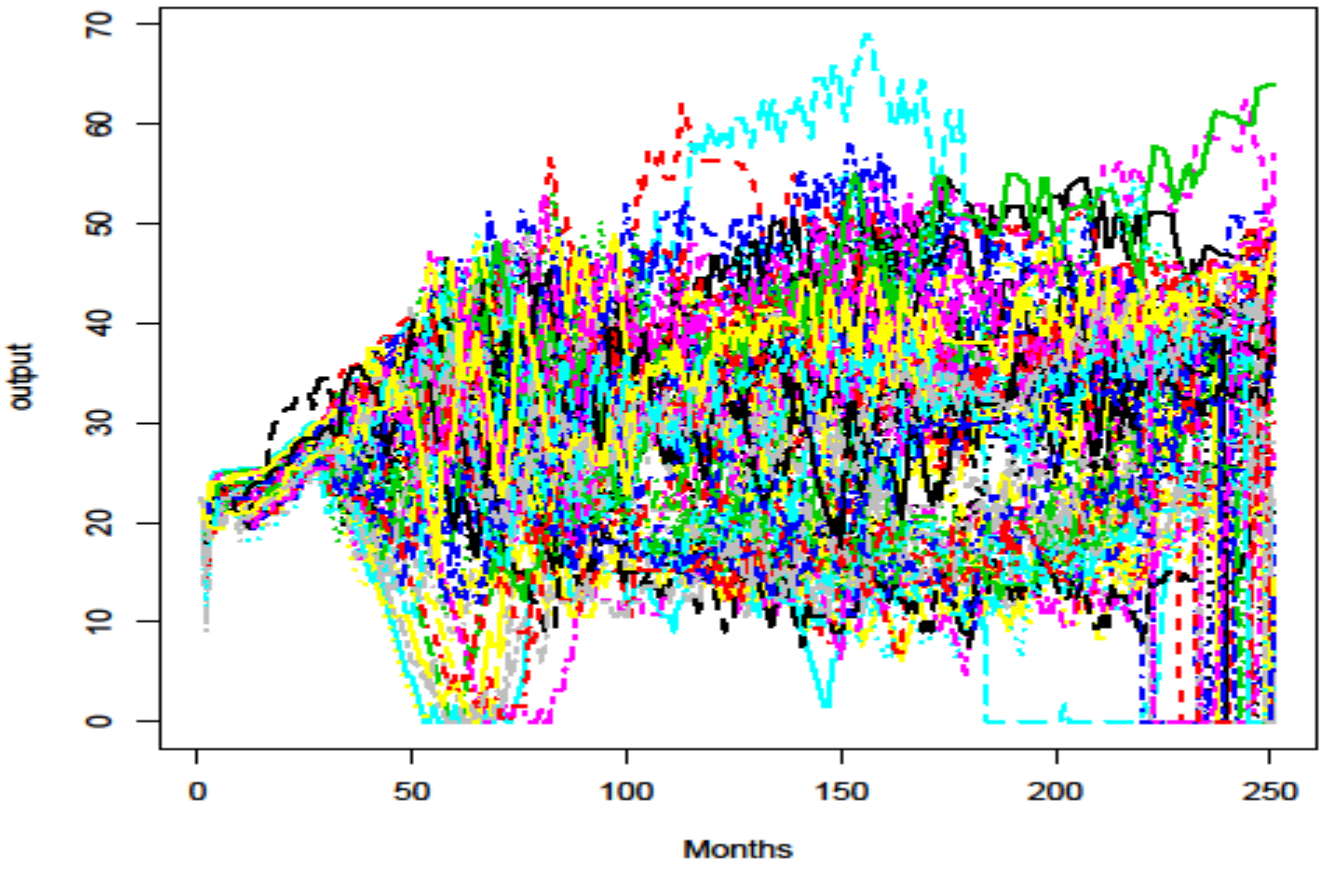
Dynamic Properties and Stylized Facts





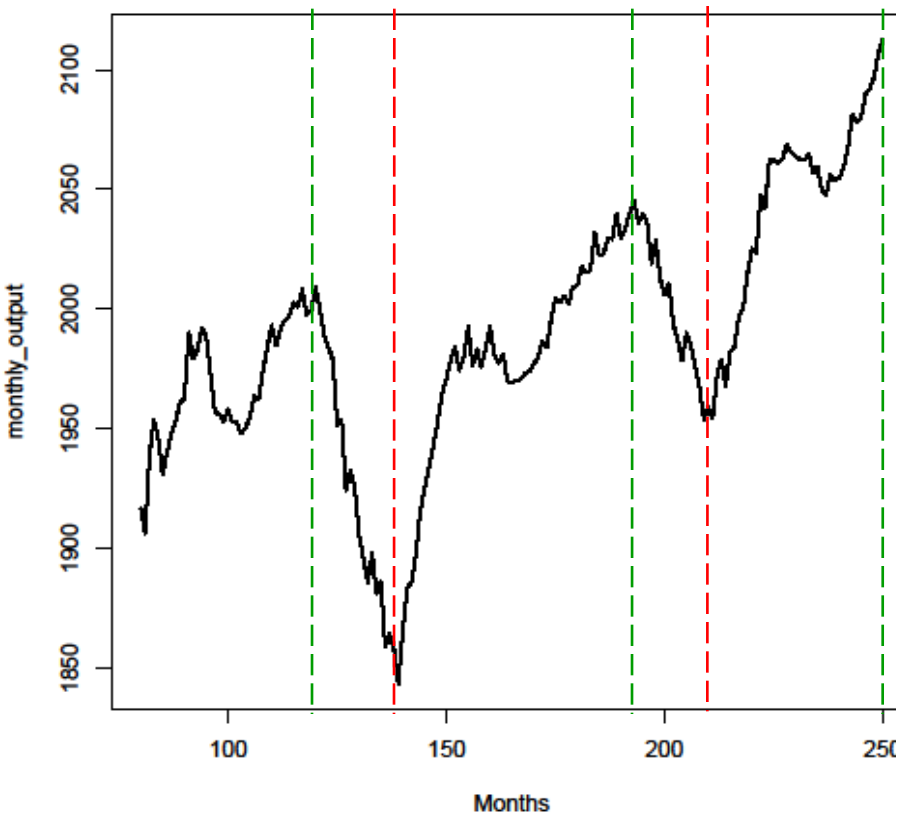
Firm Size Distribution

Dynamic Properties and Stylized Facts

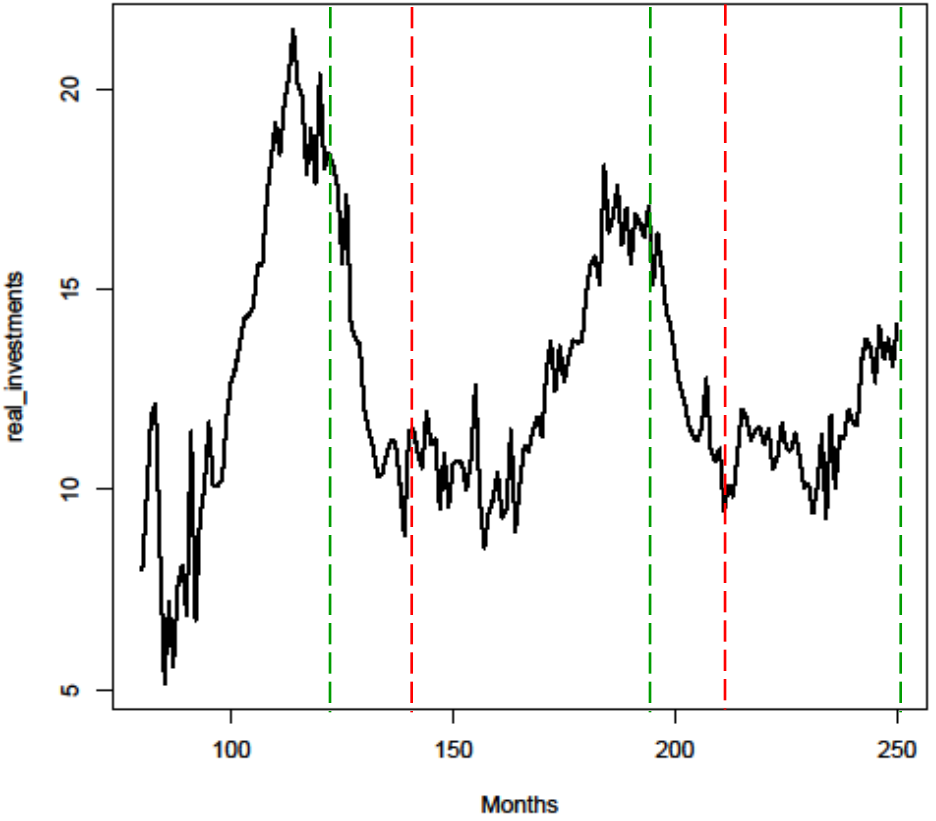


Dynamics of Individual Firm Output

Business Cycle Mechanisms

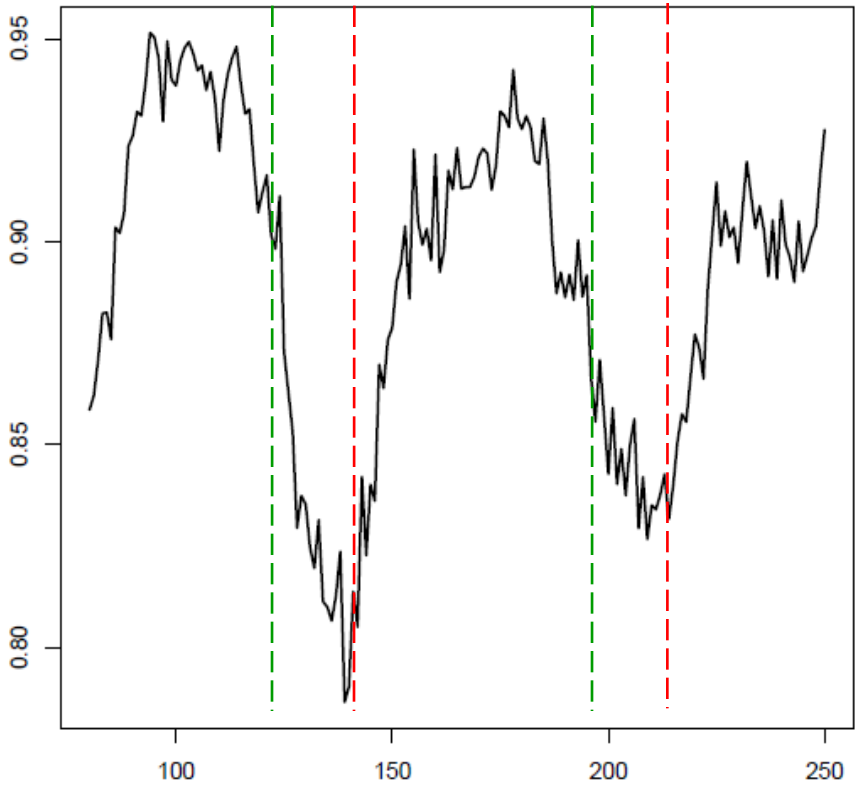


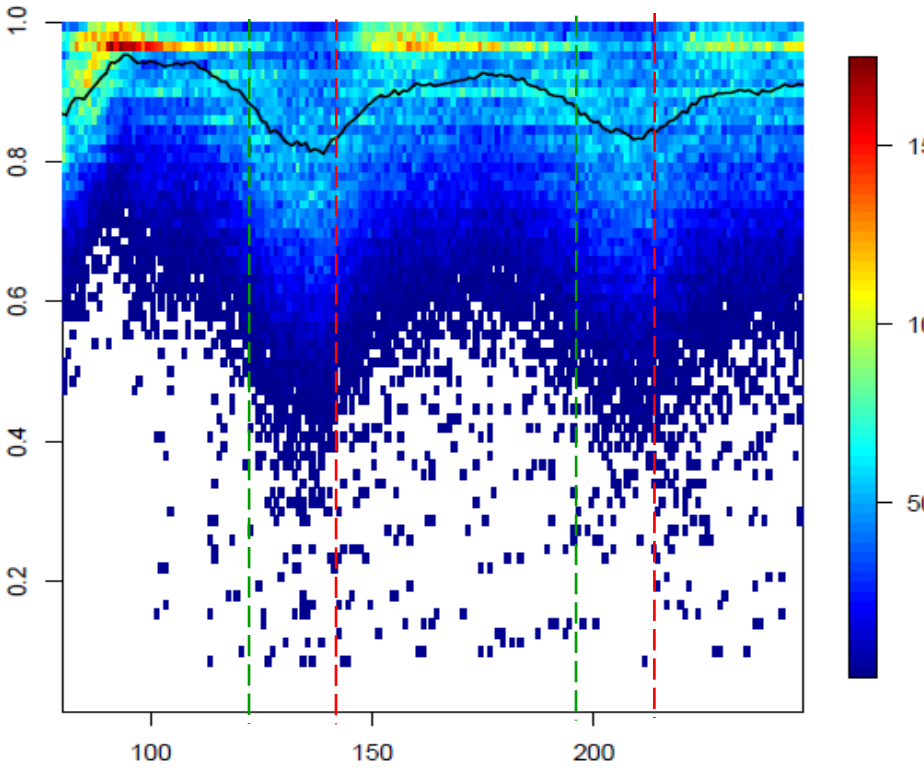
Output



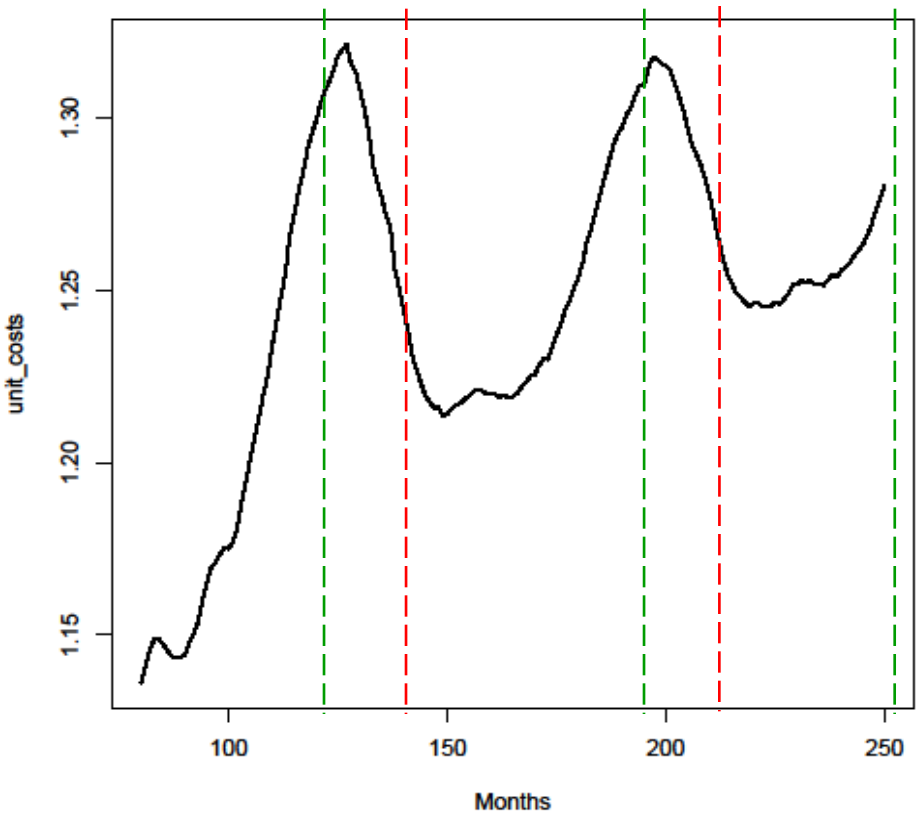
Investment

Capacity Utilization

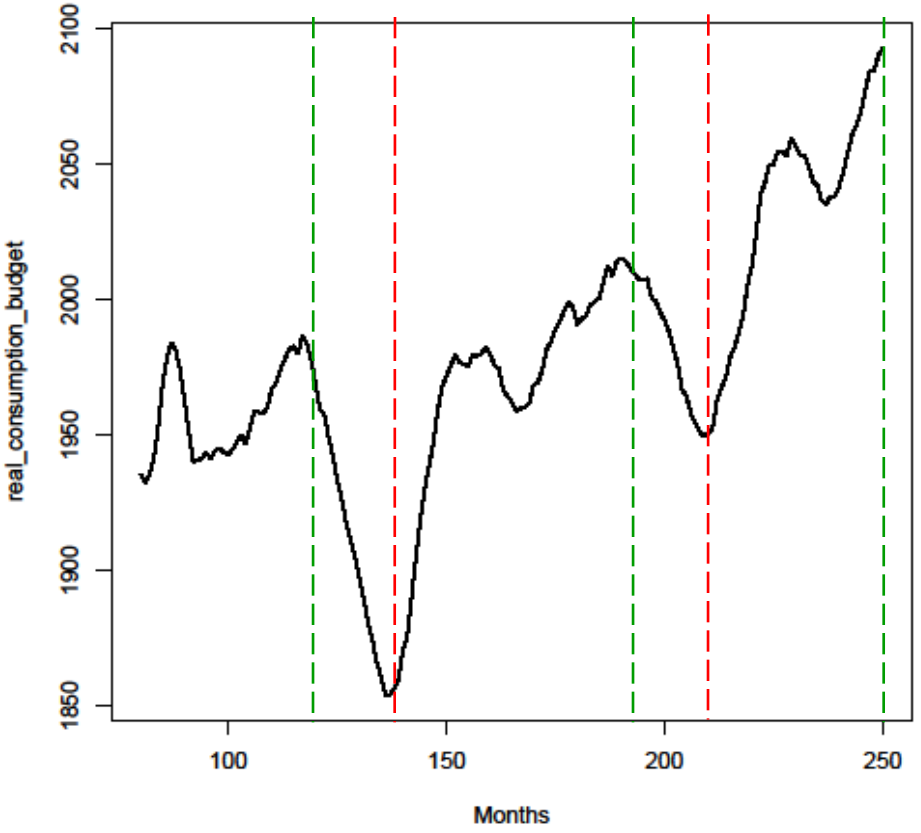




Business Cycle Mechanisms

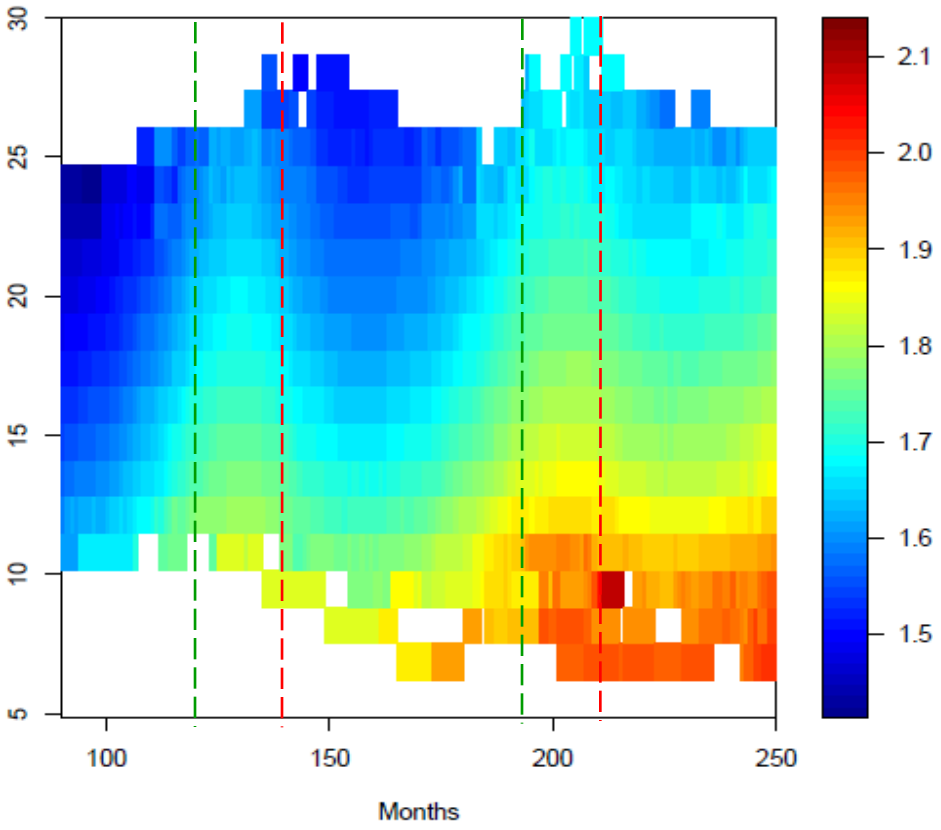


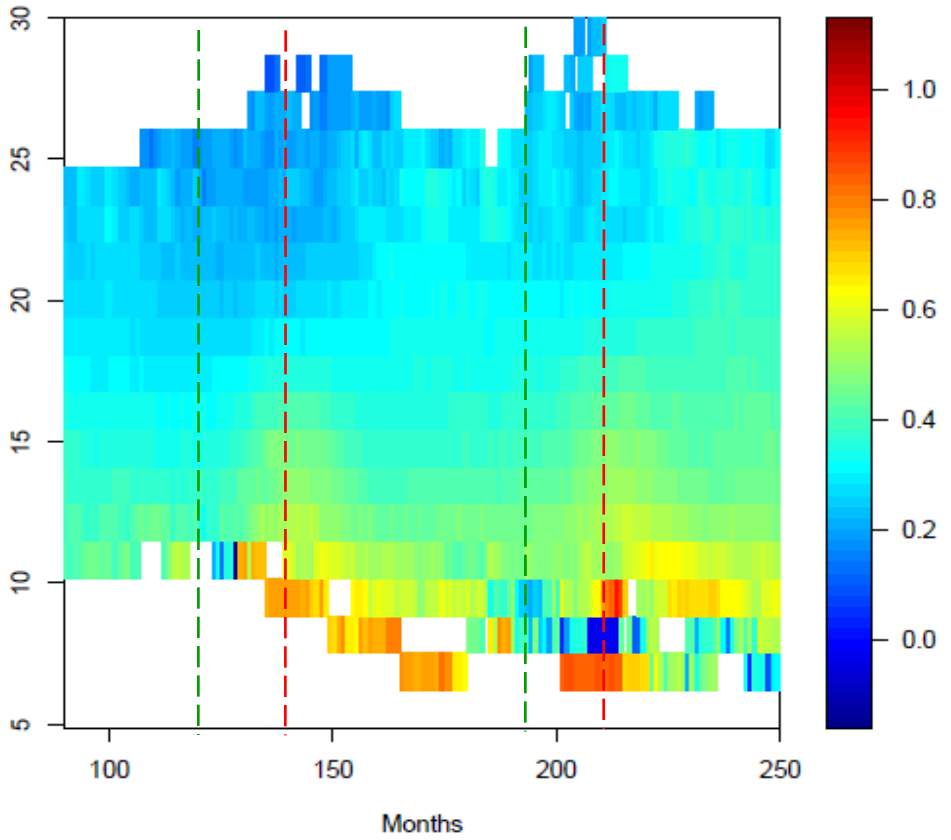
Unit Costs



Real Consumption Budget

Firm Size, Prices and Mark-Up



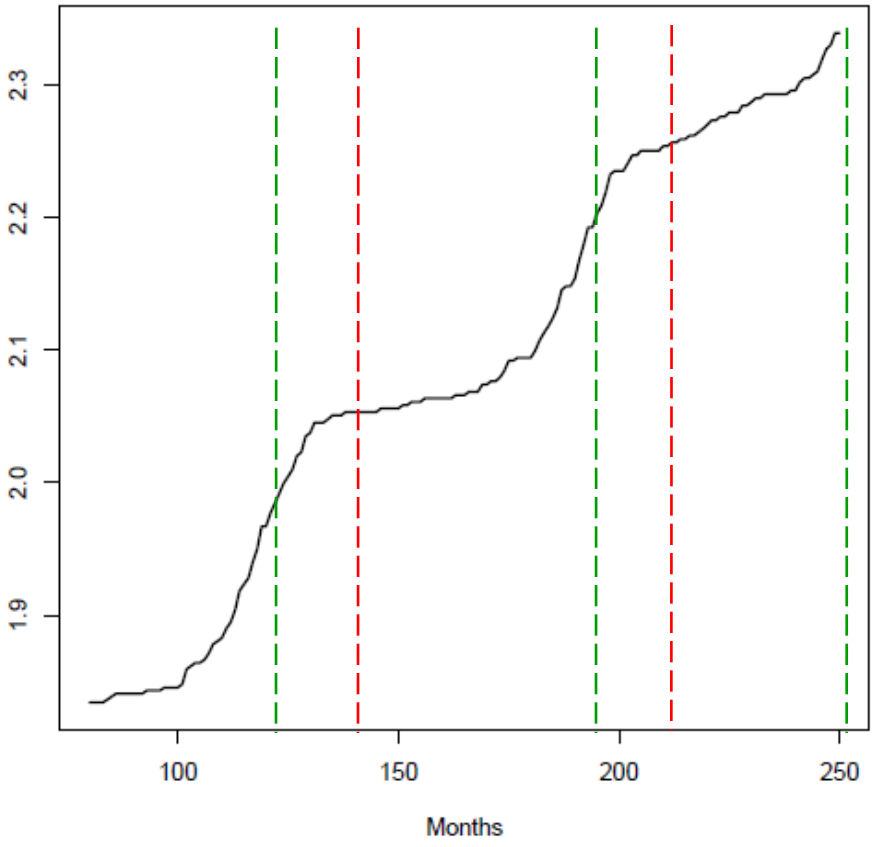


Colour Code: Price

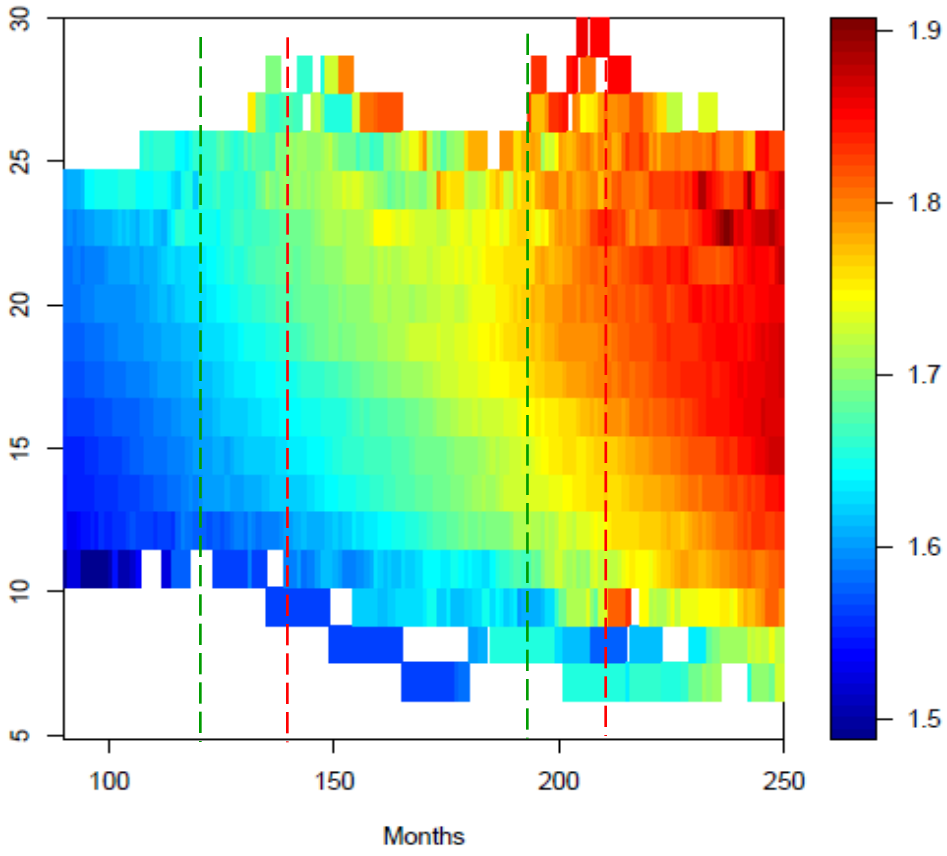
Mark-Up

Horizontal axis: capital stock

Firm Size, Technology

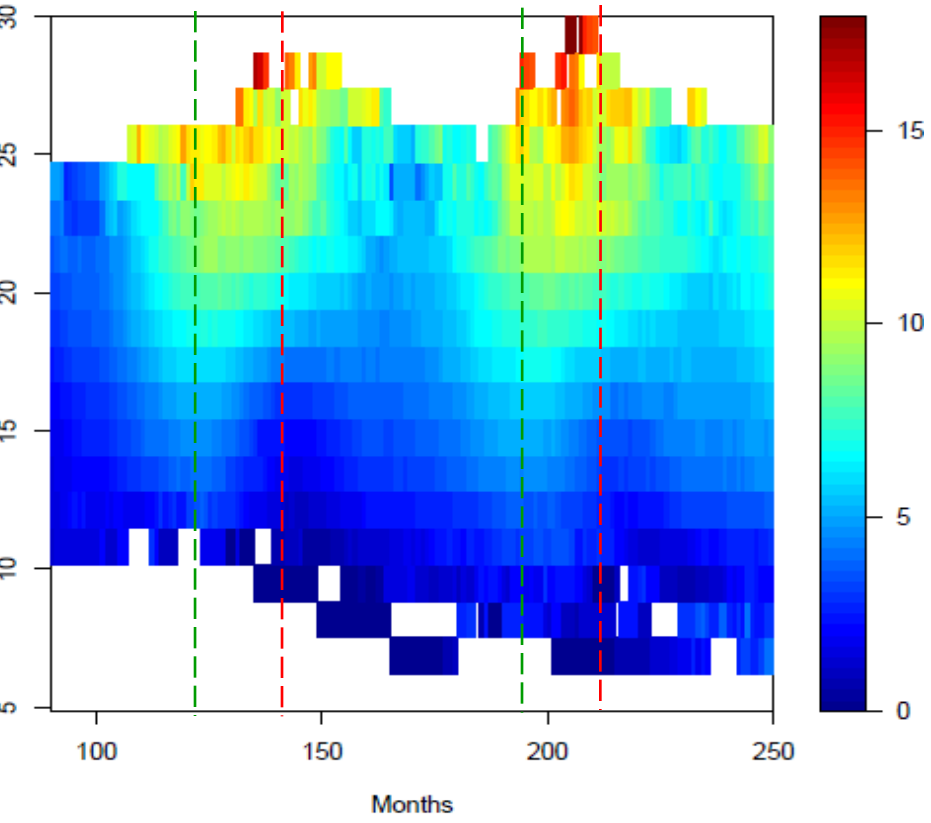


Frontier

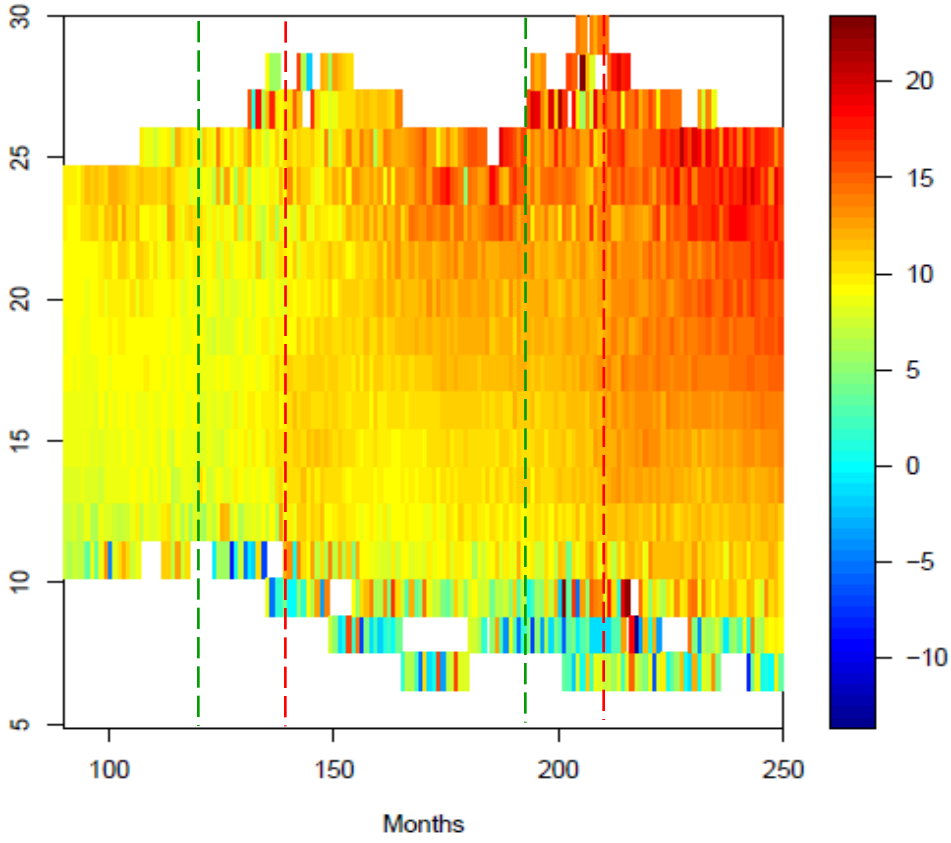


Quality of Capital Stock

Firm Size, Costs and Profits



Capital Costs/Unit



Profits

Policy Experiment: Fiscal Stabilization

- Income of households stemming from investment goods sector is smoothed (running average over 18mos)
- Proxy for automatic fiscal stabilizers
- No direct effect on accumulated governmental deficit/surplus.

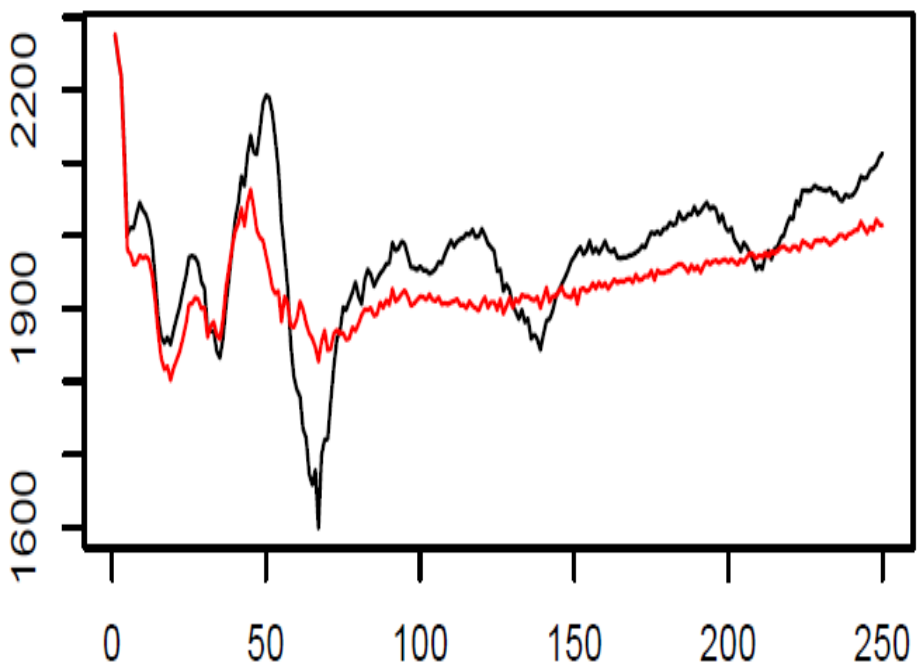
Policy Experiment: Method

- Batches of 20 runs with and without policy
- Isolation of (dynamic) policy effects on key variables using penalized spline models.

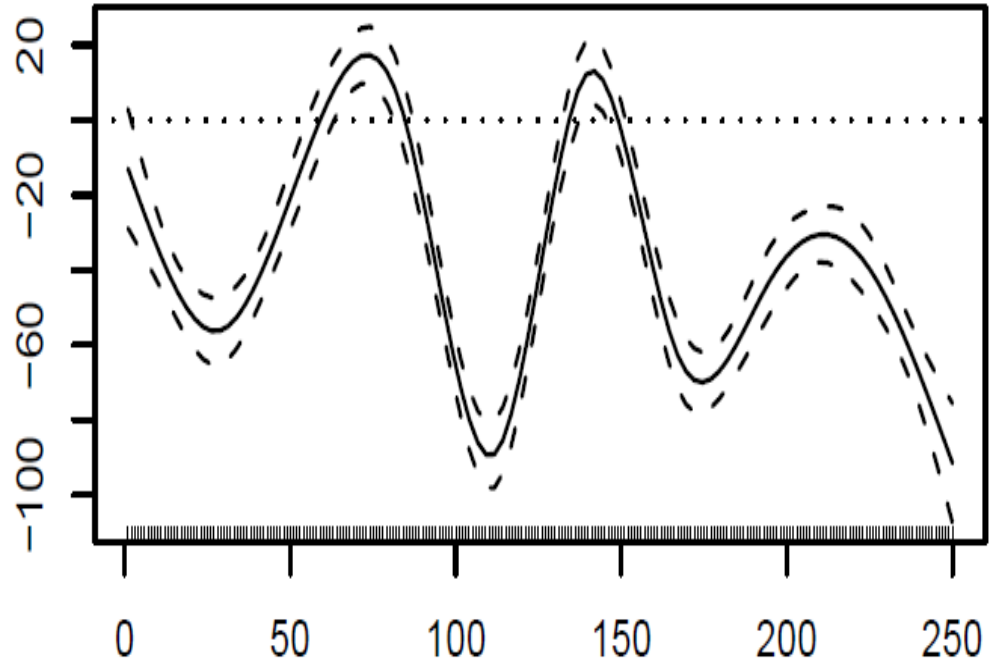
As a second step:

- Neutralization of the frontier effect by running batches w. and w/o policy under an exogenous frontier.

Effect on Output

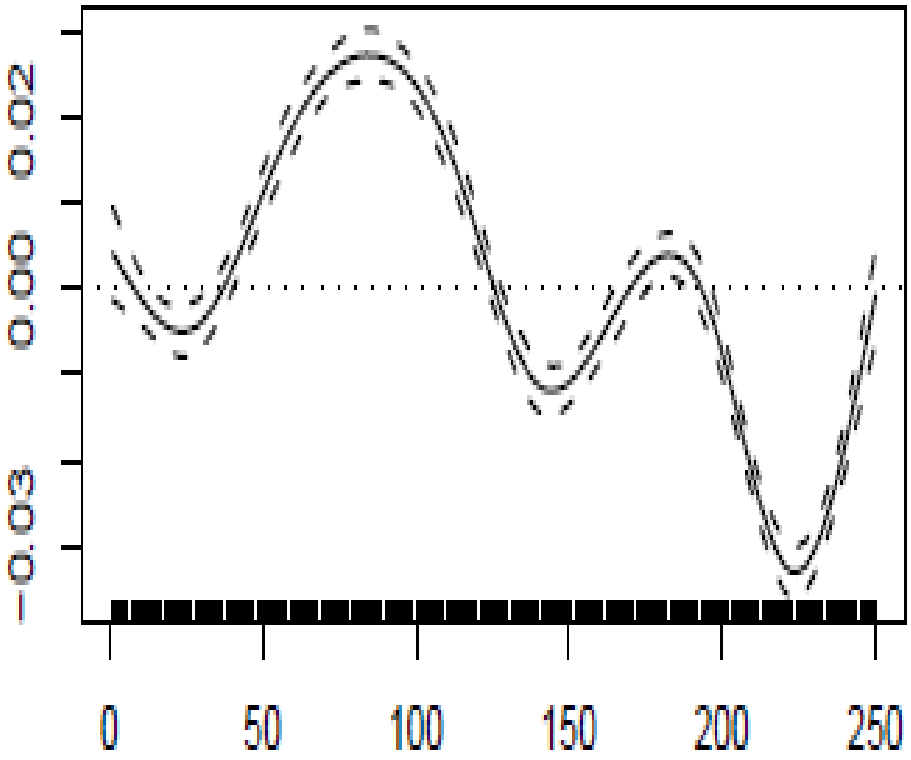


Monthly Output

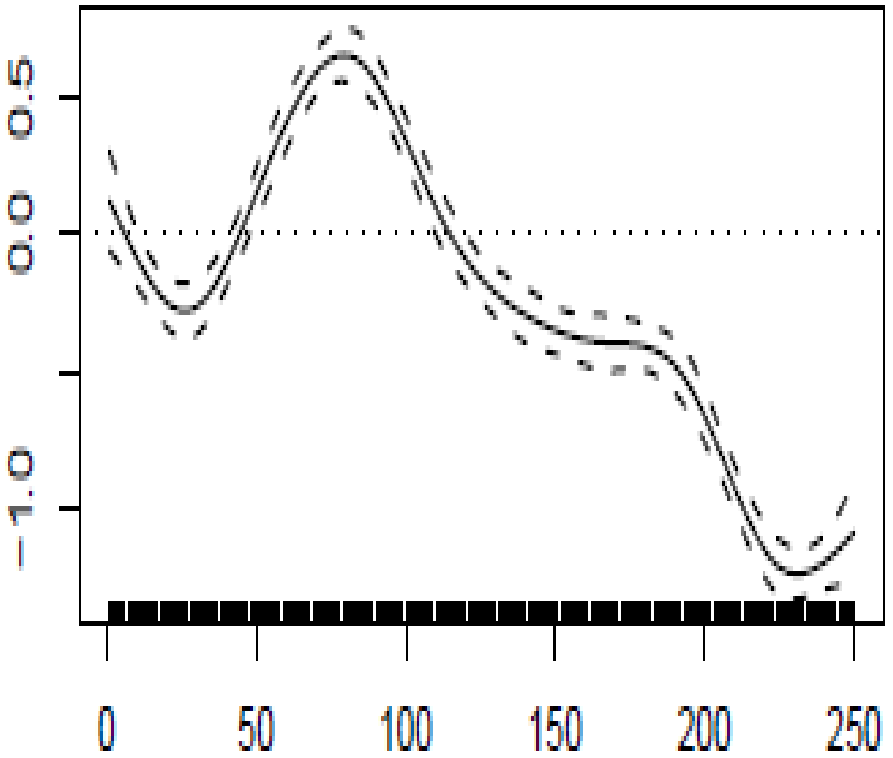


Isolated Policy Effect

Effect on Firm Profitability

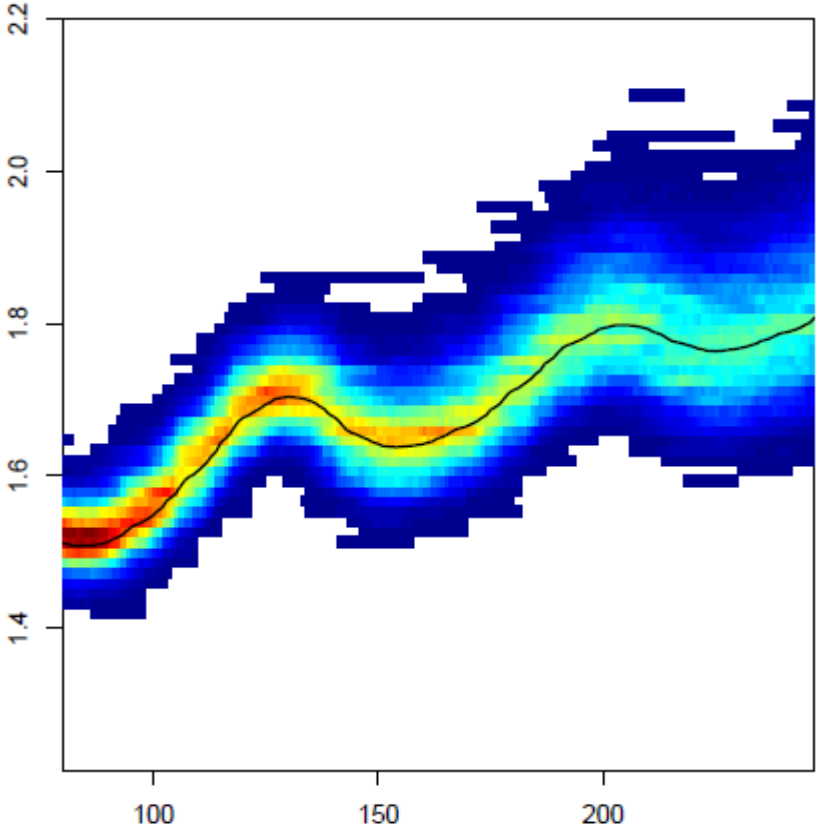


Mark-Up

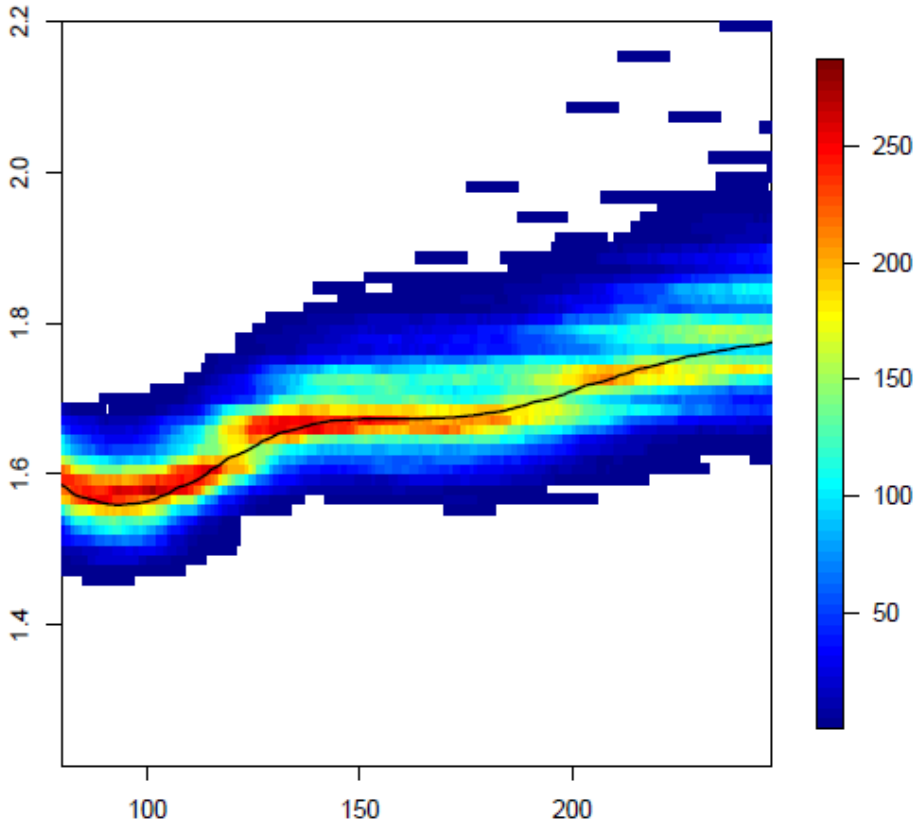


Profits

Effect on Prices and Competition

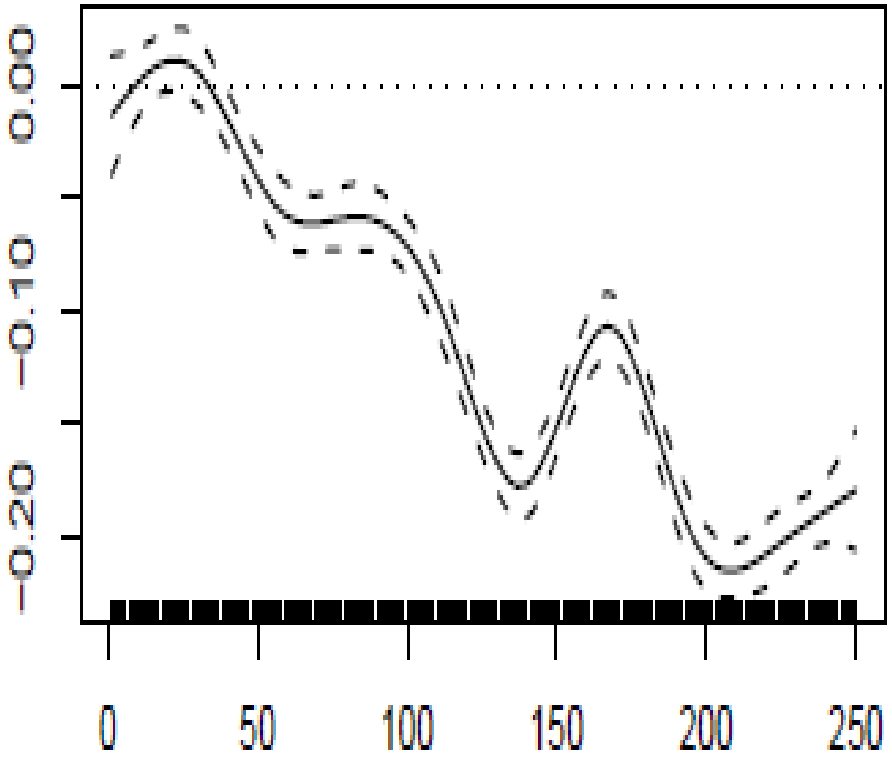


No Policy

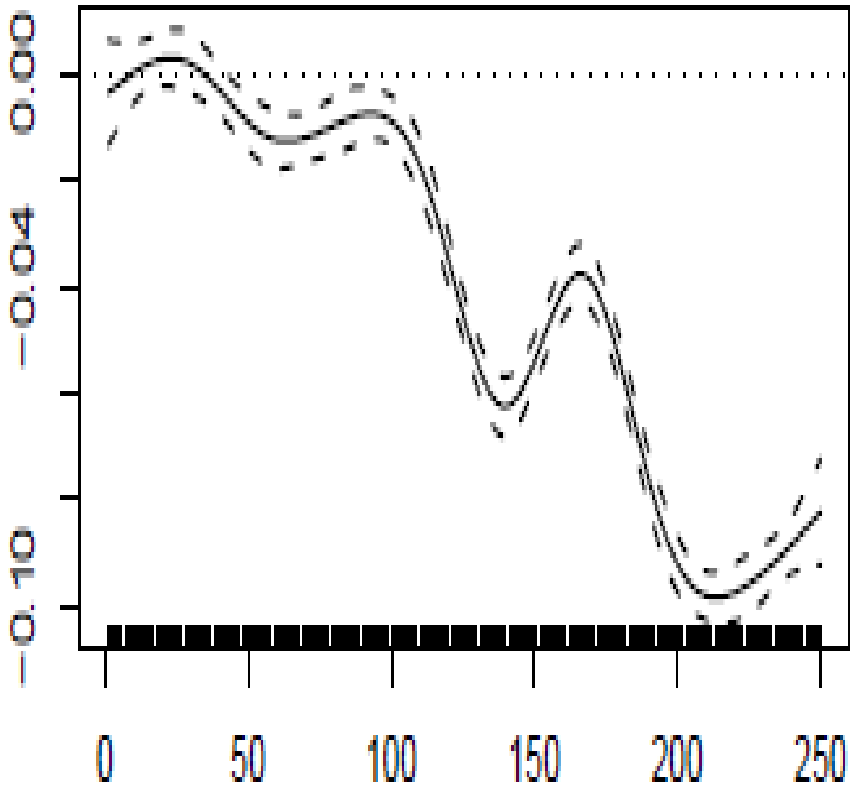


Policy

Effect on Technological Change

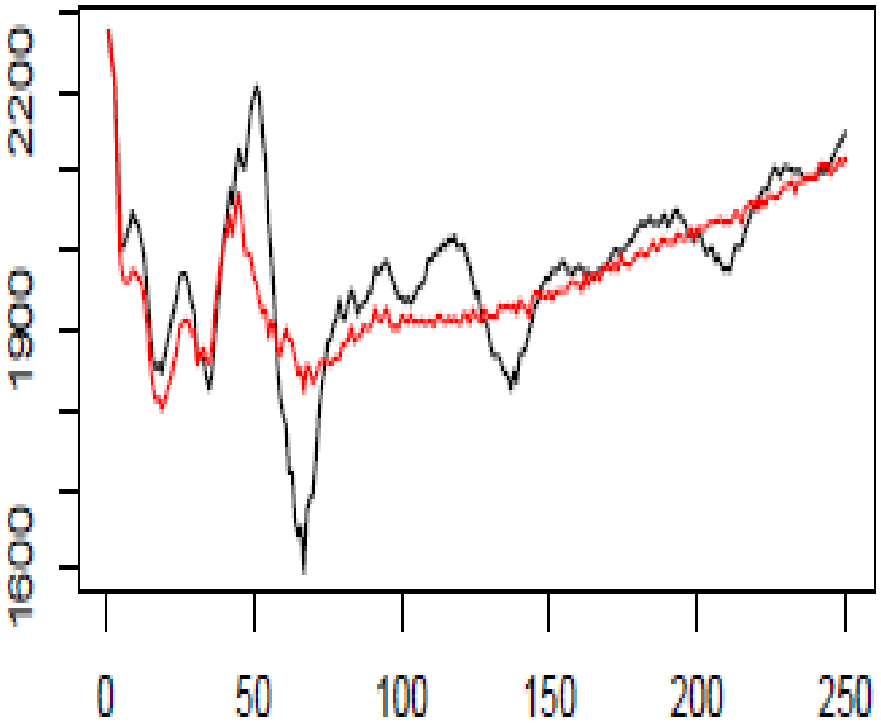


Frontier

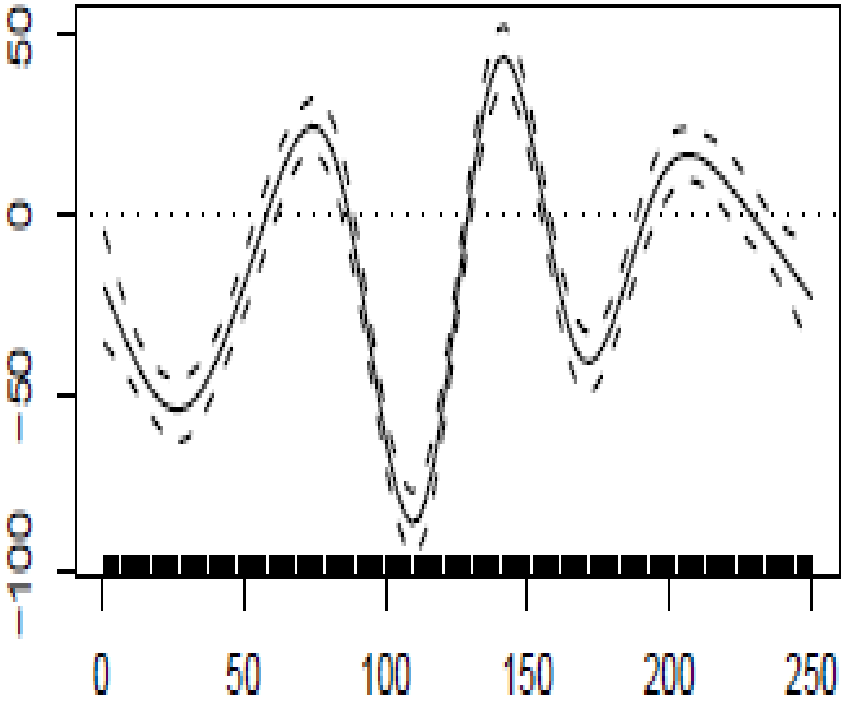


Quality of Capital Stock

Policy Effect with Exogenous Frontier

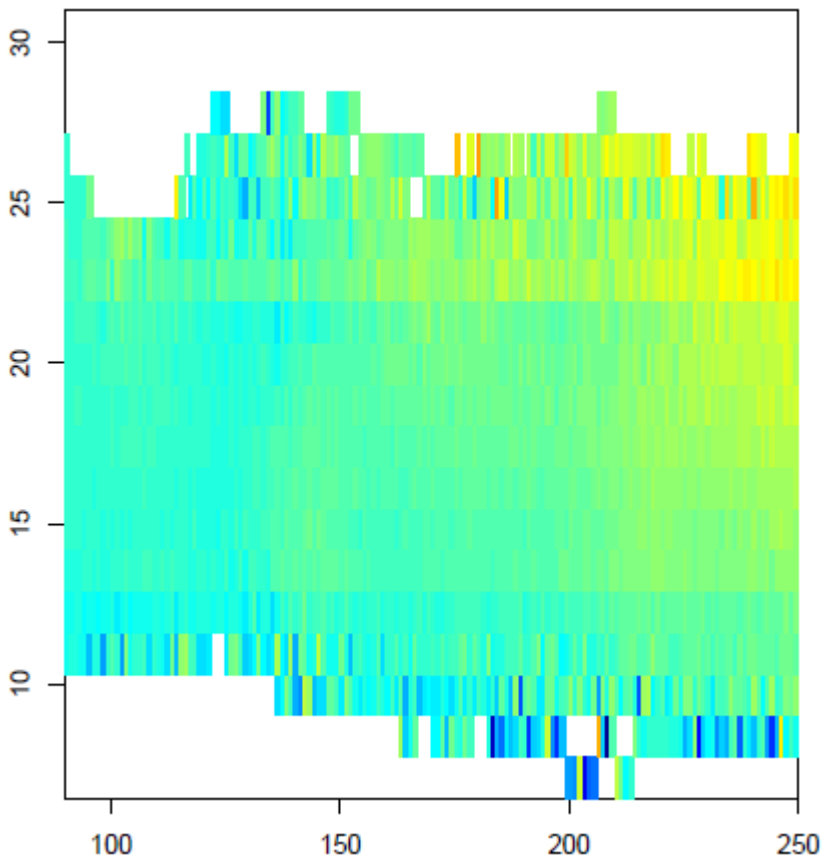


Monthly Output

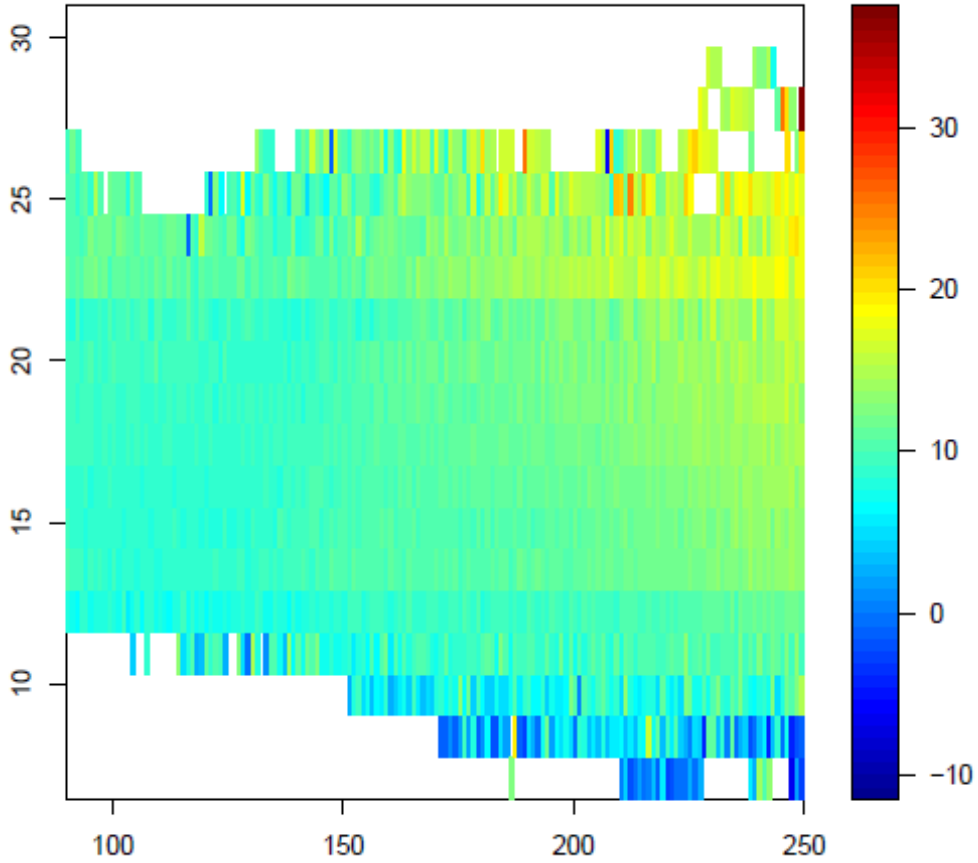


Isolated Policy Effect

Firm Size and Profits (Exog. Frontier)



No Policy



Policy

Conclusions

- Model reproduces a large set of stylized business cycle facts including an explanation for counter-cyclical mark-ups.
- Effects of business cycle on costs, markups, profits varies qualitatively between firms of different size.
- With an endogenous frontier fiscal stabilization policies have negative effects on the growth rate due to a Schumpeterian effect reinforced by demand feedbacks.

Conclusions

- With an exogenous frontier fiscal stabilization policies has no significant effect on the overall growth rate.

- Also with exogenous frontier policy seems to have negative effect on small firm profits.

Thank you for your attention!

Information about Eurace@unibi
and a (very recent) extensive model
documentation at:

http://www.wiwi.uni-bielefeld.de/vpl1/projects/eurace/eurace-unibi.html/

Related Papers

- **Dawid, H., Gemkow, S., Harting, P. and M. Neugart (2011)**, 'Labor market integration policies and the convergence of regions', forthcoming Journal of Evolutionary Economics
- **Dawid, H. and P. Harting (2011),** "Capturing Firm Behavior in Agent-Based Models of Industry Evolution and Macroeconomic Dynamics", forthcoming in G. Bünsdorf (Ed.), "Applied Evolutionary Economics, Behavior and Organizations", Edward-Elgar.
- **Dawid, H. and M. Neugart (2011),** "Agent-based Models for Economic Policy Design", Eastern Economic Journal, 37, 44-50.
- **Deissenberg Ch., van der Hoog, S., 2010**, Energy Shocks and Macroeconomic Stabilization Policies in an Agent-based Macro Model. In: H. Dawid and W. Semmler (Eds.), 'Computational Methods in Economic Dynamics', Springer: Berlin.
- **Dawid, H., Gemkow, S., Harting, P., Neugart M., (2009),** 'Spatial Skill Heterogeneity and Growth: An Agent-Based Policy Analysis', Journal of Artificial Societies and Social Simulation 12 (4) 5.
- **Deissenberg, C., van der Hoog, S. and Dawid, H. (2008),** 'EURACE: A Massively Parallel Agent-based Model of the European Economy', Applied Mathematics and Computation, 204, 541-552.
- **Dawid, H., Gemkow, S., Harting, P., Kabus, K., Neugart, M. and Wersching, K. (2008)**, 'Skills, innovation, and growth: An agent-based policy analysis', Journal of Economics and Statistics, 228, 251-275.
- **Dawid, H., Deissenberg, C. and Van der Hoog, S. (2008),** "Production and Finance in EURACE" in K. Schredelseker, F. Hauser (Eds.), Complexity and Artificial Markets, Springer, pp. 147 - 158

Statistical treatment of dynamic effects of policy measures

- Scenarios are designed where different policy measures are implemented/not implemented (p(i) = 1/0)
- Batches of simulation runs are carried out for each scenario.
- For each consdiered type of economy dynamic impact of policies and interaction effects are estimated using penalized spline methods:

$$GDP_{tpi} = s(t) + I_{[p(1)=1]}s_1(t) + I_{[p(2)=1]}s_2(t) + I_{[p(1)=p(2)=1]}s_{12}(t) + \varepsilon_{t,p,i}$$