Appropriate Macroeconomic Policies for Complex Economies

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The Great Recession and the Current Policy Debate

- **Finance and the Real Dynamics**:
  - credit crunch and the financial accelerator reduce aggregate demand and output
  - huge bail-out costs
  - higher public deficits and possible sovereign debt crises

- **Empirical literature**
  - impact of supply-side financial shocks on firms' investment (Amiti and Weinstein 2013)
  - empirical estimation of fiscal multipliers (e.g. Blanchard and Leigh, IMF 2013)
  - non-linear relation between fiscal policy and credit regimes (e.g. Ferraresi, Roventini and Fagiolo, 2013)

The policy response: austerity

- very fashionable in almost every country (e.g. Fiscal Compact)
- the myth of expansionary austerity (Alesina and Ardagna, 2009)
- thresholds in debt/GDP ratios (Reinhard and Rogoff, 2010)

- But, why such disastrous policies? Bad policies are inspired by misleading theory
- Indeed, the the economic crisis has also been the crisis of economic theory, even if a good deal of the profession has tried not to notice it.
- An alternative route. Design economic policies for complex economies composed of evolving heterogeneous interacting agents

Trichet (18/11/2010) "*The atomistic, optimising agents underlying existing models do not capture behaviour during a crisis period. We need to deal better with heterogeneity across agents and the interaction among those heterogeneous agents. Agent-based modelling dispenses with the optimisation assumption and allows for more complex interactions between agents*."

- Extend the Keynes+Schumpeter (K+S) Model (Dosi et al., 2010, 2013, JEDC) introducing heterogeneous banks
- Related Literature
  - Evolutionary Models (e.g. Nelson and Winter, 1982)
  - Multi-agent stochastic models (e.g. Kirman and co-authors)
  - propagation of bank failures in a network (Cincotti et al. (EURACE); Battiston, Delli Gatti, Gallegati and co-authors; Ashraf, Gershman and Howitt 2011, Lengnick et al 2012)
  - New-Keynesian models with asymmetric information (e.g. Greenwald and Stiglitz, 1993)
- **Role of credit in generating business cycles and crises, and in affecting long-run growth trajectories**
- **Endogenous and costly banking crises**
- **Interactions between fiscal and monetary policies**
- **Constraints on Government's ability to create deficits**

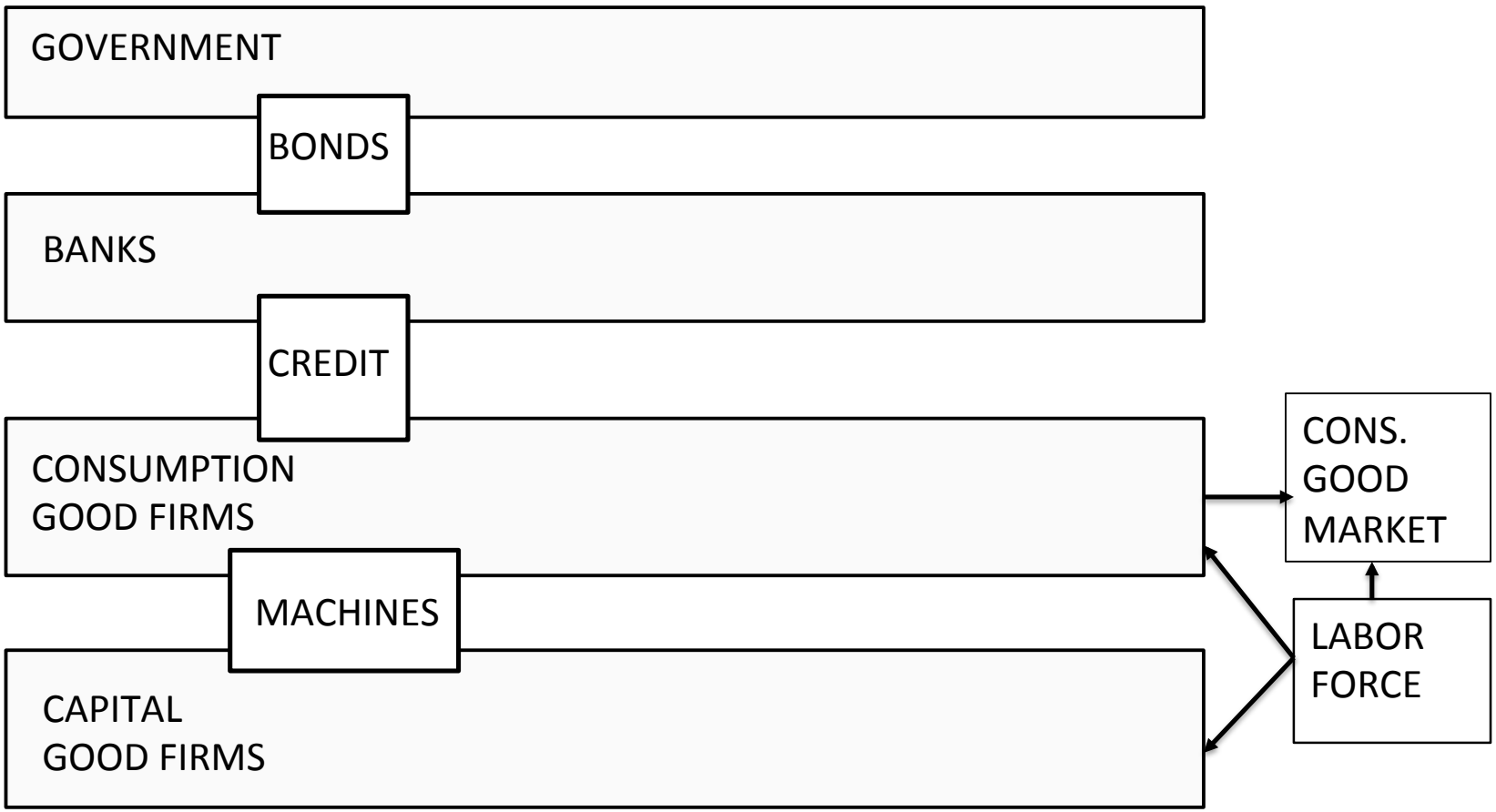
- **Assess the long-and short-run effects of different ensembles of macroeconomic policies**

In particular, we use the model as a "policy-laboratory" addressing the impact of different policy combinations conditional on the level of inequality

- **Fiscal policy:**
  - ruleless fiscal policy
  - alternative austerity rules with or without escape clauses
  - fiscal policy and the sovereign bond spread channel
- **Monetary policy:**
  - conservative Central Bank
  - Central Bank with dual mandate
  - Lender of last resort affecting the cost of public debt

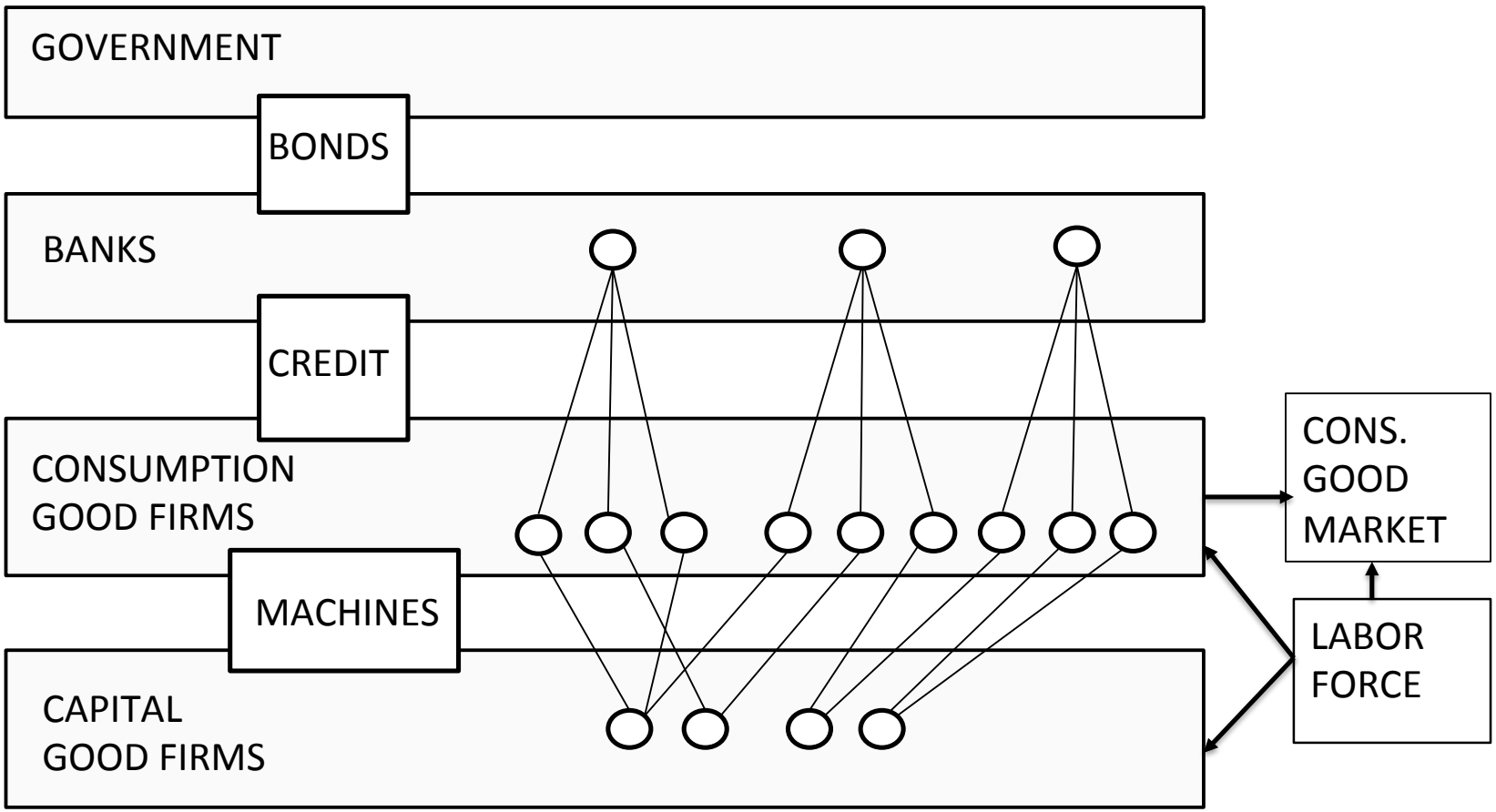
Model Structure I

Close antecedents: Dosi et al. (2010, 2013), JEDC



Model Structure II

Close antecedents: Dosi et al. (2010, 2013), JEDC



The Sequence of Microeconomic Decisions

1. Banks fix the maximum credit supply
2. Capital-good firms perform R&D, innovate and imitate
3. Consumption-good firms fix production and investmet
4. Firms ask for credit if needed, machines are paid
5. Production begins and firms hire workers
6. The consumption-good market opens
7. Firms repay their debt, bank profits and equity are computed accordingly
8. Firms' entry and exit
9. Machines are delivered to consumption-good firms

Technical Change and Capital-Good Firms

- Capital-good firms search for better machines and for more efficient production techniques
- They invest in R&D investment a fraction of past sales
- They allocate R&D funds between innovation and imitation
- Capital-good firms choose the machine to produce (trade-off between price and quality)
- They fix prices applying a mark-up on unit cost of production and send a “brochure” with the price and the productivity of their machines to consumption-good firms

Investment and Consumption-Good Firms

- **Expansion investment**
  - demand expectations (D^e) determine the desired level of production (Q^d) and the desired capital stock (K^d)
  - firm invests (EI) if the desired capital stock is higher than the current capital stock (K):

$$EI = K^d - K$$

- **Replacement investment**
  - payback period routine:
    - an incumbent machine is scrapped if

$$\frac{p^*}{c(\tau) - c^*} \leqslant b, \qquad b > 0$$

    - $c(\tau)$ unit labor cost of an incumbent machine;
    - p^*, c^* price and unit labor cost of new machines
  - also machine older than Λ periods are replaced

The Banking Sector - Credit Links

- Fixed number of banks
- Banks are heterogeneous in their number of clients (random draw of an integer from a Pareto distribution)
- Each consumption-good firm has only one bank
- Credit links are set at the initialization step and kept fixed over the simulation

The Banking Sector - Credit Demand

- **Source of firms' credit demand**
  - desired production and investment in new capacity depending on adaptive demand expectations (animal spirits)
  - replacement investment depending on technical change and pay-back period routines
- **Maximum credit demand is constrained by loan-to-value ratio**

The Banking Sector - Deposits and Credit Supply

- Bank gathers deposits (stock of liquid assets of firms) and provides credit to consumption-good firms
- Basel capital adequacy (τ_b): maximum credit supply of banks ($TC_{k,t}$) is a multiple of their equity ($NW^b_{k,t-1}$)
- Endogenous capital buffer: credit supply is reduced if the bank is fragile (ratio between bad debt and total loans)

$$TC_{k,t} = \frac{NW^b_{k,t-1}}{\tau_b * (1 + \beta BDratio_{k,t-1})}$$

- Bank net worth is:

$$NW^b_{k,t} = Loans_{k,t} + Cash_{k,t} + GovBonds_{k,t} - Deposits_{k,t}$$

The Banking Sector - Credit Allocation

- Credit is allocated to firms on a pecking-order base
- Pecking order depends on the ratio between firm net worth and sales

$$NW_{j,t-1}/S_{j,t-1}$$

- Credit rationing may arise
- Heterogeneous risk premium (credit classes)

$$r_{deb,j}(t) = r_{deb,t}\left(1 + (q-1) * k_{const}\right)$$

r_{deb} base loan rate; q credit class of firm j, k_{const} scaling parameter.

Consumption-Good Markets

- **Supply:**
  - imperfect competition: prices (p_j) $\Rightarrow$ variable mark-up (mi_j) on unit cost of production (c_j)
  - firms first produce and then try to sell their production (inventories)
- **Demand: workers' consumption**
- **Market dynamics:**
  - market shares evolve according to a replicator dynamics:

$$f_j(t) = f_j(t-1)\left(1 + \chi \frac{E_j(t) - \overline{E}(t)}{\overline{E}(t)}\right); \quad \chi \geqslant 0$$

  - firm competitiveness depends on price and unfilled demand

Banking Crisis

- **Firm failure:**
  - zero market share or negative stock of liquid assets
  - in that case, firm exits and defaults on its loans
- **Bank failure:**
  - firm's default (*BD*) has a negative effect on banks' profits:

$$\Pi^{b}_{k,t} = \sum_{cl=1}^{Cl_k} r_{deb,cl,t} L_{cl,t} + r_{res,t} Cash_{k,t} + r_{B,t} Bonds_{k,t} - r_D Dep_{k,t} - BD_{k,t}$$

  - banks fail whenever their net worth becomes negative
- **Full bail-out rule**
  - the Government always steps in and save the failing bank
  - bank bail-out has a negative impact on public budget

Labor Market

- Exogenous labor supply
- Wage dynamics determined by avg. productivity, inflation and unemployment according to different scenarios

With inflation target

$$\frac{\Delta w(t)}{w(t-1)} = \pi_{target} + \psi_1 * (\pi_{t-1} - \pi_{target}) + \psi_2 * \frac{\Delta \overline{AB}(t)}{\overline{AB}(t-1)} - \psi_3 * \frac{\Delta U(t)}{U(t-1)}$$

Without inflation target

$$\frac{\Delta w(t)}{w(t-1)} = \psi_1 * \pi_{t-1} + \psi_2 * \frac{\Delta \overline{AB}(t)}{\overline{AB}(t-1)} - \psi_3 * \frac{\Delta U(t)}{U(t-1)}$$

- Note: results are presented only for the scenario with inflation target.
- Involuntary unemployment + possibility of labor rationing

Validating the K+S Model

- **ABMs are much more complex than standard, e.g. DSGE, macroeconomic models**
- **The model should then be able at least to match the same macroeconomic stylized facts of standard models**
- **The model should also be able to match the largest possible number of microeconomic stylized facts**
- **This is relevant because standard DSGE macroeconomic models are not usually able to match any microeconomic stylized fact**

The Dynamics of the Baseline Model

Variable	**Avg. values, 100 replications**
GDP growth rate	0.030
GDP growth volatility	0.041
Unemployment rate	0.041
Share of crises (GDP growth < 3%)	0.061
Public Debt / GDP	0.091
Investment / Desired Investment	0.633
Inflation rate	0.037
Infl. Volatility	0.024
Central Bank interest rate	0.045

Macroeconomic Stylized Facts

(1) Self-sustained growth with endogenous business cycles

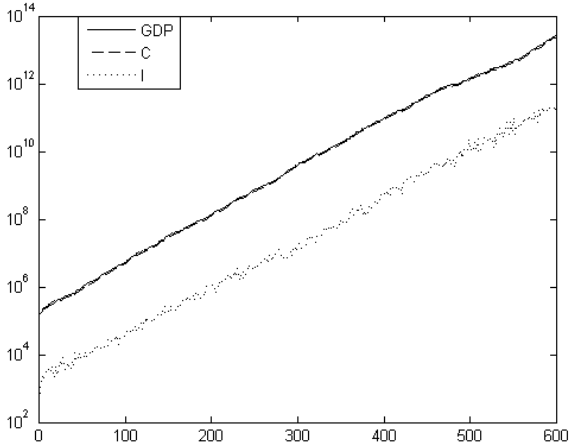
(2) Distribution of economic crisis duration is exponential (Ausloos et al, 2004)

(3) Investment more volatile than GDP; consumption less volatile than GDP

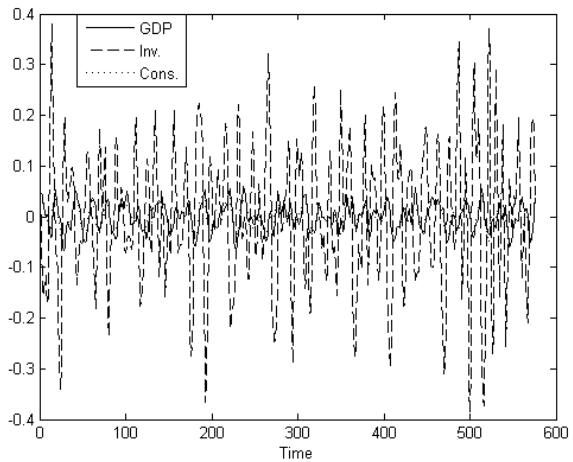
(4) Co-movements with output:

- *Procyclical:* consumption, net investment, productivity, employment, inflation, wage;
- *Countercyclical:* prices and mark-ups, unemployment

Log series of GDP, C and I



Bandpassed filtered GDP



Microeconomic Stylized Facts

Dosi, 2007

(1) Productivity dispersion among firms is large

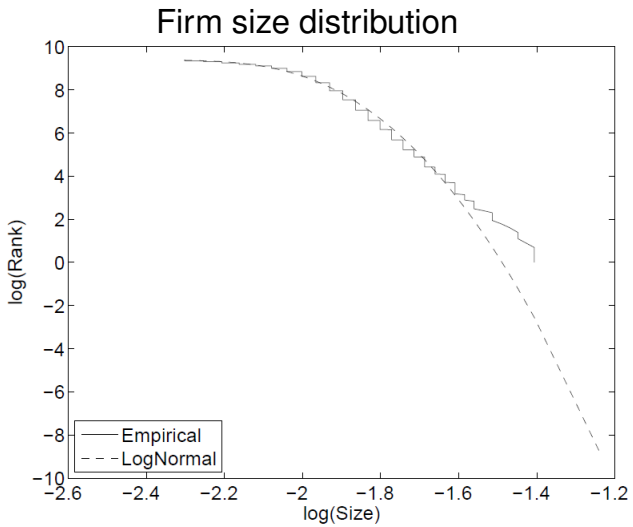
(2) Persistence in productivity differential among firms

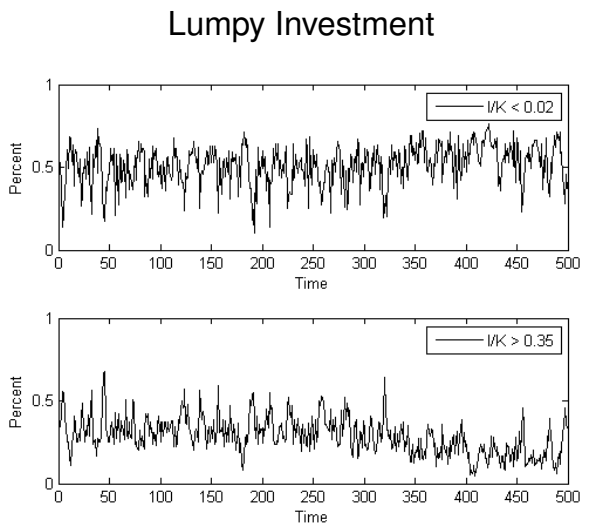
(3) Firm size distributions are right-skewed

(4) Fat-tailed firm growth-rate distributions

(5) Investment rates are lumpy

(Gourio & Kayshap, 2007)





Bank-Related Stylized Facts

Bikker and Metzemakers, 2005

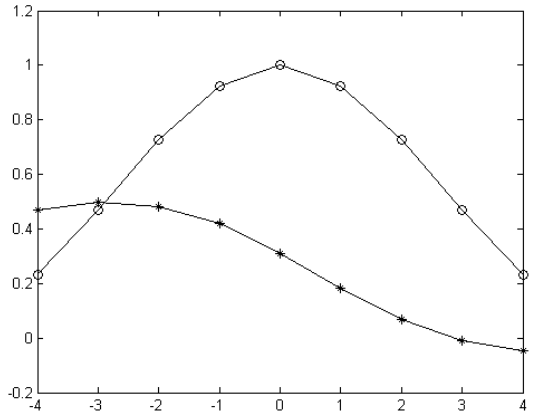
(1) Firm debt, credit supply, bank profits and bank equity are procyclical

(2) Credit characterized by boom-bust cycles (Shlaeck et al 2009; Mendoza and Terrones, 2012)

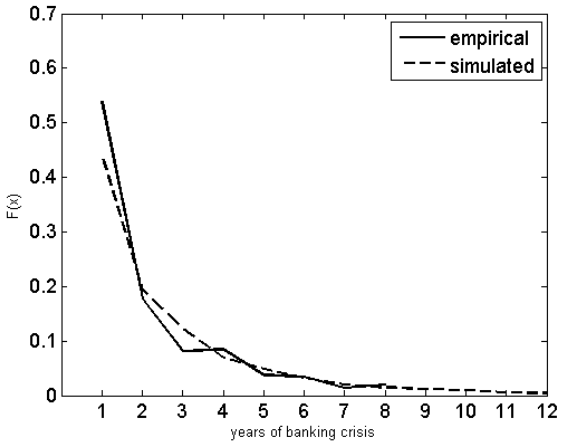
(3) Distribution of fiscal costs of banking crises is fat-tailed (Laeven and Valencia, 2008)

(4) Distribution of duration of banking crises is fat-tailed (Reinhart and Rogoff, 2009)

Debt dynamics



Duration of banking crises



General Properties of the K+S model

The necessity of fiscal policy

- **Description of the experiment:**
  - we begin eschewing the public sector from our model
- **Results**
  - Evidence of multiple growth paths: Keynesian policies are necessary to support sustained long-run economic growth

Description	**Avg. GDP Growth**	**GDP Std. Dev. (bpf)**	**Avg. Unempl.**
benchmark scenario	0.0252	0.0809	0.1072
	(0.0002)	(0.0007)	(0.0050)
no fiscal policy	0.0035	1.5865	0.8868
	(0.0012)	(0.0319)	(0.0201)

General Properties

Keynesian Demand Macro Management Policies

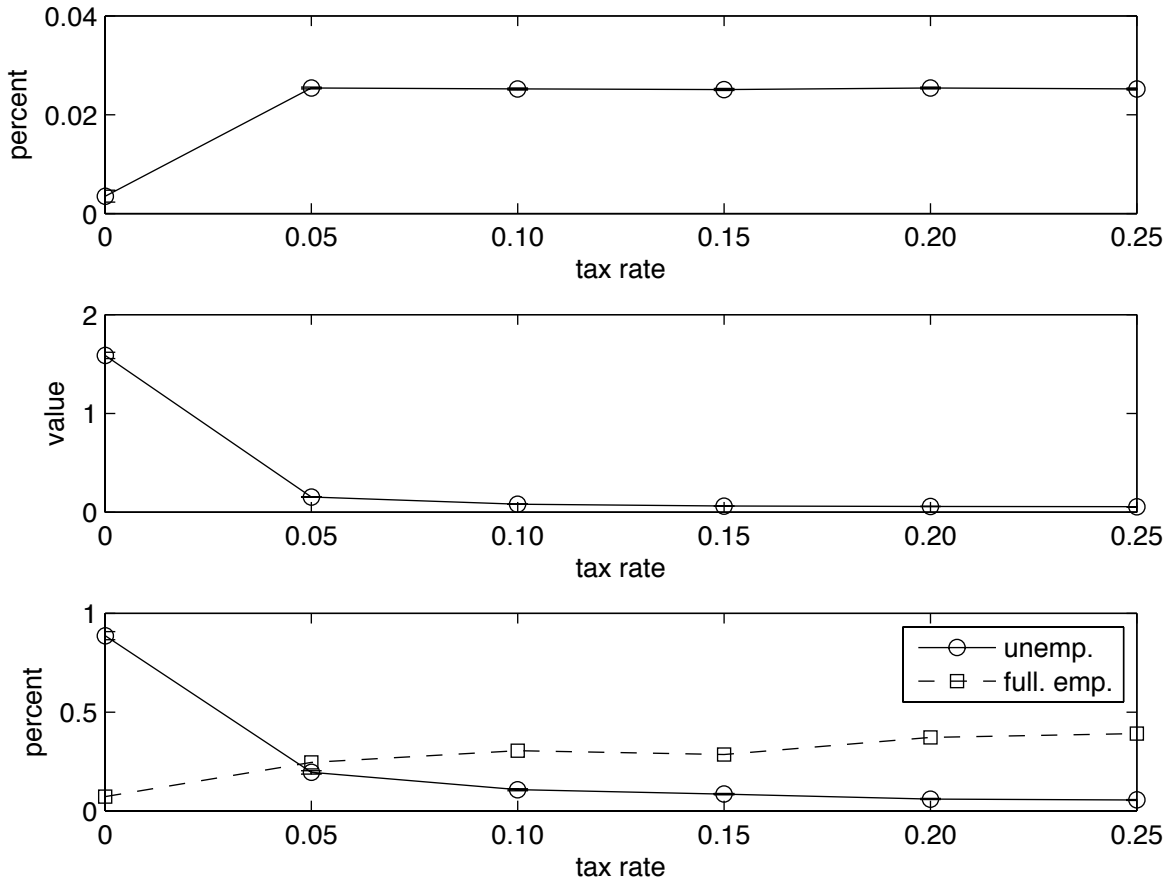


Figure: Results are obtained under balanced budget ratios of expenditures (taxes) to GDP.

Macroeconomic Policies and Heterogeneous Banks

- **Fiscal policy and the public budget:**
  - constant tax and unemployment-subsidy rate
  - the public deficit in each period is:

$$Def_t = BankBailout_t - Tax_t + G_t + r_{B,t} Debt_t$$

- **Monetary policy:**
  - We consider two scenarios

"Conservative" Central Bank

$$r_t = r_{target} + \gamma_\pi * (\pi_t - \pi_{target}), \qquad \gamma_\pi > 1$$

"Dual Mandate" Central Bank

$$r_t = r_{target} + \gamma_\pi * (\pi_t - \pi_{target}) + \gamma_U * (U_{target} - U(t)), \qquad \gamma_\pi > 1, \gamma_U > 1$$

- **Fiscal policy**
  1) baseline: automatic stabilizers + no limit to public deficit
  2) Stability and Growth Pact (SGP): $Def/GDP \leqslant 3\%$
  3) Fiscal Compact (FC): SGP + debt reduction rule
  4) adding a recession escape clause to both SGP and FC
  5) sovereign bonds spread adjust to the ratio between public debt and GDP

- **Monetary policy**
  1) baseline ("conservative"): Taylor rule only on inflation gap
  2) dual mandate: Taylor rule on inflation AND unemployment gap
  3) quantitative easing (QE): interest rate on sovereign bonds is fixed to 1%

Policy Experiments

Effects on Avg. GDP Growth

- Without escape clauses, fiscal rules lock the economy into a low growth trajectory
- The type of monetary policy is irrelevant for avg. growth

	Baseline	Dual Mand.	LLR	Bonds Spread	LLR+Dual Mand.
Baseline	1.000	1.019***	1.001**	0.994***	1.016***
SGP	0.527***	1.014***	0.716***	0.794***	0.970***
SGP +escape clause	0.995***	1.013***	0.996***	0.991***	1.017***
Fisc.Comp.	0.572***	0.958***	0.676***	0.765***	0.954***
Fisc.Comp. +escape clause	0.992***	1.021***	0.995***	0.997***	1.017***

Policy Experiments

Effects on Avg. GDP growth volatility

- Without escape clauses fiscal rules lead to higher volatility...

	Baseline	Dual Mand.	LLR	Bonds Spread	LLR+Dual Mand.
Baseline	1.000	0.865***	1.015***	1.011***	0.874***
SGP	14.645***	2.760***	11.365***	12.873***	2.950***
SGP +escape clause	1.408***	1.027***	1.341***	1.487***	0.999
Fisc.Comp.	16.204***	3.172***	12.085***	14.009***	3.201***
Fisc.Comp +escape clause	1.624***	0.980***	1.543***	1.530***	0.997

Policy Experiments

Effects on Likelihood of Economic Crises

- ...to higher incidence of economic crises...

	Baseline	Dual Mand.	LLR	Bonds Spread	LLR+Dual Mand.
Baseline	1.000	0.587***	1.032***	1.031***	0.613***
SGP	1.983***	0.813***	1.803***	1.647***	0.882***
SGP +escape clause	1.505***	0.672***	1.472***	1.777***	0.699***
Fisc.Comp.	1.880***	0.934***	1.623***	1.798***	0.931***
Fisc.Comp. +escape clause	1.953***	0.675***	1.683***	1.836***	0.691***

Policy Experiments

Effects on Avg. Unemployment Rate

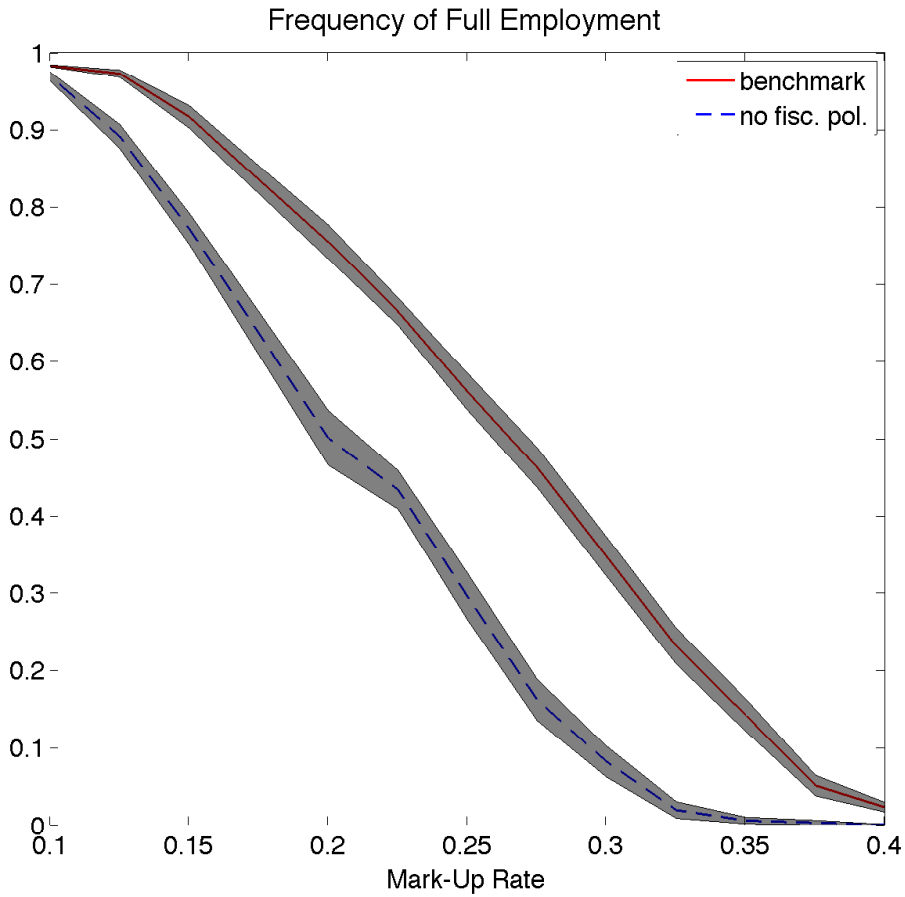
- ...and to higher unemployment rates.
- LLR policy or the presence of a bond-spread channel does not change the results
- In contrast, dual mandate monetary policy always mitigates the effects of fiscal rules on volatility, crises and unemployment
- Dual mandate monetary policy is more powerful in presence escape clauses in fiscal rules.

	Baseline	Dual Mand.	LLR	Bonds Spread	LLR+Dual Mand.
Baseline	1.000	0.322***	1.217***	1.068***	0.290***
SGP	5.692***	0.909***	4.844***	4.201***	1.312***
SGP +escape clause	1.419***	0.343***	1.563***	1.680***	0.334***
Fisc.Comp.	5.706***	1.383***	4.430***	4.963***	1.395***
Fisc.Comp. +escape clause	1.948***	0.317***	1.746***	1.679***	0.331***

Fiscal Policy and Income Distribution

Frequency of Full Employment States

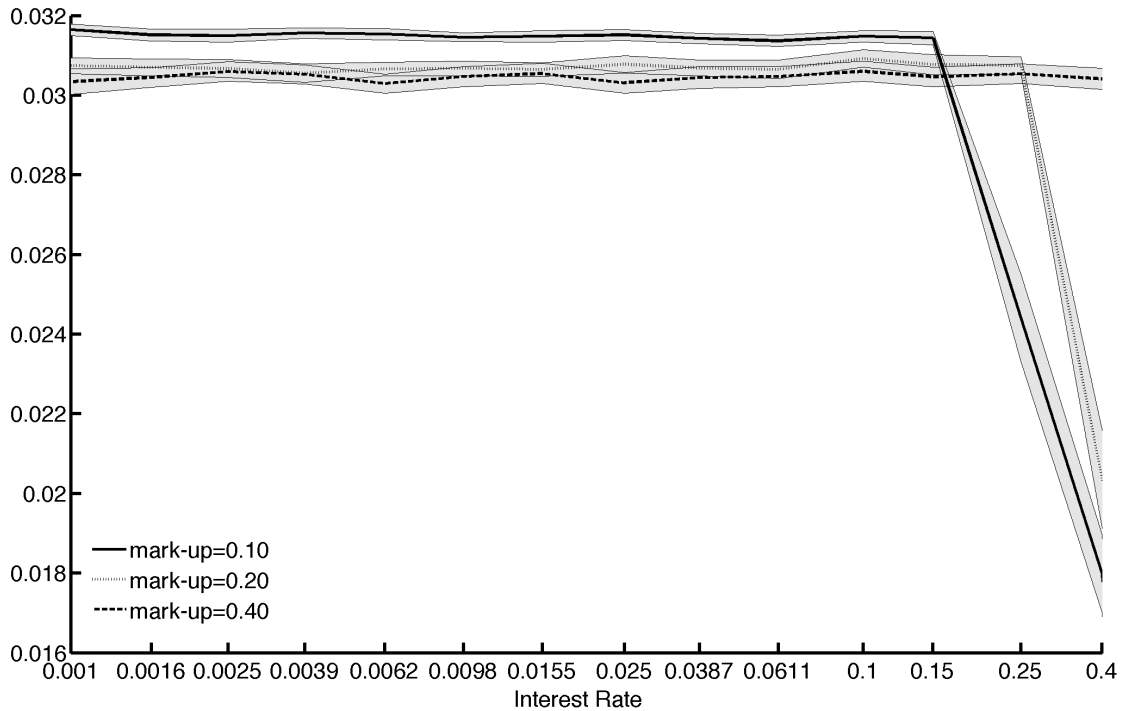
- We study the properties of the dynamics in different income distribution regimes (defined by the mark-up rate)
- We perform experiments with and without fiscal policy
- without fiscal policy, the effects of income distribution on real variables are strengthened
- long-run growth effects: high levels of the mark-up rate lock the economy into a low-growth trajectory



Monetary Policy and Income Distribution

Changing the Interest Rate

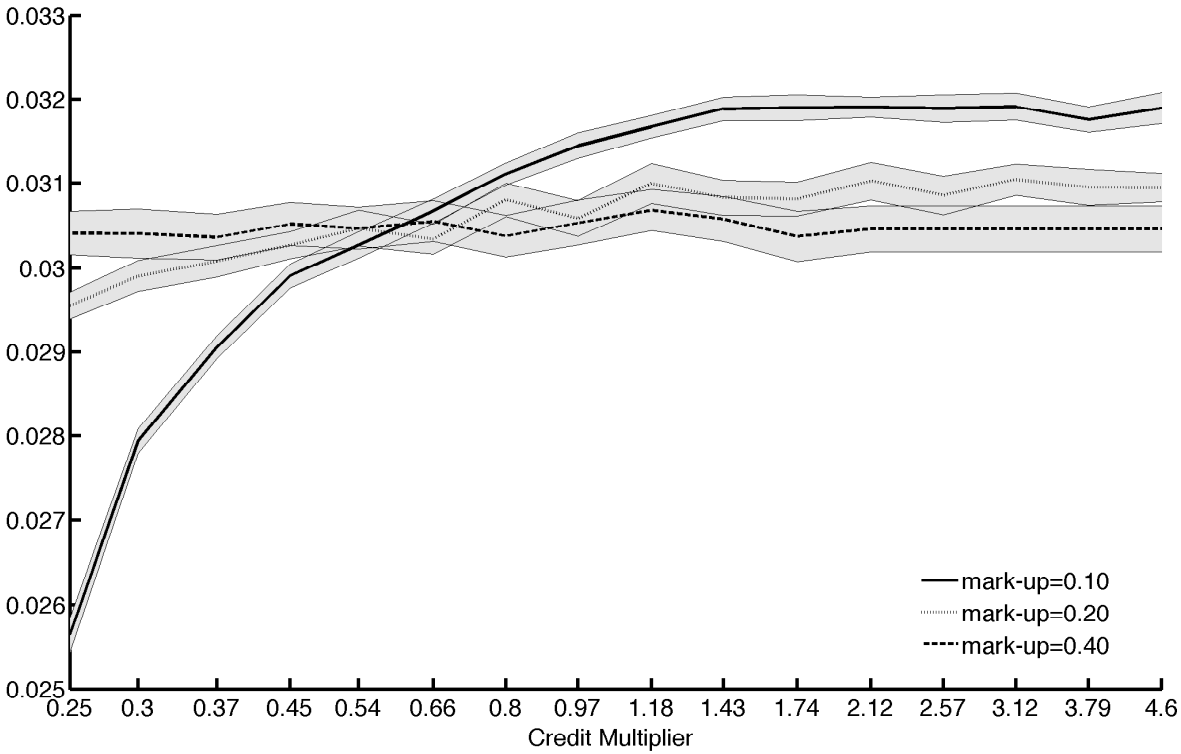
- we tune the interest rate for different mark-up levels
- at high mark-ups interest rate policy is totally ineffective
- threshold effects: high levels of interest rates lock the economy on a low-growth trajectory...



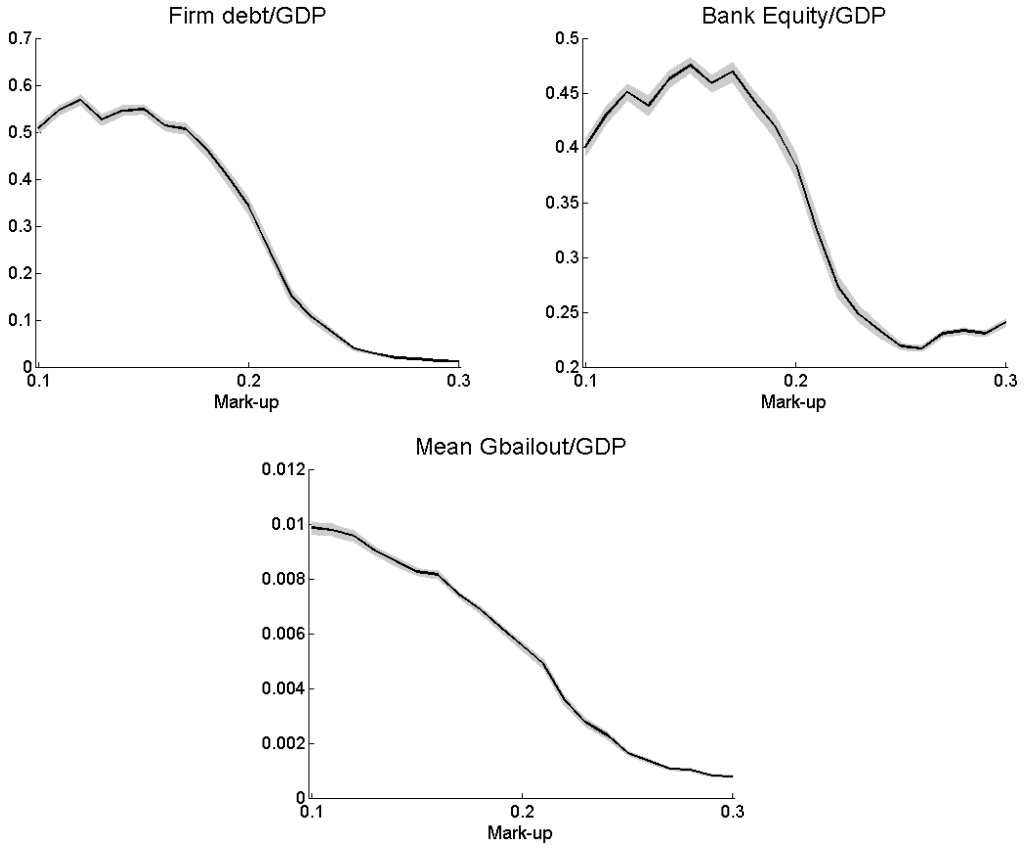
Monetary Policy and Income Distribution

Changing the Credit Multiplier

- When mark-up rate is low, low credit multipliers decrease average growth (credit rationing effect)



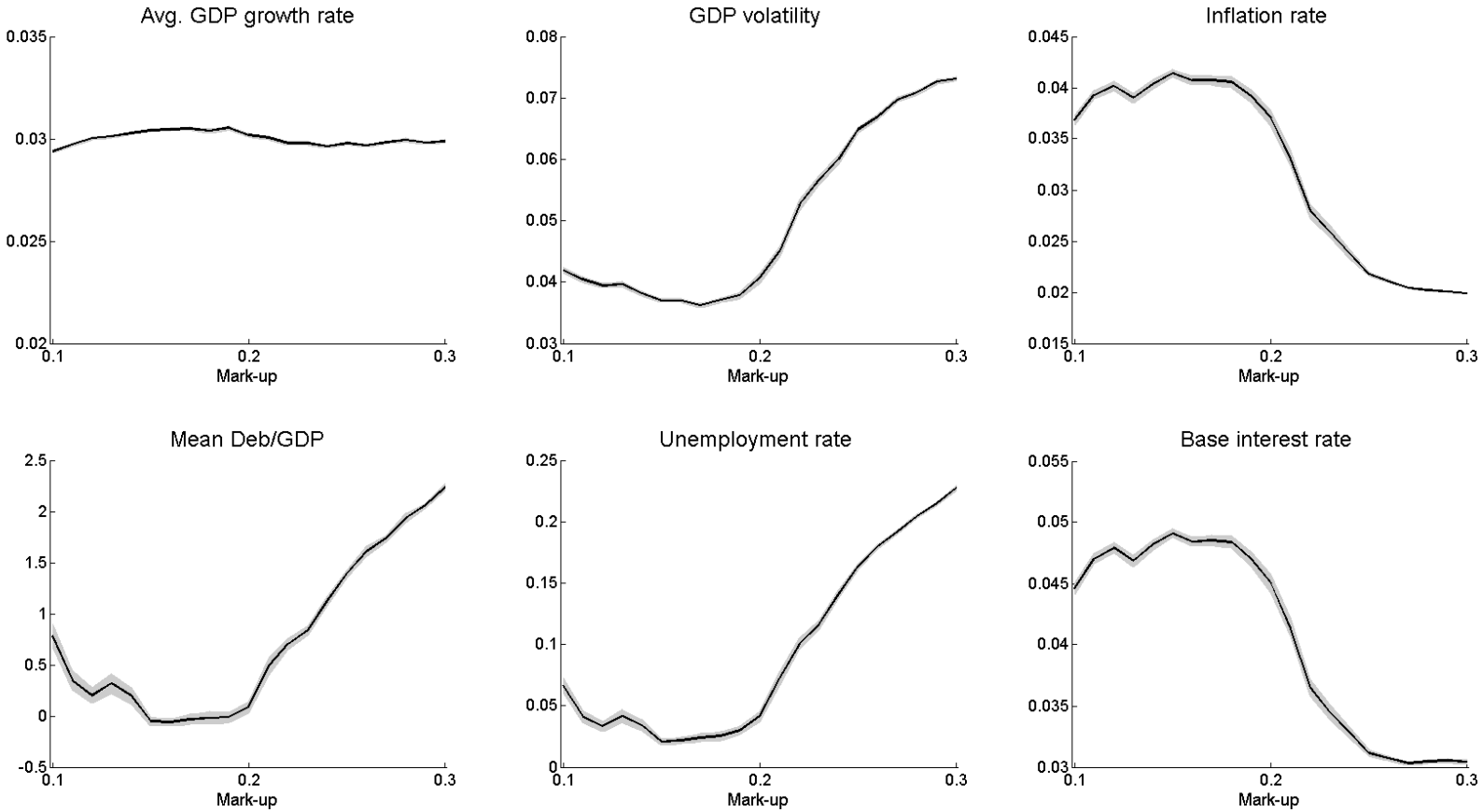
1. Income Distribution and the Banking Sector



The lower the mark-up rate:

- the higher is firms' financial dependence
- the larger the banks and the higher bank bail-out costs

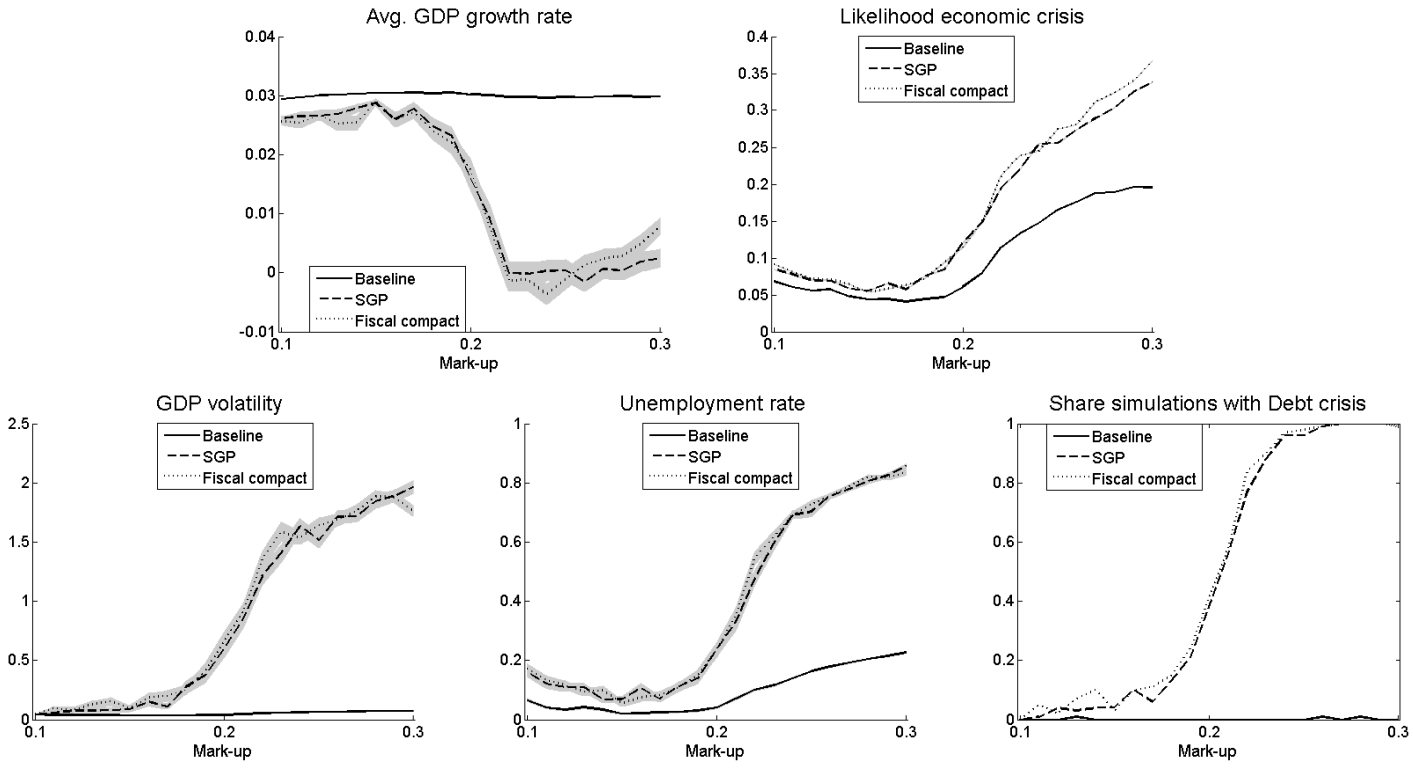
1. Income Distribution and Macroeconomic Dynamics



Higher mark-ups reduce aggregate demand paving the way to higher economic instability and to the worsening of public finance

2a. SGP and FC Austerity Rules

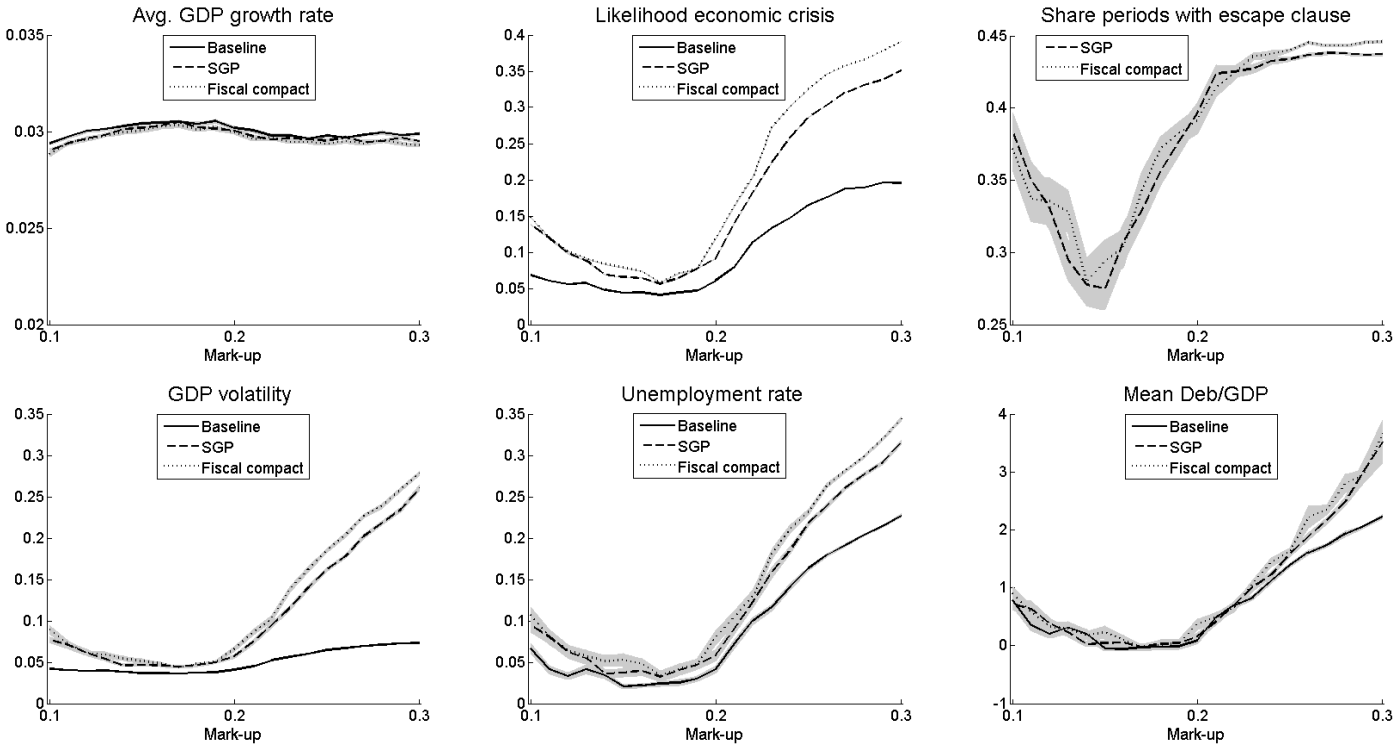
Effects for different income distribution regimes



- Austerity rules lock the economy in a low-growth and high-instability trajectory
- The negative effects of SGP and FC rule increase with inequality
- Austerity policies are self-defeating (sovereign debt crises arise)

2b. Austerity Rules with Recession Escape Clause

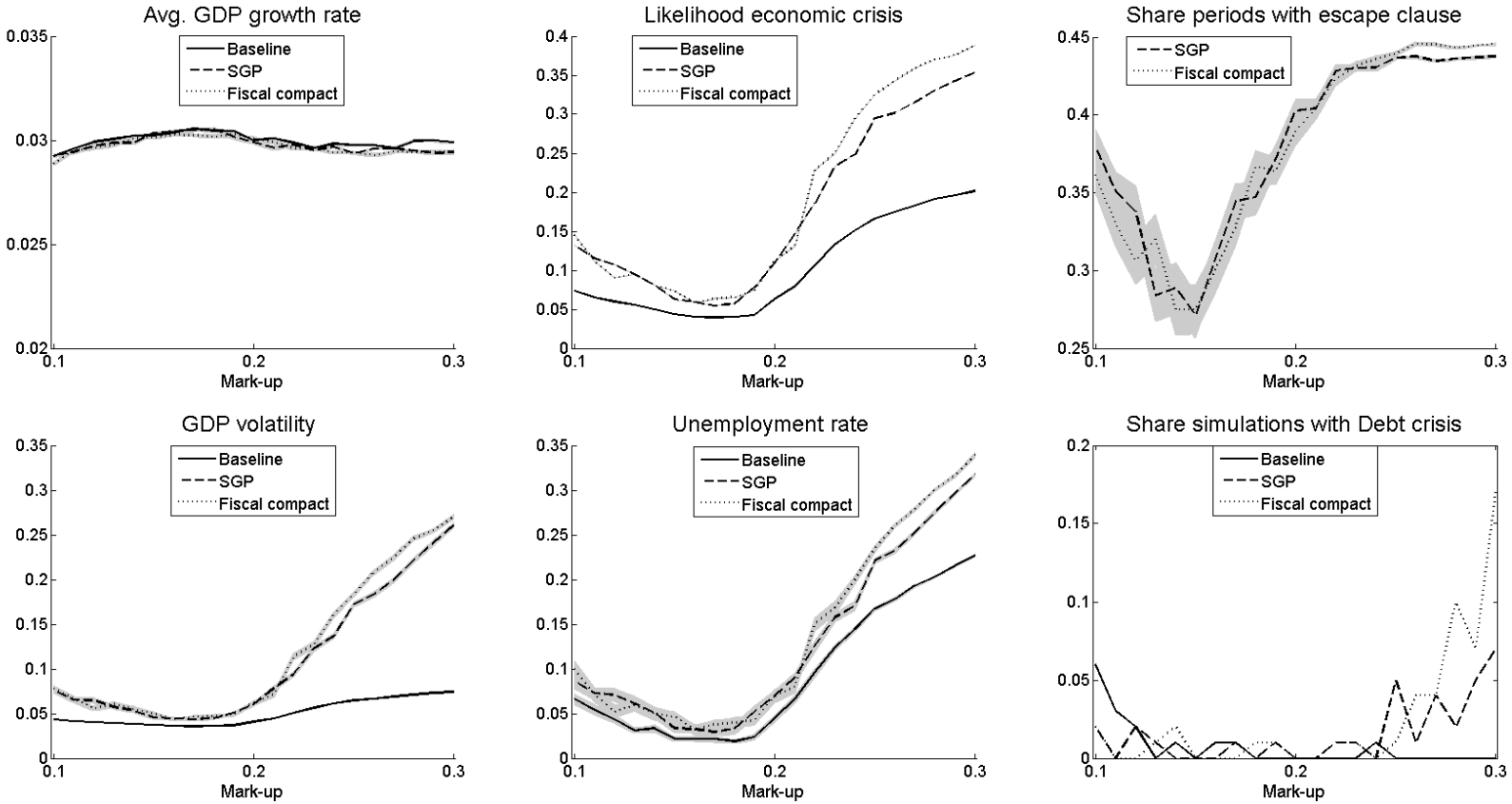
Effects for different income distribution regimes



- Escape clause prevents fiscal rules from being activated up to 45% of the periods thus limiting their strong recessionary effects
- Long-run growth is preserved, but the economy is still more unstable, unemployment is higher and austerity is still self-defeating
- Fiscal compact has a stronger negative impact than the SGP

2c. Austerity and the Sovereign Bond Spread Channel

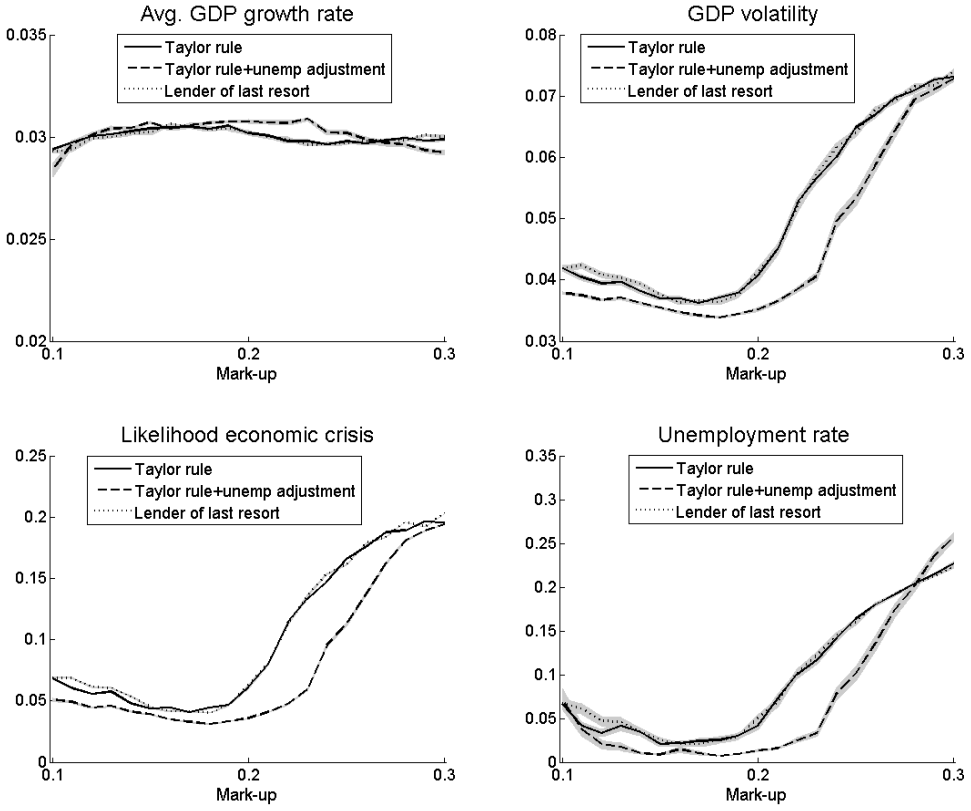
Effects for different income distribution regimes



- Results do not change when we take into account a positive feedback from the ratio between public debt and the spread on Government bonds

3. Monetary Policy and Macroeconomic Dynamics

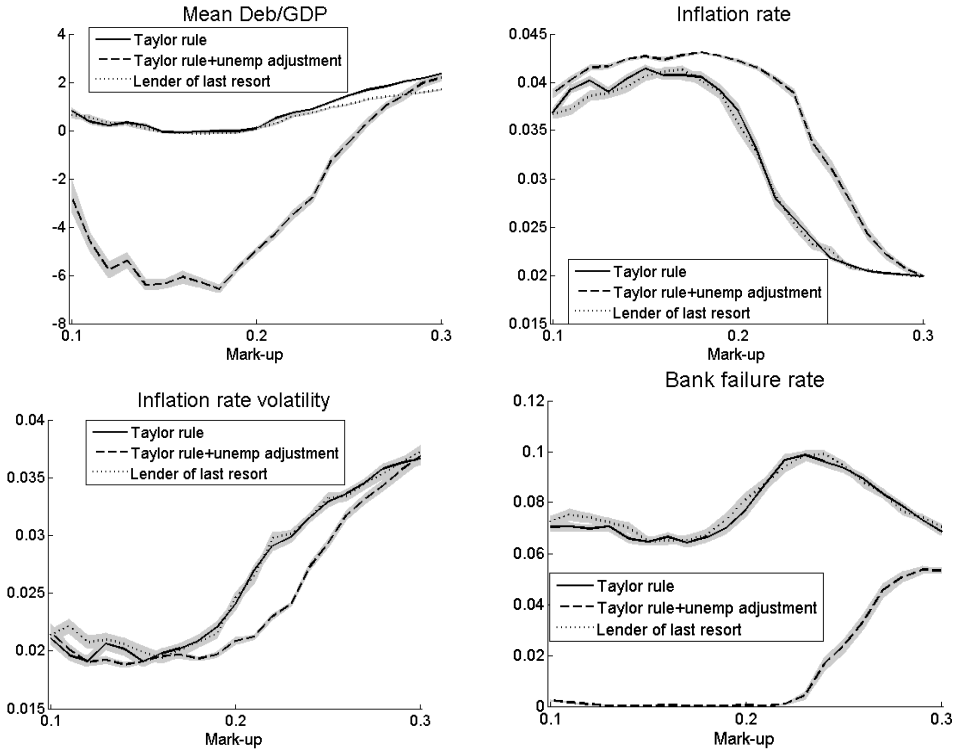
Effects for different income distribution regimes



- With a lender of last resort, there is no effect on the performance of the economy but the public debt over GDP ratio is improved
- Dual-mandate monetary policy reduces GDP volatility, unemployment and the likelihood of crises

3. Monetary Policy and the Banking Sector

Effects for different income distribution regimes



- Dual-mandate monetary policy slightly increases inflation but ...
- ... it increases the interest rate whenever unemployment is low thus improving banks' profitability and (via Basel) increasing the supply of credit to firms
- The credit channel of monetary policy appears to be relevant for macro stability

Summing up...

- **We extend the K+S model introducing heterogenous banks and allowing for banking crises**
- **We test the effect of fiscal and monetary policies under different inequality scenarios**

Policy conclusions, part I

The central role of income inequality:

- income inequality impacts on macroeconomic dynamics
- income inequality affects the effects of fiscal and monetary policies
- tension between firms' dependency on credit and aggregate demand

Policy conclusions, part II

The self-defeating effects of austerity rules:

- fiscal rules harm GDP growth, increase volatility, unemployment and likelihood of crises
- fiscal consolidations do not improve public debt and may lead to sovereign debt crises
- escape clauses mitigate the depressing effects of fiscal rules
- such results results are robust even when the spread cost of sovereign bonds is linked to the public debt

Policy conclusions, part III

Monetary policy and the banking sector

- dual-mandate monetary policy performs better than conservative one
- why? the role of the credit channel and the banking sector
- A lender of last resort has no real effects but it helps to reduce the public debt burden

Future Works

1. Further explorations of firms and banks interactions
2. Studying how the banking sector structure affect bail-out costs and more generally the performance of the economy
3. Trying different ensembles of macroeconomic policies (e.g. Abenomics, helicopter-drop quantitative easing, etc.)
4. Go deeper on the impact of fiscal policies (e.g. non-linear multipliers)

Benchmark parameters

Table: Benchmark parameters

Description	Symbol	Value
Number of firms in capital-good industry	F_1	50
Number of firms in consumption-good industry	F_2	200
Number of commercial banks	B	10
Consumption-good firm mark-up rule	μ_2	0.20
Uniform distribution supports	$[\phi_1, \phi_2]$	[0.10,0.90]
Wage setting $\Delta\overline{AB}$ weight	ψ_1	1
Wage setting Δcpi weight	ψ_2	0.05
Wage setting ΔU weight	ψ_3	0.05
Tax rate	tr	0.10
Unemployment subsidy rate	φ	0.40
Target interest rate	r_{target}	0.03
Target inflation rate	$dcpi_{target}$	0.02
Banks deposits interest rate	r_{depo}	0
Banks reserve interest rate	r_{res}	$= (1 - 0.33) * r_t$
Public bonds interest rate	r_{bonds}	$= (1 - 0.33) * r_t$
Banks loan rate (class 1)	r_{deb}	$= (1 + 0.3) * r_t$
Bank capital adequacy rate	τ_b	0.08
Share of bonds repaid each period	$bonds_{share}$	0.025
Shape parameter for the distribution of banks' clients	$pareto_a$	0.08
Scaling parameter for interest rate cost	k_{const}	0.1
Capital buffer adjustment parameter	$beta$	1
Fiscal rule max deficit to GDP	def_{rule}	0.03