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# What if supply-side policies are not enough? The perverse interaction of flexibility and austerity

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**Abstract**

In this work we develop a set of labour market and fiscal policy experiments upon the labour and credit augmented "Schumpeter meeting Keynes" agent-based model. The labour market is declined under two institutional variants, the "Fordist" and the "Competitive" set-ups meant to capture the historical transition from the Fordist toward the post "Thatcher-Reagan" period. Inside these two regimes, we study the different effects of supply-side active labour market policies (ALMPs) vs. demand-management passive labour market ones (PLMPs). In particular, we analyse the effects of ALMPs aimed at promoting job search, and at providing training to unemployed people. Next, we compare the effects of these policies with unemployment benefits simply meant to sustain income and therefore aggregate demand. Considering the burden of unemployment benefits in terms of public budget, we link such provision with the objectives of the European Stability and Growth Pact. Our results show that (i) an appropriate level of skills is not enough to sustain growth when workers face adverse labour demand; (ii) supply-side policies are not able to reverse the perverse interaction between flexibility and austerity; (iii) PLMPs outperform ALMPs in reducing unemployment and workers' skills deterioration; and (iv) demand-management policies are better suited to mitigate inequality and to improve and sustain long-run growth.

**Keywords:** Industrial-relation Regimes, Flexibility, Active Labour Market Policies, Austerity, Agent-based models

**JEL codes:** C63, E24, H53, J88

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*I Daniel Blake demand my appeal date [for benefits] before I starve. And change that shite music on the phones!* [I Daniel Blake, by Ken Loach 2016]

# 1 Introduction

In the wake of the most severe economic crisis after the Great Recession, a resurgent attention has been devoted to promote Active Labour Market Policies (ALMPs) as a measure supposedly apt to deal with structural unemployment. The argument goes back to the late seventies: ALMPs, it has been suggested, are a way to lubricate sclerotic labour markets reducing frictional unemployment (see from Baily and Tobin, 1977 all the way to OECD, 2013). ALMPs include (i) assistance in the job-search activity enhancing the matching process in the labour market, and (ii) training programs with the aim of supporting the process of skills development of unemployed people.[1] Conversely, passive, demand-management, labour market policies (PLMPs), usually including unemployment insurance and welfare benefits, are indeed called "passive" because they do not require any activation condition in order to be granted to the beneficiaries.

Conditional on the different regimes of governance of labour relations, how the two sets of policy measures fare in terms of macroeconomic outcomes? In the following we shall address this question within an agent-based model (ABM) framework.[2] More specifically, we develop a set of labour market and fiscal policy experiments upon the labour- and credit- augmented "Schumpeter meeting Keynes" model (K+S; Dosi et al., 2010, 2013, 2015, 2017c,b). In the proposed experiments, the labour market is declined under two broad institutional variants, the *Fordist*, which was the norm in developed economies till the eighties, and the *Competitive* regimes (further details below).

Inside the two labour market regimes, we compare the different effects of ALMPs (supply-side) vs. PLMPs (demand-side) on macroeconomic dynamics. In particular, we analyse the effects of active labour market policies directed at promoting job search and providing training to unemployed people under the two regimes. Finally, we test such labour market policies in different fiscal scenarios and in particular their interaction with austerity policies. Considering the burden of unemployment benefits upon the public budget, we link the provision of unemployment benefits with the objectives of "austerity rules" such as the European Stability and Growth Pact (SGP), namely a 3% deficit to GDP ratio and a 60% debt to GDP ratio, and in case of debt overhang we enforce the restructuring path prescribed by the European Fiscal Compact (FC).

The contribution of this work is twofold. From the modelling perspective, we interact a decentralized labour market – declined under two institutional variants – with a credit market allowing for the coupling of real and financial dynamics. From the policy perspective, we study

[1] There is a third type of ALMPs, namely public sectors job opportunities or alternatively, subsidized job opportunities in the private sectors. Nonetheless, the third type of policy schemes looks less coherent with the definition of ALMPs provided by the OECD, whereby a key role is played by the stimulus for unemployed people to participate in some form of training and job search programs.

[2] For ABM's considering decentralized labour markets and their impact on the macroeconomic conditions see Fagiolo et al. (2004), Dawid et al. (2008), Deissenberg et al. (2008), Dawid et al. (2012, 2014), Riccetti et al. (2014) and Russo et al. (2016), and Caiani et al. (2018). See Neugart and Richiardi (2012), Fagiolo and Roventini (2012, 2017) for critical surveys on labour market and macro ABM's, respectively.

the interaction between labour market and fiscal policies. Our results reject the combination of flexible labour markets and austerity policies as a reasonable way-out from deep crises. First, the upgrading of unemployed workers skills is largely insufficient when workers face adverse labour market demand, especially in the flexible Competitive regime. Second, supply-side policies do not seem to be able to reverse the negative interaction between flexibility and austerity. Conversely, third, demand-management policies resulting from unemployment benefits are better suited to mitigate income inequality, dampen output volatility, and sustain long-run growth.

The paper is organized as follows. Section 2 briefly discusses the empirical evidence and compares it to the prevailing policy discourse. Section 3 presents the model. The policy experiments on the labour market are discussed in Section 4. Section 5 performs the fiscal policy exercises. Section 6 presents the global sensitivity analysis' results. Section 7 concludes.

## 2 The empirical evidence and the policy discourse

Let us start with the empirical evidence on the effectiveness of ALMPs. The micro-econometric evidence is indeed rather controversial. A recent meta-research study by Card et al., 2015, extending the previous Card et al., 2010 to 207 research papers, of which one fifth relies on randomized controlled experiments, concludes that the effects of ALMPs are very heterogeneous. First, they vary according to the time horizon of the program evaluation, indicating that the effects of the policies are higher after 2-3 years from the completion of the program. Second, even if they tend to be counter cyclical and more effective in recessionary periods, the average effect of ALMPs on employment probability is rather weak, with an average effect of 2%, 5% and 10% for short, medium and long term programs, respectively. Finally, with reference to the type of ALMPs, while job-search assistance programs seem more cost-efficient, training programs result being more effective in increasing the employability opportunities, particularly when evaluated in the long term.

When moving from micro-econometric to macro-econometric, cross-country studies at a first look ALMPs appear to help in reducing unemployment and long term unemployment spells. However, most of these cross-country studies seem to suffer from endogeneity problems, as policies responses are not independent from the labour market conditions. Moreover, when looking at country-level case studies on activation policies conducted by the OECD, remarkable differences emerge in the degree of effectiveness according to (i) the amount of resources devoted to realize the policy interventions (share of the GDP), (ii) the way in which the schemes are implemented (e.g., how the agencies in charge are designed), (iii) the monitoring effort, (iv) the eligibility conditions, and (v) the activation regimes (Martin, 2015).

Indeed, what remain as open questions concerns the extent to which economies can rely on ALMPs alone during phases of severe downturns, and in particular how labour markets characterized by structurally-weak labour demand (e.g., the Mediterranean countries) can benefit from policies aimed at reducing market mismatch or at encouraging labour participation and search intensity. So, some empirical studies, such as Caroleo et al. (2001) suggest that participation in training programs do not increase the employability opportunities of young workers but only the probability to participate in another training program – the "training trap". This phenomenon has been documented in Southern European regions where the lack of labour demand might

hardly be solved by training programs. More generally, the existing micro-econometric studies are not able to capture the macroeconomic effects of the policy schemes, nor they are able to disentangle the influence of the specific institutional features characterizing the labour market, which are indeed a key element when evaluating the fate of the policy schemes (Larsen, 2004).

Together with the spurring of ALMPs, historically came a broader package of reforms as advocated by the *OECD Jobs Study* (OECD, 1994) meant to render labour market more respondent to supply and demand conditions. Two types of flexibility were suggested, namely numerical, i.e., reducing firing restrictions for firms, and in wage terms, i.e., making the wage-adjustment process more in line with the labour market conditions. The ensuing policy recommendation was to reduce worker bargaining power, unions coverage and institutional support like unemployment benefits and an effective minimum wage. We discuss the evidence on the (often negative) effects of such measures in Dosi et al. (2017c,b).

The "packaging" of ALMPs with reforms to increase the labour market flexibility has been frequent in the recent policy discourse, especially in Europe after the sovereign debt crises, (re) introduced by the oxymoronic *expansionary austerity* hypothesis. The term has been coined by Alesina and Ardagna (2010) but the notion dates back at least to the intellectual supporters of the disastrous policies of Hoover, in the US, and Bruning, in Germany, during the 1930's. According to this view, fiscal adjustment on the spending side promotes permanent stabilization, has lower costs in terms of output loss, and stabilizes consumer expectations in terms of future tax hikes. Overall, expansionary austerity has turned out to be a huge hoax: evidence in a positive relationship between public debt reduction and GDP growth is basically non-existent. On the contrary, recent contributions emphasize the role of *private* debt in triggering historically-deep financial crises. Jordà et al. (2016) find evidence that public debt is not harmful per se in normal times, but also that a high level of public indebtedness might just reduce the fiscal ability to counteract financial crises, due to private debt overhang. Thus, debt level is relevant just *after* financial crises occur, therefore impinging "drag" on the *recovery* path, rather than triggering the recessions. In line with these findings, Guerini et al. (2017) find evidence of the "Janus-faced nature of debt", distinguishing between the effects of private and public debts.

Notwithstanding the lack of any empirical support, the European policy stance (and recently also the Brazilian one among others) has embraced such a discourse with an ensembles of policy measures widening and deepening the Maastricht Treaty, namely the European Stability and Growth Pact (1997) and the subsequent Fiscal Compact (2012). The Mediterranean countries have been the hardest hit by such policy package. However, the policy experiment did not work well also for the European Union as a whole, with many indicators still below the pre-crisis period. On top of that, a diverging trend between Northern and Southern countries has dramatically emerged. We discuss the self-defeating impact of those policies in Dosi et al. (2015, 2016).

In the following, we bring together those two strands of what we could call the "Berlin-Chicago Consensus",[3] and analyse, first, the relative impact of ALMPs under different labour market regimes, and, second, the complementary effect of Fiscal Compact-type rules.

A closely related empirical question concerns the labour market effects of credit availability

[3]See Fitoussi and Saraceno (2013) for a discussion of the theoretical and empirical flaws of the "Washington-Berlin Consensus", as well as its negative impact on the macroeconomic performance of European economies.

and the impact of credit crunches. Recent studies have linked the relation between the changing lending conditions and the flows in the labour market. At least since the paper by Bernanke (1983), and particularly after the 2008 crisis, the transmission channels between credit and the dynamics of the real economy have been finally investigated. Two main transmission channels have been emphasized. First, the one propagating via households indebtedness, which goes from housing prices burst, stressed household balance sheets, reduced consumption of non tradable goods and houses, with the ensuing employment losses largely affecting non-tradable, construction and manufacturing sectors in highly leveraged economies (Mian and Sufi, 2012; Charles et al., 2016). This dynamics is beyond the scope of this work. However, the second channel originating from firms indebtedness, going through the deteriorating effect of bad lending practices toward the balance sheets of firms (particularly small and medium ones) which once become financially constrained, incur in massive lay-offs (Chodorow-Reich, 2014), is not.

To explain the slow recovery path registered in the Western economies, both in output and employment, one shall evaluate not only the cyclical components attributable to the crises, as the debt overhang, but also the role played by the *structural* elements. In particular, factors like the slack in the productivity path (Fernald et al., 2017), the reduced firms entry rate, and the slow down in capital accumulation (Siemer, 2014), which are pre-crisis patterns that have emerged before the 2008 burst of the housing prices. Indeed, the two-way interaction between cyclical and long-term phenomena is one of the major challenges to the analysis of the macroeconomic dynamics. That, of course, involves the (possibly endemic) presence of hysteresis in the labour market, a documented finding during the Great Recession (Yagan, 2017; Jaimovich and Siu, 2012). Indeed, hysteretic effects plausibly extend to all macro phenomena involving some form of dynamic increasing returns or coordination externalities, as we discuss in Dosi et al. (2018). However, their precise forms and degrees crucially depend also on the institutional architectures of economic interactions, including of course labour market and credit ones, and on policies. This is indeed the focus of the analysis that follows.

# 3 The model

We build a general *disequilibrium*, stock-and-flow consistent, agent-based model, populated by heterogeneous workers, firms and banks which behave according to boundedly rational rules. More specifically, we extend the credit-augmented "Schumpeter meeting Keynes" (K+S) model (Dosi et al., 2010, 2013, 2015, 2017a) with explicitly decentralizing the interactions among firms and workers in the labour market (Dosi et al., 2017b,c), further adding endogenous processes affecting of workers' skills dynamics. Together with an explicit credit market, this set-up allows an in-depth analysis of the determinants of labour demand, wages and ultimately GDP growth and income distribution.

The three-sector economy in the model is composed of four populations of heterogeneous agents, $L^S$ consumers/workers, $F_t^1$ capital-good firms, $F_t^2$ consumption-good firms, $B$ banks, plus the Government and the Central Bank.[4] The basic structure of the model is depicted in Figure 1. Capital-good firms invest in R&D and produce heterogeneous machine-tools whose pro-

[4]The subscript $t$ stands for time, agent specific variables are denoted by a subscript $\ell$ in case of workers, $i$ for capital-good firms, $j$ for consumption-good firms, and $k$ for banks.

ductivity stochastically evolves over time. Consumption-good firms combine machines bought from capital-good firms and labour in order to produce products for consumers. There is a banking sector represented by a fixed number of banks that take deposits and provide loans to firms to finance production and investment plans. Workers submit job applications to a (limited) random subset of firms. Firms hire according to their individual adaptive demand expectations. The Government levies taxes on firms and banks profits, pays unemployment benefits, provide training for unemployed and imposes a minimum wage, according to the policy setting, absorbing excess profits and losses from the Central Bank and keeping a relatively stable debt in the long run.

In the following, we first summarize the functioning of the capital-good, consumption-good and banking sectors of our economy, and then present the labour market dynamics, detailing the skills accumulation and deterioration mechanisms and the policy experiments configuration. In Appendix A, we briefly present the firms', workers', banks', Central Bank and Government behavioural rules (for details, see Dosi et al., 2010, Dosi et al., 2015 and Dosi et al., 2017c). The model main variables, its configurations, the parameter set-ups and the main results of the sensitivity are presented in Appendix B.

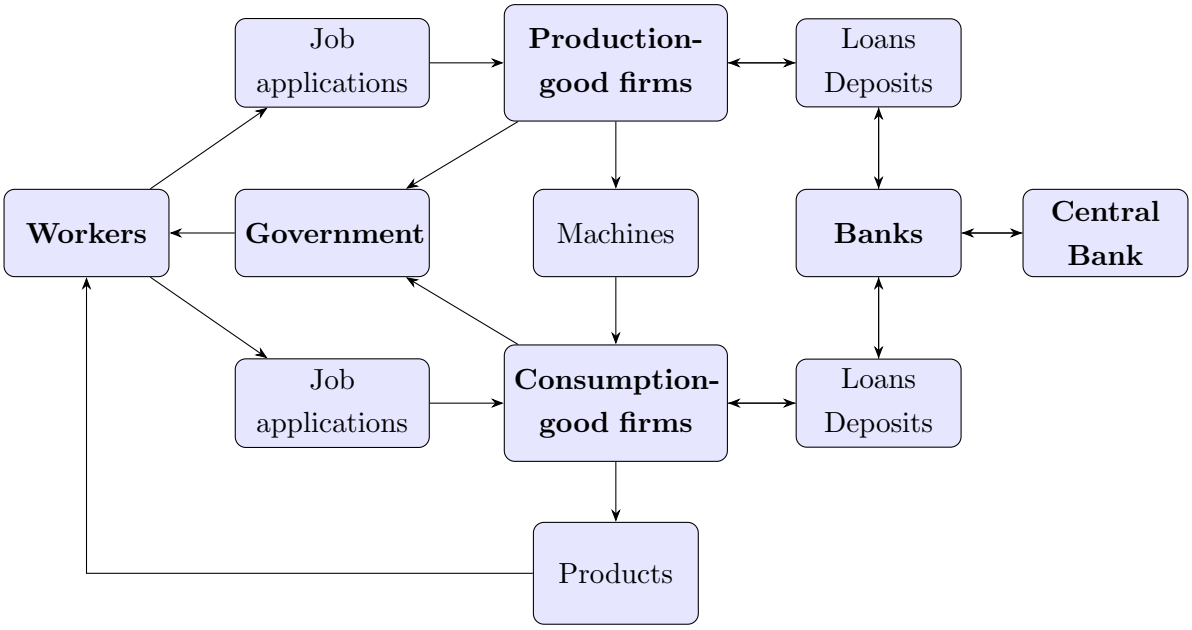



**Figure 1:** The model overall structure. Boxes in bold style represent the model's agents.

### 3.1 The capital- and consumption-good sectors

The capital-good industry is the locus where innovation is endogenously generated in the model. Capital-good firms develop new machine-embodied techniques or imitate the ones of their competitors in order to produce and sell more productive and cheaper machinery. On demand, they supply machine-tools to consumption-good firms, producing with labour as the only input. Firms have access to bank loans to cover liquidity problems up to a limit. The capital-good market is characterized by imperfect information and Schumpeterian competition driven by technological innovation. Machine-tool firms signal the price and productivity of their machines

to their current customers as well to a subset of potential new ones, and invest a fraction of past revenues in R&D aimed at searching for new machines or copy existing ones. Prices are set using a fixed mark-up over (labour) costs of production.

Consumption-good firms produce a quality-differentiated single good employing capital (composed by different "vintages" of machine-tools) and labour under constant returns to scale. Desired production is determined according to adaptive (myopic) demand expectations. Given the actual inventories, if the current capital stock is not sufficient to produce the desired output, firms order new machines to expand their installed capacity, paying in advance – drawing on their retained past profits or, up to some limit, on bank loans. Moreover, they replace old machines according to a payback-period rule. As new machines embed state-of-the-art technologies, the labour productivity of consumption-good firms increases over time according to the mix of vintages of machines in their capital stocks. Consumption-good firms choose in every period their capital-good supplier comparing the price and the productivity of the machines they are aware of. Firms then fix their prices applying a variable mark-up rule on their production costs, trying to balance profit margins and market shares. More specifically, firms increase their mark-up and price whenever their market share is expanding and vice versa. Imperfect information is also the normal state of the consumption-good market so consumers do not instantaneously switch to the most competitive producer. Market shares evolve according to a (quasi) replicator dynamics: more competitive firms expand, while firms with relatively lower competitiveness levels shrink, or exit the market.

The process of entry-exit is entirely endogenous in both sectors. Firms leave the market whenever their market shares get close to zero or their net assets turn negative (bankruptcy). Conversely, the number of entrants stochastically depends on the number of incumbents and on the prevailing financial conditions. When the sectoral liquidity-to-debt ratio is shrinking new firms find it easier to enter, and vice versa.

### 3.2 The banking sector and monetary policy

The structure of the credit market closely follows the one presented in Dosi et al. (2015). The banks collect deposits from firms and evaluate the provision of loans on request. Firms in both sectors hold a fixed relationship with a (randomly chosen) single bank. The supply of credit is bounded by each bank's capital and Basilea-type regulatory capital-adequacy constraints. The available credit is allocated by each bank according to a pecking order where demanding clients are ranked by the liquidity-to-sales ratio. Credit rationed firms are not be able to fully accomplish their investment plans.

The Central Bank may fix the prime interest rate ($r_t$) using a single or dual mandate Taylor rule, depending on the policy set up. Parts of banks' deposits are held by the central bank as compulsory reserves. There is an interest rate structure according to which there is corridor binding the interest rate fixed by the central bank between the interest rate on deposits $r_D$, the lower bound, and the interest rate on loans ($r_t^{deb}$), the upper bound: $r_D \leq r_t^{res} \leq r_t \leq r_t^{deb}$. The interest rate on reserves ($r_t^{res}$) and loans are defined according to mark-down and mark-up rules, respectively, given the prime interest rate. Central bank bail-outs the banking system when total net worth turns negative.

### 3.3 The labour market and skills dynamics

The labour market in the model implements a fully-decentralized search and hiring process between workers and firms (more in Dosi et al., 2017b,c). The aggregate supply of labour $L^S$ is fixed and all workers are available to be hired in any period. When unemployed, workers submit a certain number of job applications to firms. Employed workers may apply or not for better positions, according to the institutional set up. Larger firms have a proportionally higher probability of receiving job applications, which are organized in separated, firm-specific application queues. The labour market is characterized by imperfect information as firms only observe workers skills and wage requests and workers are aware only of the wage offers they may receive.

Firms decide about their individual labour demand based on the received orders (capital-good sector), the expected demand (consumption-good sector), and the expected labour productivity levels. Considering the number and the productivity of the already employed workers, firms decide whether to (i) hire new workers, (ii) fire part of the existing ones, or (iii) keep the existing labour force. Each hiring firm defines a unique wage offer for the applicant workers, based on its internal conditions and the received applications. Workers select the best offer they get from the firms to which they submitted applications, if any. If already employed, depending on the institutional regime, they might quit the current job if a better wage offer is received. There are no further rounds of bargaining between workers and firms in the same period. Thus, firms have no guarantee of fulfilling all the open positions, and no market clearing is ever guaranteed. Moreover, there are no firing or hiring transaction costs.

### 3.4 Policy experiments

In the foregoing we describe the policy experiments we undertake in order to study the different effects of ALMPs vs. PLMPs. The two supply-side policy schemes we implement in the K+S model are: **ALMP 1** involving the support to the worker job-search activity with the aim of reducing mismatches in the labour market, and **ALMP 2** based on training program targeting the improvement of the skills of unemployed people.

#### 3.4.1 ALMP 1: reducing mismatches and enhancing job search

To study the effect of the support in the job search activity, we compare the model properties under different degrees of informational imperfection in the workers job application process. In particular, we are interested in the impact on the matching process between firms and workers in terms of open positions vacancy and hiring rates.

In the model, the search and matching process occurs through the following steps. First, each firm gets in probability a fraction of the candidate workers in its application queue $\{\ell^s_{j,t}\}$, proportional to firm market share $f_{j,t}$:

$$\mathrm{E}(L^s_{j,t}) = \left(\omega(1-U_{t-1}) + \omega_{un}U_{t-1}\right) L^S f_{j,t-1}, \tag{1}$$

where $L^S$ is the (fixed) total labour supply, $U_t$ is the unemployment rate and $\omega, \omega_{un} \in \mathbb{R}^+$ are parameters defining the number of job application queues each seeker joins, if employed or

unemployed, respectively. Considering the set of workers in $\{\ell^s_{j,t}\}$, each firm select the subset of desired workers $\{\ell^d_{j,t}\}$ to make a job (wage) offer:

$$\{\ell^d_{j,t}\} = \{\ell_{j,t} \in \{\ell^s_{j,t}\} : w^r_{\ell,t} < w^o_{j,t}\}, \quad \{\ell^d_{j,t}\} \subseteq \{\ell^s_{j,t}\}. \tag{2}$$

Firms target workers that would accept the wage offer $w^o_{j,t}$, considering the wage $w^r_{\ell,t}$ requested by workers, if any. Each firm hires workers up to its total demand $L^d_{j,t}$ is fulfilled (or up to all workers in its queue, whichever is lower). So, the number of workers $L_{j,t}$ the firm employs, given the existing workforce $L_{j,t-1}$, is bound by:

$$0 \leq L_{j,t} \leq L^d_{j,t} \leq L^s_{j,t}, \qquad L^z_{j,t} = L_{j,t-1} + \#\{\ell^z_{j,t}\}, \quad z = d, s. \tag{3}$$

Therefore, the number of candidates in the job application queue $L^s_{j,t}$ is a critical constraint to the achievement in the matching process of the desired number of workers $L^d_{j,t}$. By the same token, as firms have heterogeneous wage offers $w^o_{j,t}$, workers increase their chances of getting a higher wage as the number of queues to which they participate increases. As the intensity of the search process is captured by the parameters $\omega$ and $\omega_{un}$, they in fact control the level of information available to the labour market participants. By varying those two parameters, in the following we shall study the impact of increasing width of job search activity. Of course, higher intensity of the search increases the information firms and workers are able to access and in principle ought to foster the efficiency of the matching process.

### 3.4.2 ALMP 2: Government-sponsored training

We extended the K+S model to account for the processes of accumulation and deterioration of workers' skills. Such processes are driven by worker-specific job tenures, assuming a learning-by-doing process when employed, a gradual deterioration of skills while unemployed. Here, we allow for the possible upgrade of the skills of unemployed workers participating in Government sponsored (re) training program. The skill level $s_{\ell,t} > 0$ of each worker $\ell$ evolves over time as a multiplicative process:

$$s_{\ell,t} = \begin{cases} (1+\tau_T)s_{\ell,t-1} & \text{if employed in } t-1 \\ (1+\tau_G)s_{\ell,t-1} & \text{if unemployed but under training in } t-1 \\ \dfrac{1}{1+\tau_U}s_{\ell,t-1} & \text{if unemployed and not under training in } t-1, \end{cases} \tag{4}$$

where $\tau_T \geq 0$ is a parameter governing the learning rate while the worker is employed, $\tau_G \geq 0$ is the learning rate of unemployed workers under training and $\tau_U \geq 0$, the corresponding parameter accounting for the skills deterioration when a worker is unemployed. As a consequence, when worker $\ell$ is employed or being trained her abilities improve over time, as she becomes more experienced in her task or acquire new skills. Conversely, unemployed workers lose skills. When a worker is hired, she immediately acquires the minimum level of skills already present in the firm (the incumbent worker with the lowest skills), if above her present level. Workers have a fixed working life: after a fixed number of periods $T_r$, workers retire and are replaced by younger ones,[5] whose skills are set to the current minimum level of employed workers.

[5] At the start of each simulation, initial workers ages are randomly draw in the integer range $[1, T_r]$ and all start from the same skills level.

Workers' skills define their individual (potential) productivity $A_{\ell,t}$:

$$A_{\ell,t} = \frac{s_{\ell,t}}{\bar{s}_t} A_i^\tau, \qquad \bar{s}_t = \frac{1}{L^S} \sum_\ell s_{\ell,t}, \tag{5}$$

where $\bar{s}_t$ is the average worker skills level, $A_i^\tau$ is the "standard" productivity of the vintage of the machinery which the worker operates, and $L^S$, the (fixed) total labour supply. Thus, the ratio $s_{\ell,t}/\bar{s}_t$, the worker normalized skills, represents her ability to produce more (if $s_{\ell,t} > \bar{s}_t$) or less than the "standard" associated with a given machine technology.[6]

The learning by tenure/doing process is well established in the literature at least since the seminal contribution of Arrow (1962). On the empirical side, for the links between job tenure, capability accumulation and firm productivity, see Zhou et al. (2011) and Lucidi and Kleinknecht (2009), among others.

Under ALMP 2, Government offers training to fraction $0 \leq \Gamma \leq 1$ of unemployed workers, randomly selected. Non-participating workers undergo a process of skills deterioration (at the $1/(1+\tau_U)$ rate) while trained ones learn at a rate $(1+\tau_G)$ rate (cf. Equation 4). In case of $\tau_G = 0$, of course the public training program just prevents skills deterioration.

The unit cost of the Government-sponsored training program is equal to a fraction $\Gamma_{cost}$ of the current average wage in the economy $\bar{w}_t$. So, the public expenditure devoted to the training activity is defined as:

$$G_t^{train} = (L^S - L_{t-1}^D)\Gamma \bar{w}_{t-1} \Gamma_{cost}. \tag{6}$$

### 3.4.3 Demand-management policies

The Government taxes firms and banks profits at a fixed rate $tr \geq 0$ and collects revenues as defined by:

$$Tax_t = \left(\Pi_t^1 + \Pi_t^2 + \Pi_t^b\right) tr, \tag{7}$$

where $\Pi_t^1$, $\Pi_t^2$ and $\Pi_t^b$ are the aggregate total profits of the capital-good, the consumer-good and the banking sectors, respectively.

The Government pays a benefit $w_t^{un}$ to unemployed workers which is a fraction of the current average wage $\bar{w}_t$:

$$w_t^{un} = \psi_T \bar{w}_{t-1} \tag{8}$$

where $0 \leq \psi_T \leq 1$ is a parameter representing the target benefit level, which can be reduced according to the applicable fiscal rules (see below). The unemployment benefit is the main tool of passive labor market policies (PLMPs). Considering the foregoing training cost $G_t^{train}$, the total public expenditure is:

$$G_t = (L^S - L_t^D) w_t^{un} + G_t^{train}. \tag{9}$$

Therefore, the public primary deficit (or surplus) is:

$$Def_t = G_t - Tax_t, \tag{10}$$

[6]Note that, in this specification, the firm-level effective productivity $A_{j,t}$ is a truly emergent property, resulting together from the technical innovation dynamics (the introduction of new vintages $A_i^\tau$), the worker skills evolution and the effective demand, which guides firms when deciding the capital stock dynamics and the employed machine mix (see Appendix A for details).

Accordingly, the stock of public debt is updated:

$$Deb_t = Deb_{t-1} + Def_t - \Pi_t^{cb} - G_t^{bail}, \tag{11}$$

where $\Pi_t^{cb}$ is the operational result (profits) of the Central Bank and $G_t^{bail}$ is the cost of rescuing (bail-out) the banking sector during financial crises, if any.

In the policy experiments, the provision of unemployment benefits will be studied under two alternative fiscal policy scenarios:

1. AS: Automatic Stabilizer. Unemployment benefits are provided without any binding constraint due to fiscal consolidation.

2. FC: Fiscal Compact. The public deficit on gross domestic product ratio ($Def_t/GDP_t$) shall not exceed 3% and the public debt on gross domestic product ratio ($Deb_t/GDP_t$) shall not exceed 60%. Whenever any of the current ratios turn binding, a restructuring procedure is enforced: the debt overhang is gradually repaid by reducing the unemployment benefits until the target(s) are met.

### 3.5 Timeline of events

In each simulation period, which can be taken to roughly represent a quarter, the following timeline of events take place:

1. Policy variables (prime rate and unemployment benefits) are fixed;
2. Total (potential) credit supply by banks to firms is determined;
3. Workers (employed, unemployed or under training) update their skills;
4. Machines ordered in the previous period (if any) are delivered;
5. Capital-good firms perform R&D and signal their machines to consumption-good firms;
6. Consumption-good firms determine their desired production, investment and workforce size;
7. Firms allocate cash-flows and (if needed) borrow from banks to operate and invest;
8. Firms send/receive machine-tool orders for the next period (if applicable);
9. Job-seeker workers send applications to firms;
10. Wages are set (indexation or bargaining) and job vacancies are partly or totally filled;
11. Firms pay wages and government pays unemployment subsidies and provides training;
12. Consumption-good market opens and the market shares are driven by competitiveness;
13. Firms and banks compute their profits, pay taxes and repay (quotas of) their debt;
14. Exit takes place, as near-zero share and bankrupt firms are eschewed from the market;
15. Aggregate variables are computed and the cycle restarts;
16. Entry occurs.

### 3.6 Alternative institutional regimes

The model is configured under two alternative institutional regimes (see Table 11 in Appendix B) which we call *Fordist* and *Competitive*.[7] Their characteristics are telegraphically sketched in Table 1.

| | Fordist (baseline) | Competitive |
|---|---|---|
| **Wage sensitivity to unemployment** | low (rigid) | high (flexible) |
| **Workers search activity** | unemployed only | unemployed and employed |
| **Labour firing restrictions** | under losses only | none |
| **Workers hiring priority** | higher skills | lower payback |
| **Workers firing priority** | lower skills | higher payback |
| **Unemployment benefits** | yes | yes (reduced) |
| **Minimum wage indexation** | full | partial |
| **Firms credit limits** | low | high |
| **Banks capital requirements** | high | low |

**Table 1:** Main characteristics of tested policy regimes.

Under the *Fordist regime*, wages are insensitive to the labour market conditions and indexed on a convex combination between economy-wide and firm-level productivity growth. There is a sort of covenant between firms and workers concerning long-term employment: firms fire only when their profits become negative, while workers are loyal to employers and do not seek for alternative jobs. When hiring and firing, firms aim to keep the more skilled workers. Labour market institutions contemplate a minimum wage fully indexed to the aggregate economy productivity and unemployment benefits are financed by taxes on profits.

Conversely, in the *Competitive regime*, flexible wages respond to unemployment in decentralized labour market dynamics, and are set by means of an asymmetric bargaining process where firms have the last say. Employed workers search for better paid jobs with some positive probability and firms freely adjust (fire) their excess workforce according to their planned production. The hiring and firing of workers by firms are based on a trade-off between skills and wages, using a simple payback-like comparison rule. The Competitive regime is also characterized by different labour institutions: minimum wage is only partially indexed to productivity and unemployment benefits (together with the associated taxes on profits) are relatively lower.

We also differentiate the two regimes in terms of the parameters governing prudential limits in the supply of credit, with the Competitive characterised by a *higher* credit limit to firms indebtedness and a *lower* minimum bank capital adequacy rate (see Appendix A for the details on the credit supply mechanism). Both variations effectively ease the credit provisions by banks to firms despite the inherent increasing in the financial fragility of these agents.

In Section 5 we experiment with a regime transition along the simulation history, capturing a set of labour-market structural reforms. This institutional shock, aimed at spurring flexibility on the relations among agents in the labour market, implies that the social compromise embodied

[7] The two regimes roughly capture two alternative *wage-labour nexus* in the language of the *Regulation Theory* (see, within a vast literature, Boyer and Saillard, 2005 and Amable, 2003).

in the Fordist regime is replace by the Competitive one. The shocks also incorporate financial deregulation in the credit market.

### 3.7 Empirical validation

The K+S model is able to generate endogenous growth and business cycles, emergent crises, and to reproduce a rich set of macro stylized facts (relative volatility, co-movements, etc.) and micro ones (firm size distributions, firm productivity dynamics, etc.) as shown in the top panel of Table 2 (more details in Dosi et al., 2010, 2013, 2015, 2017a). In addition, the labour-enhanced version of the model (Dosi et al., 2017b,c), which explicitly accounts for decentralized firm-worker interactions, robustly replicate most of the labour market empirical regularities (cf. the bottom panel of Table 2).

| Microeconomic Stylized Facts | Aggregate-level Stylized Facts |
|---|---|
| Skewed firm size distributions | Endogenous self-sustained growth with persistent fluctuations |
| Fat-tailed firm growth rates distributions | Fat-tailed GDP growth rate distribution |
| Heterogeneous productivity across firms | Endogenous volatility of GDP, consumption and investment |
| Persistent productivity differentials | Cross-correlation of macro variables |
| Lumpy investment rates of firms | Pro-cyclical aggregate R&D investment and net entry of firms in the market |
| Heterogeneous skills distribution | Persistent and counter-cyclical unemployment |
| Fat-tailed unemployment time distribution | Endogenous volatility of productivity, |
| Fat-tailed wage growth rates distributions | unemployment, vacancy, separation and hiring rates |
| | Unemployment and inequality correlation |
| | Pro-cyclical workers skills accumulation |
| | Beveridge curve |
| | Okun curve |
| | Wage curve |
| | Matching function |

**Table 2:** Stylized facts matched by the K+S model at different aggregation levels.

## 4 ALMPs experiment results

### ALMP 1: search activity and mismatches

We start by presenting the effects of different degrees of search activity and the corresponding impact on the matching process between supply and demand. In the model, there are two parameters for setting the search intensity/information level in the labour market, namely $\omega$ and $\omega_{un}$, which set the mean number of job applications sent by employed and unemployed workers to firms on each period, respectively. By changing the number of applications we mimic the effect of policies aimed at improving the job-search intensity and we analyse the consequences

upon the hiring rate and ultimately on the labour demand. Note also that we assume that such a policy can be implemented at no cost. Table 3 reports the tested configurations for both institutional regimes.[8]

| | Search activity | | |
|---|---|---|---|
| $(\omega, \omega_{un})$ | Low (Baseline) | Medium | High |
| **Fordist** | $(2, 5)$ | $(50, 50)$ | $(100, 100)$ |
| **Competitive** | $(2, 5)$ | $(50, 50)$ | $(100, 100)$ |

**Table 3:** Configuration of parameters $(\omega, \omega_{un})$ for different levels of worker job-search activity.

Figure 2 presents a performance comparison exercise in terms of (a) hiring rates (hired workers over total labour supply) and of (b) vacancy rates (unfilled positions over total labour supply) among the three different degrees of search intensity in both regimes. With reference to the Fordist case, the search intensity *does not* significantly affect either the number of hired workers or the number of unfilled positions. Conversely, moving to the Competitive set up, the higher intensity of search leads toward mildly higher hiring and vacancy rates, signalling that although the matching improves, this occurs at the cost of higher turbulence in the labour market. Notably, as shown by Figure 2(c), in the Competitive case the average worker skills level *decreases* under the high search scenario, due to the shorter tenure (time in the job) periods.

On top of that, the key metrics related to the long-run dynamics of the model, like GDP and productivity growth, unemployment, and inequality are *not* affected by the increased of search activity in both regimes, as evidenced in Table 4.[9] In fact, the only statistically relevant impact of the increased information level is a mild reduction in the (already low) unemployment level in the Fordist regime.

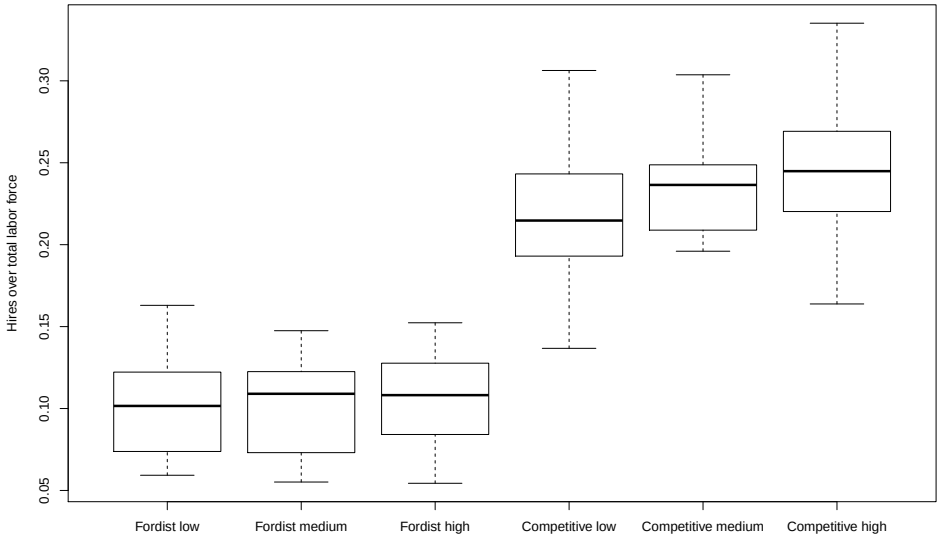
From this first battery of results it clearly emerges that job-search-enhancing ALMPs aimed at fostering efficiency in the labour market are not effective under a more rigid industrial relations regime like the Fordist, while they look more relevant in the more flexible Competitive institutional set up in terms of increasing the matching process measured in terms of hiring rate. Nonetheless, this improvement comes at the cost of additional turbulence, as shown by the increased unfilled vacancies. And at least equally important, these experiments show that this kind of policy are ineffective to boost the long-run growth. Naturally, the assessment of the impact of ALMP 1 would be even worse if one also considered the cost of its implementation.

[8]The intensity labels (low, medium, high) are just references for the chosen parameter values, admittedly extreme to allow for the exploration of scenarios closer to the complete information case. Of course, the submission of 50 or 100 job applications in a single period (quarter) would represent a very high level of search activity when compared to the empirical evidence.

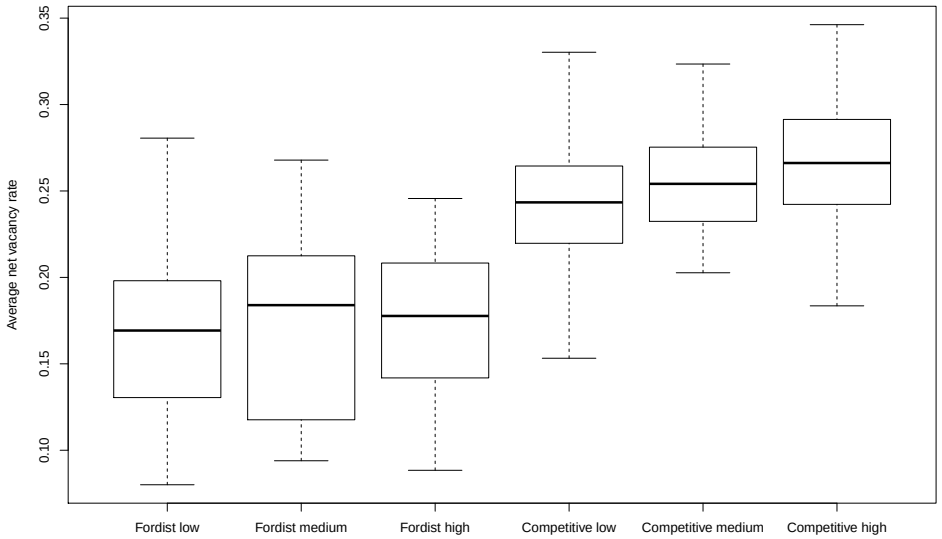
[9]This table, as well the similar ones below, compares the average results from different model configurations on several macroeconomic variables as the ratio (division) between the respective variables for each of the variants with respect to the same variable for the chosen baseline case. Also a two-means t-test is performed in each case to evaluate if the difference between the variant and the baseline is statistically significant and at which p-value level.

**Figure 2:** Performance comparison between regimes and different degrees of intensity of job search. Statistics for 50 MC runs in period $[200, 400]$. Bar: median | box: 2nd-3rd quartile | whiskers: max-min | dots: outliers.

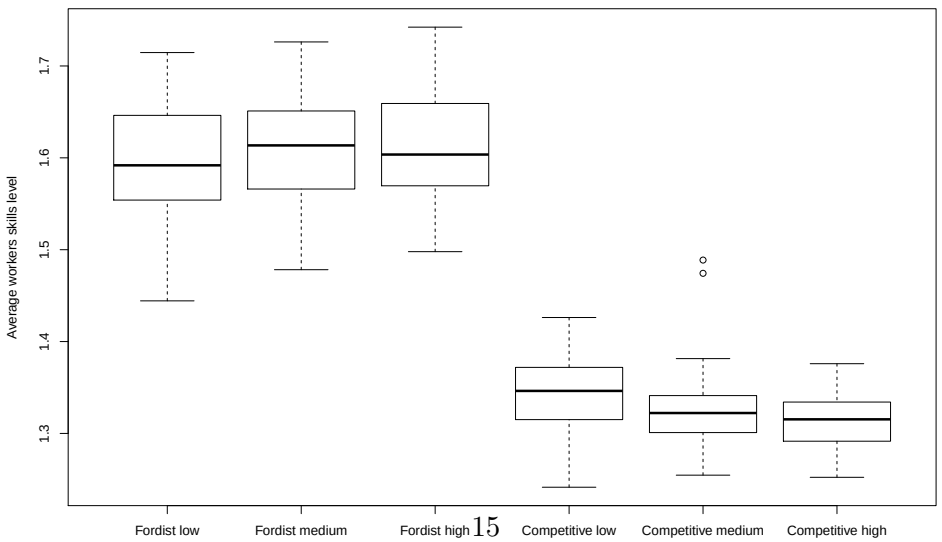
**(a)** Hiring rate




**(b)** Vacancy rate




**(c)** Workers average skills



| Fordist | Low (Baseline) | Medium | | High | |
|---|---|---|---|---|---|
| | Baseline | Ratio | p-value | Ratio | p-value |
| **GDP growth** | 0.02 | 0.94 | 0.28 | 0.99 | 0.83 |
| **Productivity growth** | 0.02 | 0.95 | 0.33 | 1.00 | 0.91 |
| **Unemployment** | 0.02 | 0.62 | 0.01 | 0.59 | 0.01 |
| **Income concentration** | 0.05 | 1.20 | 0.05 | 1.09 | 0.18 |
| Competitive | Low (Baseline) | Medium | | High | |
| | Baseline | Ratio | p-value | Ratio | p-value |
| **GDP growth** | 0.01 | 0.96 | 0.71 | 0.95 | 0.72 |
| **Productivity growth** | 0.01 | 0.95 | 0.69 | 0.97 | 0.77 |
| **Unemployment** | 0.20 | 1.01 | 0.87 | 1.03 | 0.35 |
| **Income concentration** | 0.18 | 1.01 | 0.77 | 0.99 | 0.67 |

**Table 4:** Performance comparison among three alternative scenarios in two regimes. Averages for 50 MC runs in period $[200, 400]$. p-value for a two-means t test, $H_0$: no difference between scenarios.

## ALMP 2: the effects of qualification training

Let us turn to the simulation results on the ALMP 2 experiment. The four scenarios under analysis are summarized in Table 5. They are configured in order to compare three different changes: (i) in the institutional set up from Fordist to Competitive labour relations, (ii) the provision of passive vs. active labour market policies in the Competitive regime, (iii) the combination of the two. The experiment is meant to explore whether flexible labour markets – properly "oiled" by the policy schemes – might have (at least) the same efficiency and equity outcomes of a more rigid market. Moreover, we investigate the extent to which the adopted policy scheme can "lubricate" labour market matching and, through that sustain aggregate demand. In the following, we compare the aggregate empirical regularities of the alternative configurations in terms of the efficiency and equity performances of the system.

| | Unemployment benefits | Qualification training |
|---|---|---|
| **Fordist** | ✔ | ✖ |
| **Competitive 1** | ✔ | ✖ |
| **Competitive 2** | ✖ | ✔ |
| **Competitive 3** | ✔ | ✔ |

**Table 5:** The tested ALMPs and PLMPs configuration scenarios.

We start analysing the *movement* in some regularities in the matching process. Table 6 presents the slopes for the fitted Beveridge, matching function and Okun curves.[10]

The Beveridge curve captures the degree of frictional mismatch in the labour market by connecting the vacancy to the unemployment rate. A clear *outward shift* emerge in the curves moving from the Fordist to the Competitive regimes, independently from the precise policy mixes which mirror similar historical evidence. This shift depicts a change in the efficiency of

[10]The linear fittings are performed by ordinary least-squares regression. The average $R^2$ was 0.22, indicating a reasonably good fitting to a linear model.

the matching process. This "malfunctioning" behaviour, namely a *positive* correlation between vacancy and unemployment rates, has been documented in the recent years and explained by an increasing mismatch between labour demand and labour supply.[11] The reasons generally put forward for the increase are both the cyclical components of the business cycle, and also structural changes in long-term unemployment. The latter includes changes in the composition of labour supply and the potential twisting effects of the policies schemes. Here we suggest that of particular relevance for the interpretation of the evidence is the effect exerted by the *reduction* in aggregate demand upon the labour market efficiency, via an increase in the long-term unemployment rate.

| | Fordist | Competitive | | |
|---|---|---|---|---|
| | | Un.ben. | Train. | Un.ben.&train. |
| **Beveridge curve** | -0.043 | 0.360 | 0.061 | 0.205 |
| | (0.054) | (0.044) | (0.028) | (0.046) |
| **Matching function** | 0.279 | 0.557 | 0.397 | 0.571 |
| | (0.014) | (0.042) | (0.035) | (0.037) |
| **Okun curve** | -0.202 | -0.219 | -0.192 | -0.197 |
| | (0.020) | (0.018) | (0.019) | (0.014) |

**Table 6:** Fitted coefficient (slope) of a OLS regression for selected curves. Averages for 50 MC runs in period $[200, 400]$. MC standard errors in parentheses.

Further support on the effects of the reduced aggregate demand upon the labour market matching efficiency can be inferred from the matching function curve, i.e. basically the relationship between the probability of finding a job and the vacancy/unemployment ratio. In line with the empirical evidence, the two variables are positively correlated in the four scenarios. However, the training only policy is the *least* effective alternative in a Competitive regime in order to improve matching (or to increase the curve slope), as presented in Table 6. This policy is significantly worse with respect to the two alternatives which include the continuing provision of unemployment benefits.

Finally, when analysing the Okun curve slope, the negative correlation between unemployment and GDP growth, Table 6 shows a close behaviour in the all set ups, independently from the adopted policy schemes. Again, these results hint at the detrimental effects of unemployment on output growth.

A further step in understanding the effects of the combination of a regime change and the alternative policy schemes involves the analysis of the dynamics of macroeconomic variables. Figure 3(a) presents the dynamics of the actual and the full-utilization GDP. Two of the configurations are set at time $t = 0$ under the Fordist regime without training (the lines 'Fordist' and 'Competitive + Unemployment Benefits') and the other two, under Fordist with training (the lines 'Competitive + Training' and 'Competitive + Unemployment Benefits + Training'). At $t = 100$ (dotted line) we introduce an institutional regime change to the three Competitive variants. The trajectories of the GDP (the averages of 50 Monte Carlo simulation runs) show

[11] See Bova et al. (2017) who document how 10 out of 12 of the OECD countries under examination experienced an outward shift of the Beveridge Curve during the recent crisis.

a long-run divergence between the set-ups.[12] Clearly, the worst performer is the training-only Competitive scenario (with no unemployment benefits), wherein only the supply side policy is undertaken.

A careful look at the skills dynamics presented in Figure 3(b) clarifies the effects of the training programs. Under the policy settings offering them, the average skills dynamics improves sensibly. Indeed, the training program is effectively protecting the unemployed worker skills from deterioration. Yet, it cannot compensate the increased average unemployment level and so it does not recover the Fordist skilling level. In fact, as skills accumulate under worker job tenure (see Equation 4), since the Competitive set-ups are characterized by a lower average tenure as compared to the Fordist one, the bias in favour of the latter is significant.

The detrimental effects of wage and numerical flexibility introduced by the regime change are also documented in Table 7, which shows the significant differences among the scenarios for the vacancy and the unemployment rates. Finally, note that the unemployment rate is even higher under the training-only scenario, while it is mitigated to some extent by the provision of unemployment benefits, confirming their Keynesian effects.

| | Fordist | Competitive | | | | | |
|---|---|---|---|---|---|---|---|
| | | Un.ben. | | Train. | | Un.ben.&train. | |
| | Baseline | Ratio | p-value | Ratio | p-value | Ratio | p-value |
| **GDP growth** | 0.02 | 0.79 | 0.00 | 0.73 | 0.00 | 0.88 | 0.06 |
| **Volatility of GDP growth** | 0.11 | 0.99 | 0.91 | 1.22 | 0.00 | 0.89 | 0.01 |
| **Recovery from GDP crises** | 9.30 | 1.91 | 0.00 | 2.18 | 0.00 | 2.16 | 0.00 |
| **Losses from GDP crises** | 0.98 | 4.85 | 0.00 | 7.37 | 0.00 | 4.43 | 0.00 |
| **Capacity utilization** | 0.79 | 1.03 | 0.00 | 1.02 | 0.10 | 1.03 | 0.01 |
| **Productivity growth** | 0.02 | 0.81 | 0.01 | 0.76 | 0.00 | 0.90 | 0.08 |
| **Unemployment** | 0.02 | 13.39 | 0.00 | 16.02 | 0.00 | 13.32 | 0.00 |
| **Vacancy** | 0.17 | 1.41 | 0.00 | 1.32 | 0.00 | 1.36 | 0.00 |
| **Workers skills** | 1.60 | 0.84 | 0.00 | 0.88 | 0.00 | 0.91 | 0.00 |
| **Wages dispersion** | 0.10 | 1.65 | 0.00 | 1.81 | 0.00 | 1.82 | 0.00 |
| **Income distribution** | 0.05 | 3.81 | 0.00 | 5.64 | 0.00 | 3.96 | 0.00 |
| **Mark-ups** | 0.22 | 1.00 | 0.35 | 1.02 | 0.00 | 1.01 | 0.00 |
| **Loans** | 0.57 | 15.20 | 0.31 | 1.87 | 0.01 | 1.50 | 0.01 |
| **Financial fragility** | 0.00 | 2.63 | 0.00 | 2.79 | 0.00 | 1.85 | 0.03 |

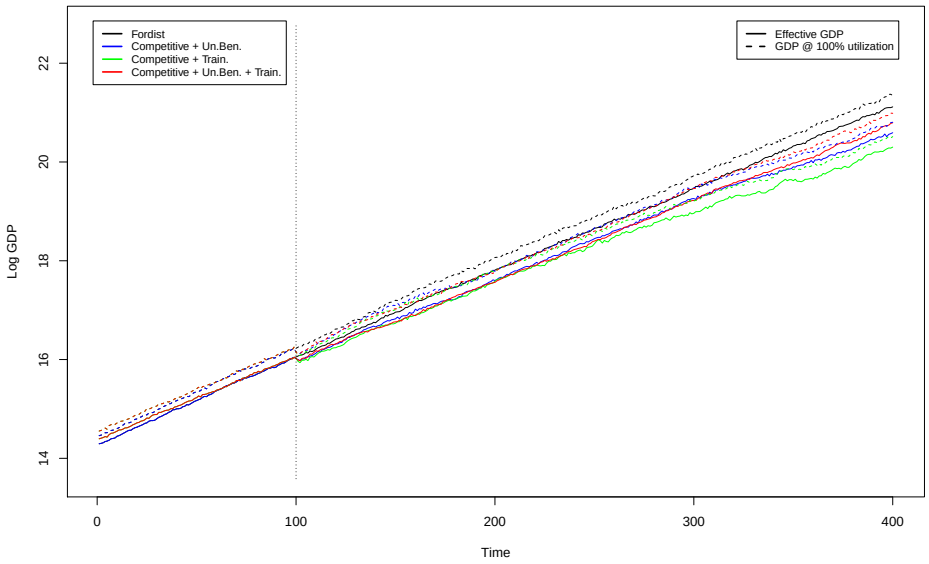
**Table 7:** Performance comparison among four alternative scenarios, selected time series. Averages for 50 MC runs in period $(200, 400)$. p-value for a two-means t test, $H_0$: no difference between scenarios.

Moving from efficiency toward equity variables, Figure 3 and Table 7 also present some metrics on income inequality. It is quite evident that in absence of unemployment benefits ALMPs are not able to mitigate the negative effects of labour market flexibility. In fact, the profit share is mildly higher in the Competitive variants. Further, a much more striking difference emerges in the income concentration measure (the Gini coefficient) which include income of both employed and unemployed workers. Figure 3(c) shows how deeply the index is affected by the

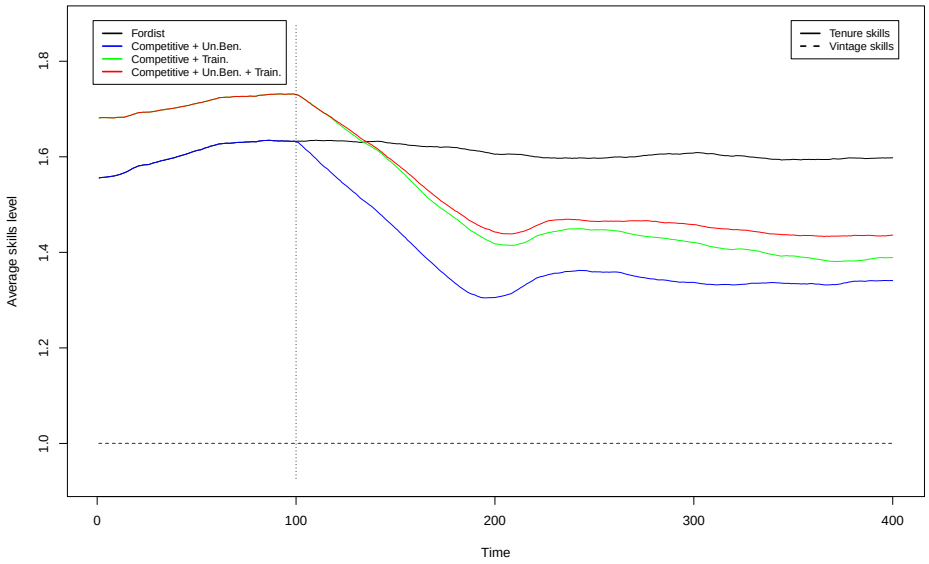
[12] Those are interesting examples of super-hysteresis. For a definition of the concept and a discussion about it, see Dosi et al. (2018).

**Figure 3:** Macroeconomic dynamics in alternative policy regimes. Lines represent 50 MC runs averages.

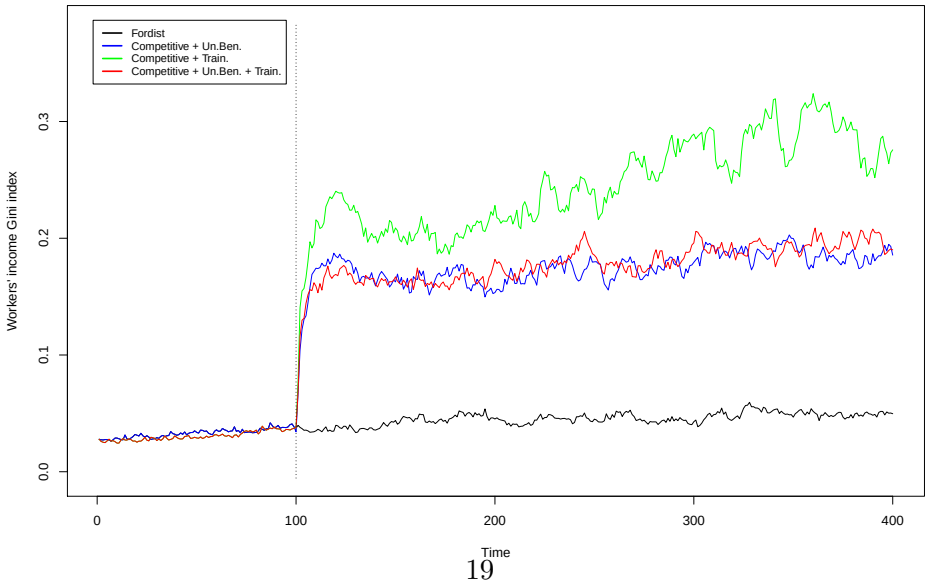
**(a)** Actual and full capacity GDP




**(b)** Average worker skills




**(c)** Income concentration



regime change, presenting a highly positive change (i.e. worsening distribution) when the supply-side-only policy is performed. Finally, when looking at inequality among employed workers (the real wages dispersion), a similar pattern appears. Those results confirm that not even the combination of supply and demand labour market policies (ALMPs and PLMPs, respectively) is able to mitigate the negative outcomes from the regime change to the Competitive one.

Let us now address the potential for hysteresis in more flexible labour markets (which we discuss at greater length in Dosi et al., 2018). Figure 4 presents the scenario performance in terms of (a) the GDP growth, (b) the GDP average losses incurred during deep crises, and (c) the average number of periods required for the GDP to recover the pre-crisis trend level. Under the Competitive variants, *even with* both ALMPs and PLMPs, the average GDP growth rate is lower. The supply-side-only scheme exhibits a much worse performance than traditional Keynesian demand-side policies. Looking at the losses of the GDP due to deep crisis (more that 3% GDP reduction) and the duration of the crises, a similar picture emerges. Losses are substantially higher under the training-only Competitive variant and recovery periods are longer. The relative performance metrics of the various policy scenarios is presented in Table 7. Overall the training-only scheme usually exhibits the worst outcomes.

The bottom-line of this second battery of experiments is that demand-side policies like unemployment benefits are better suited to foster economic growth, reduce unemployment, and mitigate inequalities. At the same time, supply side policies aimed at raising skills of unemployed workers are *not enough* to counterbalance adverse labour markets, despite their positive effect attenuating the overall worker skills deterioration.

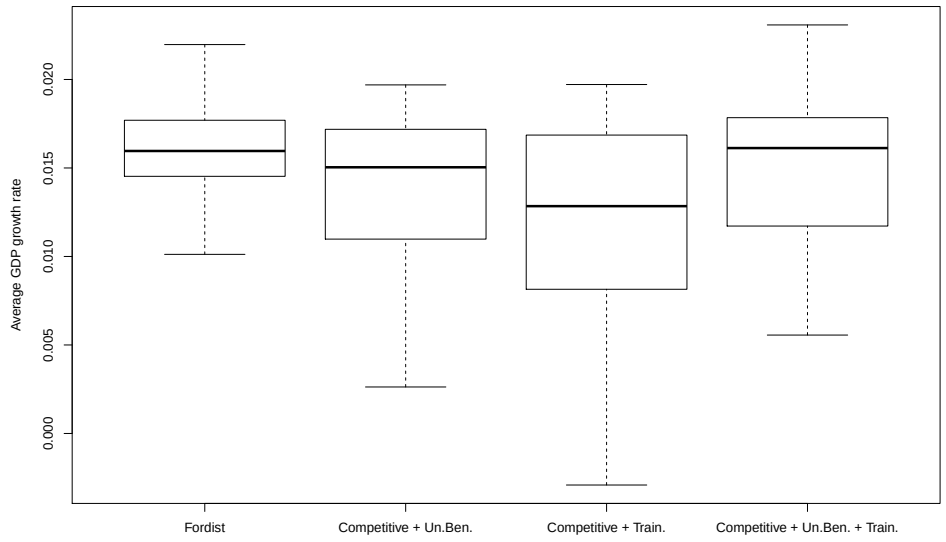
The symmetric litmus test in order to evaluate the effects of the policy schemes, whose costs affect the government budget, is to understand whether they impact on those who take part to the policy-sponsored program. In particular, with reference to (re)qualification training initiatives, the policy maker is usually interested in evaluating the impact of the program at least upon (i) the wage level, (ii) the wage growth, and (iii) the unemployment duration. Therefore, we asses the effectiveness of training-based ALMPs comparing those three metrics among the policy scenarios.

Figure 5(a) presents the worker-level wage distributions for the alternative regimes. If the training scheme would have helped trained workers in getting a higher wage compared to untrained ones, we should have observed a wage distribution shifted toward the right. However, the distributions of the three Competitive scenarios are almost overlapping, with just a positive but small impact of training. Similarly, Figure 5(b) shows wage growth dynamics: the presence and participation to the training program has no relevant influence in this respect (completely overlapping distributions). The most striking result concerns the distribution of the unemployment duration, presented in Figure 5(b). The training-only scenario (the green curve and dots) presents the most right-skewed distribution, hinting at the fact that the training scheme is *not able* to reduce the duration of unemployment spells. Indeed, here the model replicates the "training trap" phenomena mentioned in Section 2. Such an evidence also reinforces the detrimental effects of the reduced aggregate demand due to the regime change and the absence of unemployment benefits on the labour market.

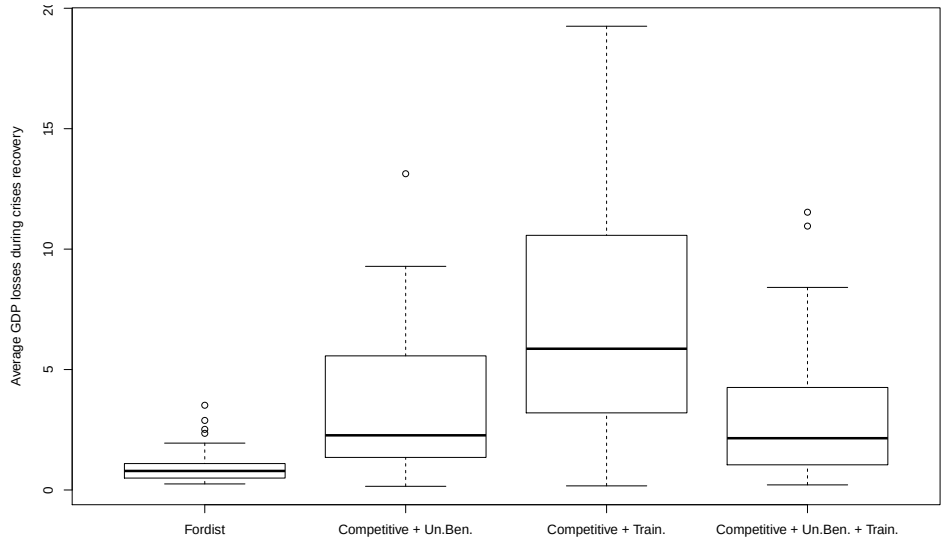
Finally, in order to evaluate the transmission mechanisms from the labour market to the credit market and their interactions, let us present some comparisons in terms of the financial

**Figure 4:** Performance comparison between policy scenarios. Statistics for 50 MC runs in period $[200, 400]$. Bar: median | box: 2nd-3rd quartile | whiskers: max-min | dots: outliers.

**(a)** GDP growth




**(b)** Losses from GDP crises




**(c)** Recovery from GDP crises

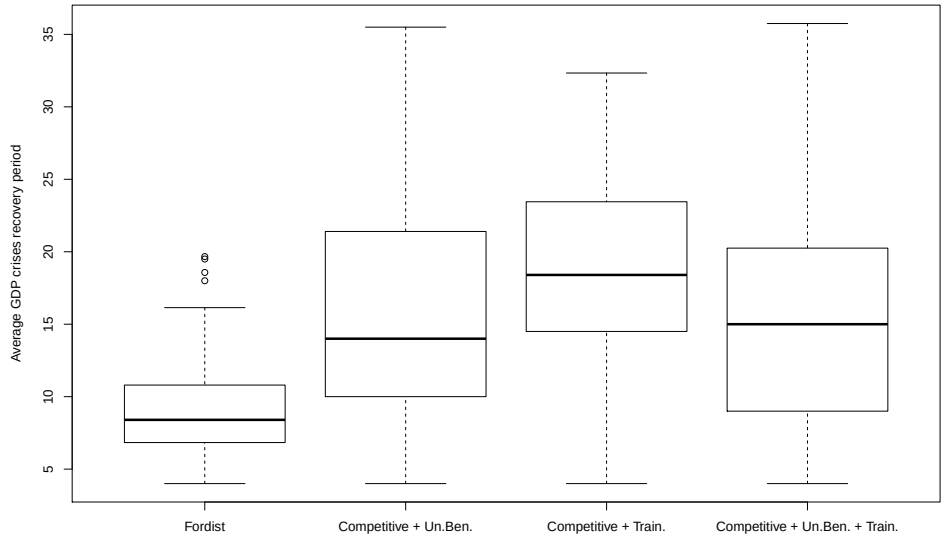
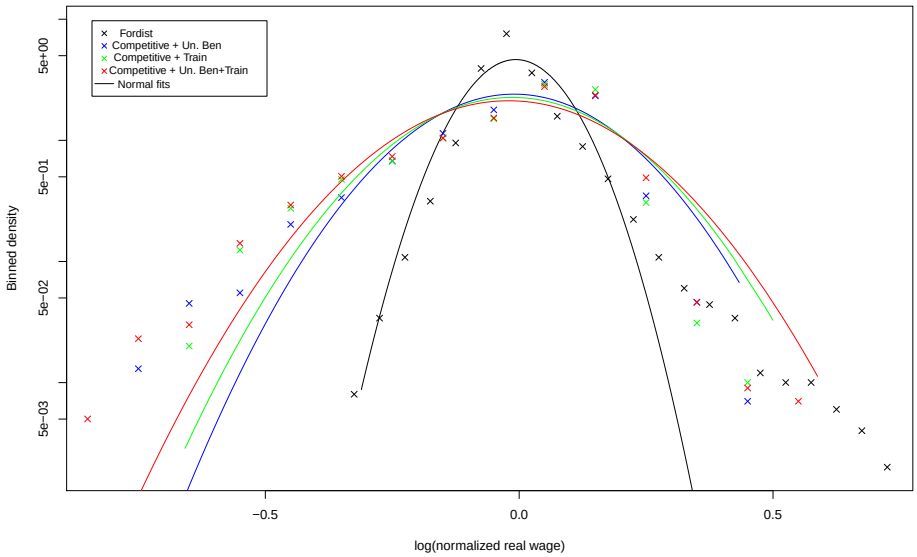
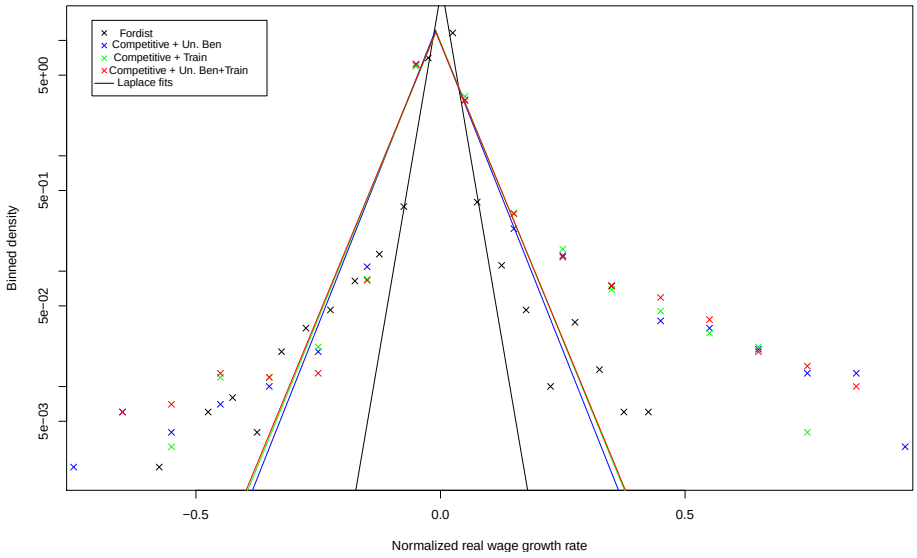


**Figure 5:** Worker-level analysis. Data pooled from 10 simulation runs in period $[200, 400]$.

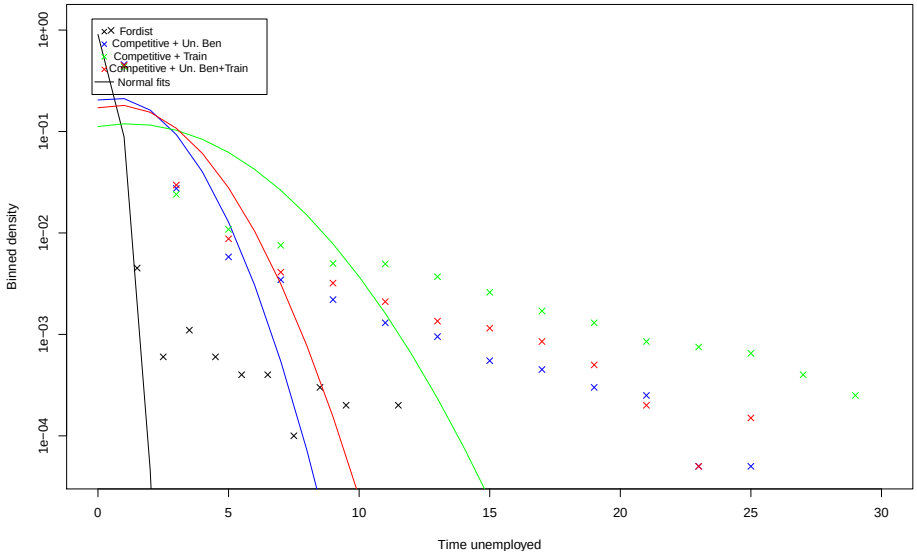
**(a)** Log-normalized real wages distribution




**(b)** [Log-normalized real wage growth distribution




**(c)** Unemployment time distribution



| | Unemp. benefits | Qualif. training | Fiscal policy |
|---|---|---|---|
| **Fordist** | ✔ | ✖ | Automatic stabilizer |
| **Competitive AS** | ✔ | ✔ | Automatic stabilizer |
| **Competitive FC** | ✔ | ✔ | Fiscal Compact |

**Table 8:** The tested fiscal rule configuration scenarios.

performance of the economy. Figure 6 shows (a) the total loans provided by banks and (b) the financial fragility of banks under the alternative scenarios. Considering the increased prudential limits and the reduced capital requirements applicable to banks after the policy regime transition at $t = 100$ (see Section 3.6), a rise in both macro variables should be expected. More interestingly, the total supply of loans and in particular the degrees of financial fragility are differently affected by the variants in the Competitive regime. The overall levels and volatility of the stock of debt kept by firms increase as the labour market policies are changed, as presented in Figure 6(a). Remarkably, the adoption of training-only policies are particularly negative for the stability of the financial system, as indicated by Figure 6(b). The message here seems clear: moving to a more flexible labour and more deregulated credit market regimes potentially augments systemic risk of the banking system, which is only mitigated by a combination of PLMPs and ALMPs.[13]

## 5 The European policy mix: flexibility and austerity

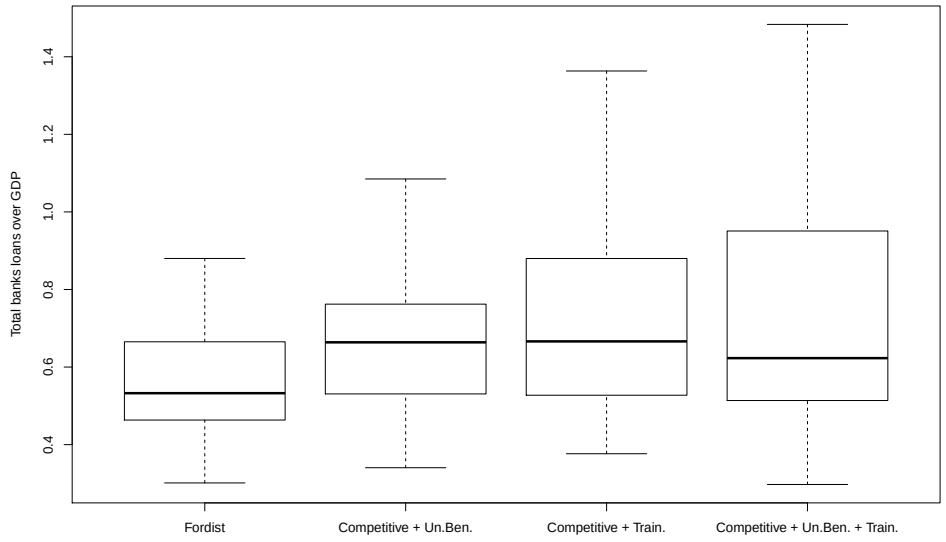
Let us move a step forward and study policy mixes between Competitive labour markets with ALMPs and fiscal austerity, testing the implementation of the full package of reforms – as several countries recently did – might affect the system. In particular, we test the best-performing variant of the Competitive regime as presented in the previous section (including both demand and supply policies) under two alternative fiscal policies. The first entails an automatic stabilizer rule (AS) wherein there is no hard limit to public expenditure, while the second applies the Fiscal Compact rule (FC) that enforces strict prescriptions for the public deficit and debt as described in Section 1. Of course, the claimed objectives of the policy schemes are (i) to improve GDP growth, (ii) the stabilization of public finance, and (iii) the smoothing of labour market mechanisms. A Fordist scenario is included for reference. Do they succeed? Table 8 illustrates the three tested configurations. In particular, let us focus on the performance of the economy when unemployment benefits have no binding constraints as compared to a set-up whereby they must be cut to comply with the FC requirements.

Figure 5 presents a concise set of the relevant metrics that describe the behaviour of the model under AS and FC fiscal rules. Figure 5(a) shows the long-term path of GDP (actual and if all available capacity is used). Not surprisingly, whenever the FC rule is binding, and so unemployment benefits are reduced, the performance of the system is *inferior as the GDP growth trajectory is permanently damaged*. This super-hysteresis phenomenon (Ball, 2014; Blanchard et al., 2015) is more present in all Competitive set-ups as compared to the Fordist baseline but is more pronounced under the FC scenario. Moreover, when comparing GDP losses in deep

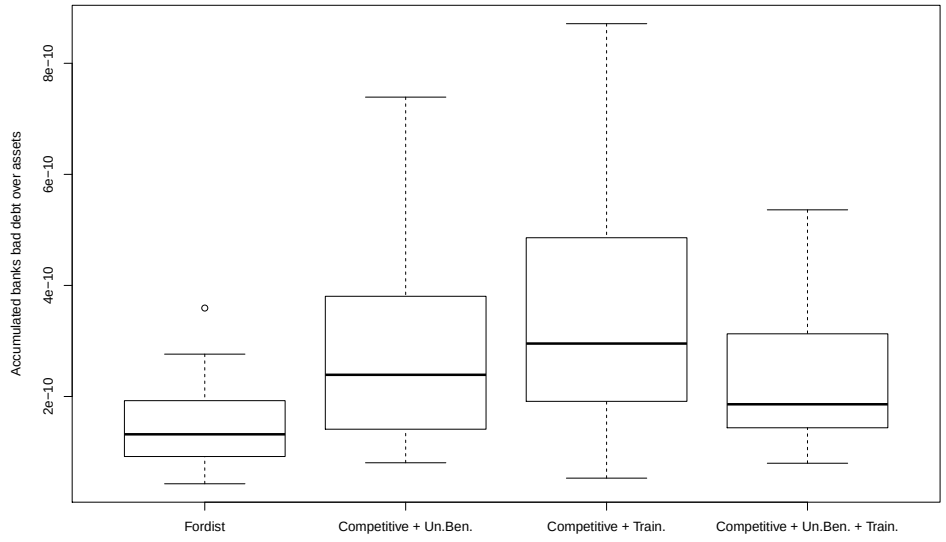
[13]Note that the macroeconomic impact of the regime change is largely attributable to changed conditions on the labour market, irrespectively of the parametrization of the credit market.

**Figure 6:** Performance comparison between policy regimes. Statistics for 50 MC runs in period $[200, 400]$. Bar: median | box: 2nd-3rd quartile | whiskers: max-min | dots: outliers.

**(a)** Loans




**(b)** Financial fragility

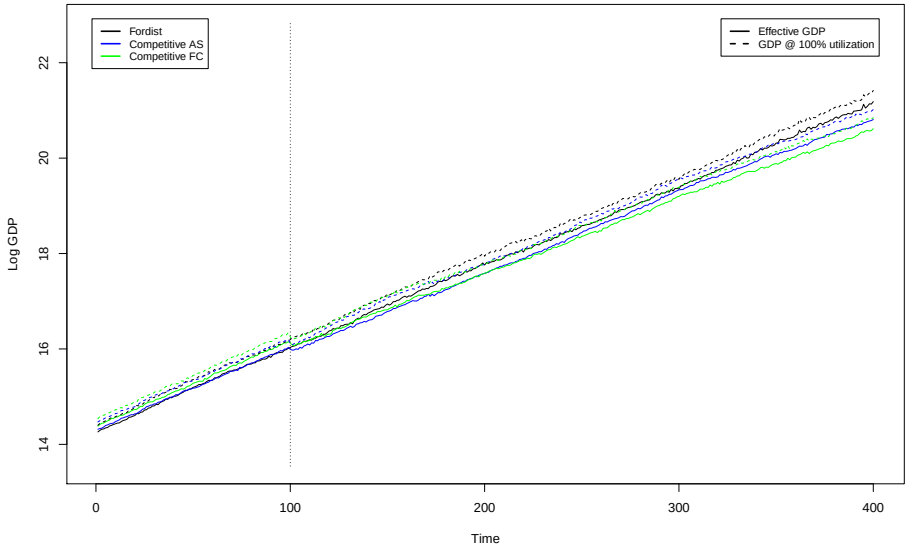


crises (Figure 5(b)), the FC rule clearly reveals the significant costs associated to "turning off" the Keynesian automatic stabilizers during some of the periods in which they are actually more required.

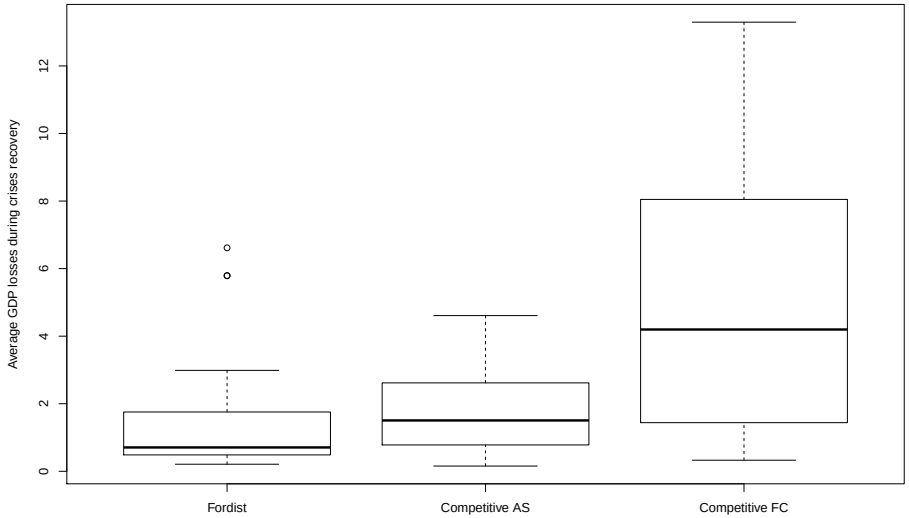
The status of public finance *does not improve* in the Competitive set ups when compared to the Fordist baseline, well the opposite. First, public deficit (see Figure 5(c)) shows the long-run sustainability problem of the Competitive AS scenario, given the explosive path of public debt revealed in Figure 5(d). Conversely, second, even when the Competitive FC is sustainable in the long run, its associated social costs might be dramatic: Figure 5(d) shows that public debt in the FC scenario only slowly converge to the Fordist case in the long run due to its short-term *self-defeating* nature. Indeed, as shown in Dosi et al. (2015, 2016), austerity policies might well be self-defeating also in the long-run, bringing the economy to the surge of the total collapse.

**Figure 7:** Macroeconomic dynamics in alternative policy regimes (a,c,d) and performance comparison (b). Lines (a,c,d) represent 50 MC runs averages. Statistics (b) for 50 MC runs in period [200, 400]. Bar: median | box: 2nd-3rd quartile | whiskers: max-min | dots: outliers.

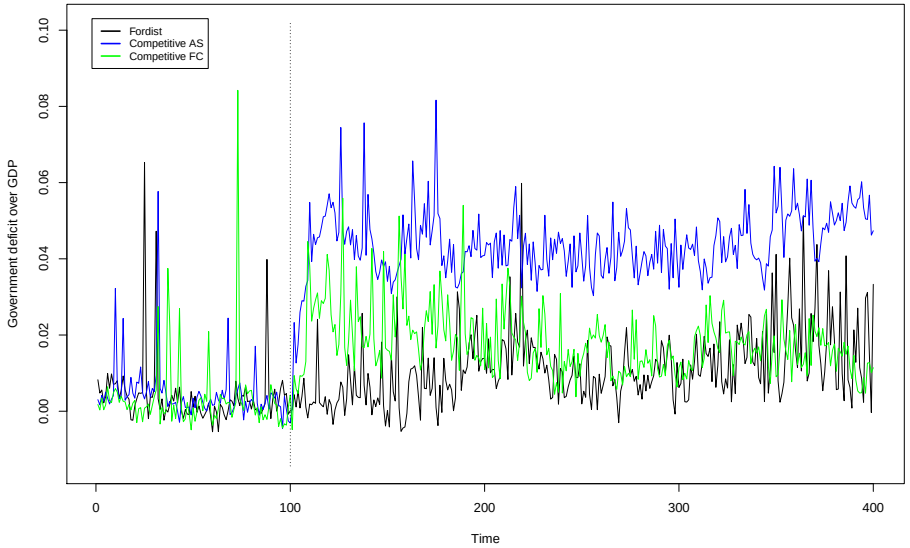
**(a)** Actual and full capacity GDP



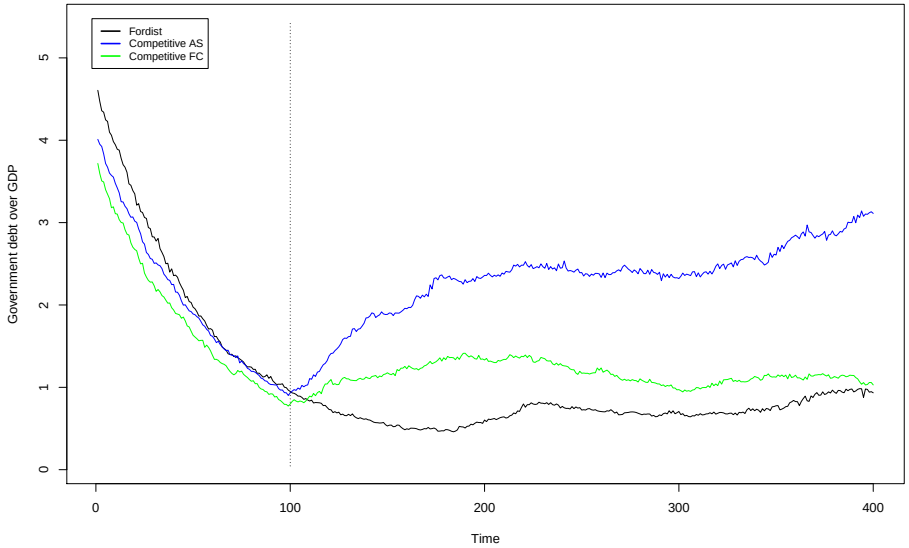

**(b)** Losses from GDP crises




**(c)** Public deficit/GDP ratio




**(d)** Public debt/GDP ratio



A set of additional relative metrics is presented in Table 9 using the Fordist case as the baseline. First and foremost, the Competitive regime under all the three tested policy settings show a clear tendency to operate on much higher unemployment and inequality levels, as already discussed above, yet more pronounced in the FC case.[14]

| | Fordist | Competitive | | | |
|---|---|---|---|---|---|
| | | AS | | FC | |
| | Baseline | Ratio | p-value | Ratio | p-value |
| **GDP growth** | 0.02 | 0.97 | 0.53 | 0.76 | 0.00 |
| **Volatility of GDP growth** | 0.12 | 0.84 | 0.00 | 1.11 | 0.07 |
| **Recovery from GDP crises** | 11.31 | 1.37 | 0.16 | 2.02 | 0.00 |
| **Losses from GDP crises** | 1.84 | 1.57 | 0.30 | 3.37 | 0.00 |
| **Inflation** | 0.00 | -6.46 | 0.00 | -2.15 | 0.02 |
| **Capacity utilization** | 0.81 | 1.00 | 0.89 | 0.98 | 0.09 |
| **Productivity growth** | 0.02 | 1.02 | 0.64 | 0.82 | 0.03 |
| **Unemployment** | 0.02 | 10.09 | 0.00 | 12.12 | 0.00 |
| **Vacancy** | 0.15 | 1.52 | 0.00 | 1.47 | 0.00 |
| **Workers skills** | 1.86 | 0.84 | 0.00 | 0.82 | 0.00 |
| **Wages dispersion** | 0.11 | 1.66 | 0.00 | 1.74 | 0.00 |
| **Income distribution** | 0.05 | 3.34 | 0.00 | 4.71 | 0.00 |
| **Mark-ups** | 0.22 | 1.02 | 0.00 | 1.03 | 0.00 |

**Table 9:** Performance comparison among automatic-stabilizer and austerity policies, selected time series. Averages for 50 MC runs in period $(200, 400)$. p-value for a two-means t test, $H_0$: no difference between scenarios.

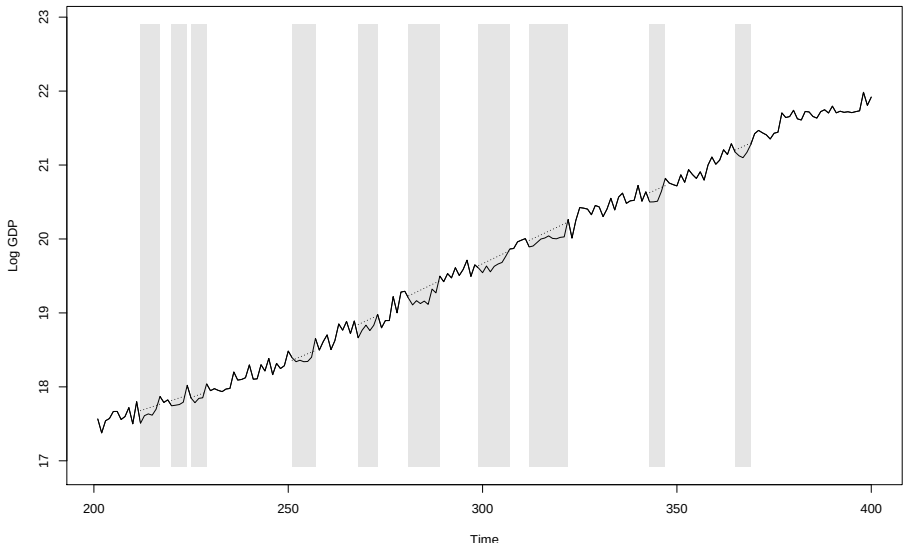
A last but not least result from Table 9 shows that not only the average cost and time to recover from big crises are substantially increased under the FC rule, but also the frequency of large downturns is significantly augmented. Figure 8 presents some graphical representative samples of this phenomena, marking in grey the recovery periods after all crises in which the GDP shrinks at least 3% and plotting with dotted lines the pre-crisis growth trend.[15] The difference in terms of hysteresis among the three set ups is rather pronounced. The Fordist regime presents frequent but mild fluctuations whose recovery periods are usually short, as measured by the length of the grey areas. In comparison, the Competitive AS sample exhibits deeper crises and longer recoveries. Note, however, that in this case the dashed lines have similar slopes, indicating that the "growth potential" is being (more or less) preserved during the crises. This situation changes in the FC sample, with even stronger and more lasting crises, wherein more frequently the dashed line slope changes, indicating the highest level of hysteresis and consequently the long-lasting, recession-shaped, lower GDP growth rates.

[14] As a side note, but also in line with the empirical track, both Competitive scenarios operate under a significantly lower (consumer) inflation rate.

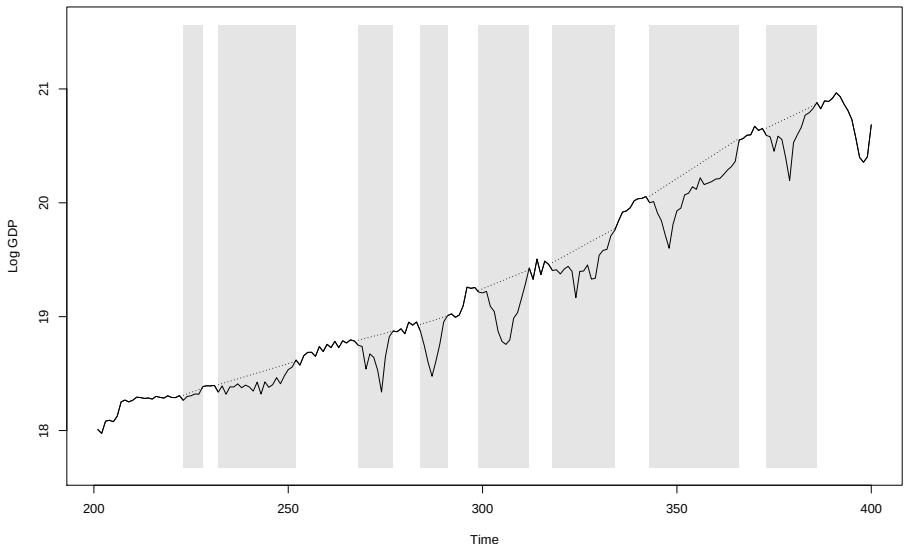
[15] The plots are selected from the 50 Monte Carlo runs used for statistics gathering in each of the tested configurations.

**Figure 8:** GDP long-term trend recovery after crisis. Selected runs in period $[200, 400]$. Dashed line: pre-crisis trend | grey boxes: trend recovery period.

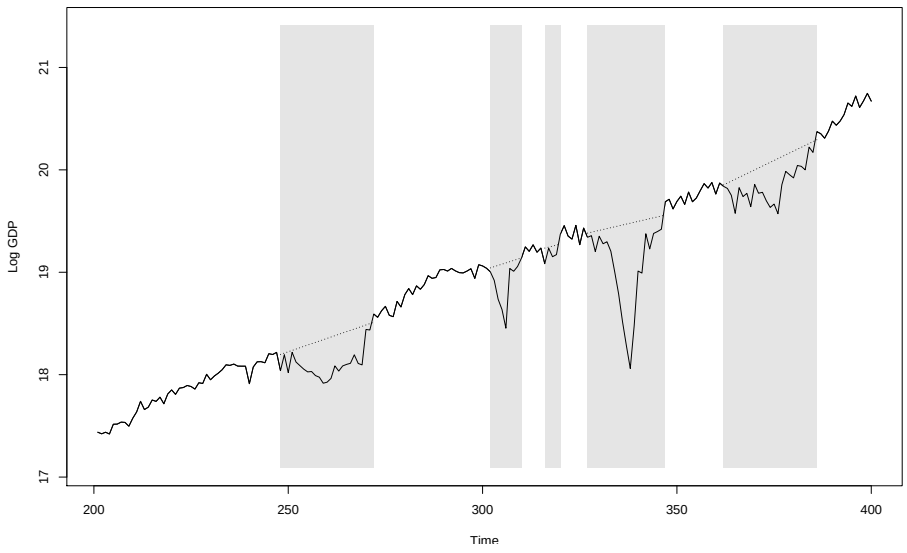
**(a)** Fordist




**(b)** Competitive AS




**(c)** Competitive FC



# 6 Sensitivity analysis

We performed a global sensitivity analysis (SA) to explore the effects of alternative model parametrizations, to warrant the robustness of our results adressing the frequent criticism of ABMs concerning the importance of the model structural properties vs. "lucky" parameter configurations.[16] The SA exercise is performed in the period $t \in [200, 400]$ for a set of metrics relevant to the current discussion, namely the unemployment ($\bar{U}$), vacancy ($\bar{V}$) and hiring ($\bar{L}_{entry}$) average rates and the workers skills average level ($\bar{s}$).[17] All the model's parameters, their "calibration" values, as well the key SA tests statistics, are detailed in Table 10 (Appendix B).

The sensitivity analysis is performed on the most extreme Competitive scenario *cum* Fiscal Compact but the main properties hold under all Competitive scenarios. Out of the 79 parameters and initial conditions in this K+S version, as a first step we reduce the relevant parametric dimensionality, by means of a Morris elementary effects screening procedure (EE). This is important because it allows discarding from the in-depth analysis those parameters and initial conditions (the "factors") which do not significantly affect the selected model metrics, if any.[18] The EE analysis indicates that $\bar{U}$ is the metric sensitive to the larger number of factors (19) while $\bar{s}$ is the least sensitive, as no factor presented a statistically relevant effect on it. $\bar{L}_{entry}$ and $\bar{V}$ are in an intermediate situation with 15 and 8 influential factors, respectively.[19] In total, 24 unique *relevant* factors were identified after discarding duplicates.

In order to better understand the effect of each of the 24 relevant factors over the selected metrics, directly or in interaction, in the second step we perform a Sobol Variance Decomposition (SVD).[20] Because of the relatively high computational cost to produce the SVD using the original model, a simplified version of it – a meta-model – is estimated using the Kriging method and employed for the SA.[21] The meta-model is estimated by numerical maximum likelihood using a set of observations sampled from the original model using a high-efficiency, nearly-orthogonal Latin hypercube design of experiments (Cioppa and Lucas, 2007).

[16] For technical details on the global sensitivity analysis methodology applied here, see Dosi et al. (2017d). On the empirical validation of agent-based models, see also Fagiolo et al. (2017).

[17] Other relevant metrics, like the macro aggregates growth rates, the hysteresis losses, the inequality measures, and the industrial performance indicators were already evaluated in previous papers based on the labour-augmented K+S model and are not be replicated here. The general results from these past analyses indicate a relatively small dependence of the qualitative model results on the chosen parametrization, in most cases.

[18] Briefly, EE proposes both a specific design of experiments, to efficiently sample the parametric space under a multi-path, one-factor-at-a-time strategy, and some absolute importance statistics, to evaluate direct and indirect (nonlinear/non-additive) effects of parameters on the model results as well their statistical significance (Morris, 1991, Saltelli et al., 2008).

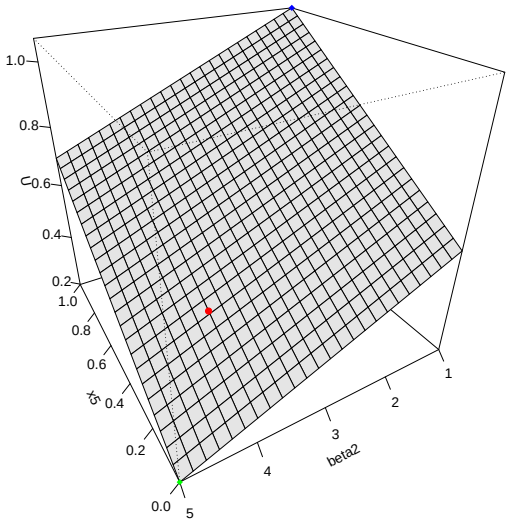
[19] The selection criteria includes the top 80% EE contributors at 5% significance.

[20] SVD is a variance-based, global SA method consisting in the decomposition of the variance of the chosen model metric into fractions according to the variances of the factors selected for analysis, better dealing with nonlinearities and non-additive interactions than EE or traditional local SA methods. It allows to precisely disentangle both direct and interaction quantitative effects of the factors on the chosen metrics over the entire parametric space (Sobol, 1993, Saltelli et al., 2008).

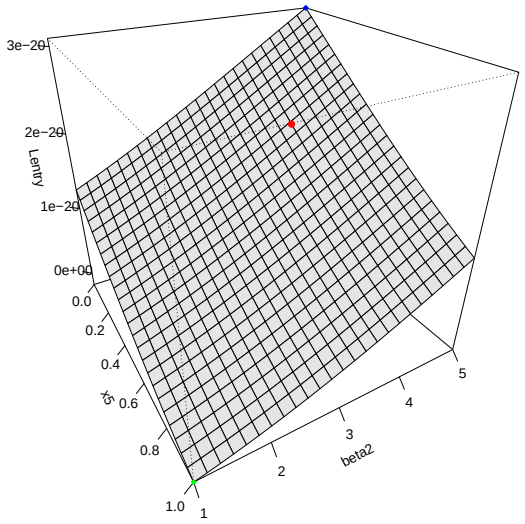
[21] In summary, the Kriging meta-model "mimics" our original model using a simpler, mathematically-tractable approximation, fitted over a sample of the original model response surface. Kriging is a spatial interpolation method that under fairly general assumptions provides the best linear unbiased predictors for the response of complex, non-linear computer simulation models (Rasmussen and Williams, 2006, Salle and Yildizoglu, 2014).

**Figure 9:** Global sensitivity analysis: response surfaces.
Surfaces modelled using the fitted Kriging meta-model. Red dot: calibration settings | Markers: maximum (blue) and minimum (green) predicted values.

**(a)** Average unemployment rate ($\bar{U}$)




**(b)** Average hiring rate ($\bar{L}_{entry}$)




The SVD results indicated a common and small subset of just five *important* factors for the chosen metrics, except $\bar{s}$ as discussed before, mostly through direct effects and not in interaction (linear effects). Interestingly, all important factors come from the technological dynamics part of the model, in particular for the entrant firms. These factors, in order of importance, define (i) the maximum technical advantage of an entrant ($x_5 : +$), (ii) the shape of the technological opportunity space for entrant firms ($\beta_2 : -$, $\alpha_2 : +$), (iii) the upper shape of the same space for the incumbent firms ($\beta_1 : -$), and (iv) the notional upper limit of the technological search space ($\bar{x}_1 : +$). The signals in parenthesis indicate positive or negative effects on the affected metrics.

The impacts of all the tested factors in the SVD are quite mild. Just two factors, $x_5$ and $\beta_2$, account for more than 80% of the estimated meta-model effects on the metrics $\bar{U}$, $\bar{L}_{entry}$ and $\bar{V}$ ($\bar{s}$ is not significantly affected by any factor). Figure 9 presents an exploration of the Kriging meta-model response surface for the two critical factors on the two most sensitive metrics. The almost flat surfaces clearly indicate the (almost) linear interaction nature of the system response surface for the identified critical factors. Figure 9(a) renders the surface for the average unemployment rate $\bar{U}$ and show that unemployment is affected by the entry of technologically advanced firms in the market, in a classical "creative destruction" Schumpeterian sense. Indeed, this metric is very sensitive to changes in the two factors, in an additive way. Note that the presented surface corresponds to a Competitive regime configuration where "Keynesian" drivers are nearly absent. Figure 9(b) presents the response surface for the average hiring rate $\bar{L}_{entry}$.[22] Indeed, the "inclined" surface is mostly horizontal, as this metric varies very little even for the full excursion of the interacting factors. The average vacancy rate $\bar{V}$ (not shown) has the same shape and even lower sensitivity.

[22]Notice the highly stretched $z$-axis scale due to auto-scaling.

# 7 Conclusions

Are supply-side labour market policies sufficient in order to get an economy going out of a big recession? The plain answer is negative. Indeed, our results debunk the discourse advocating the combination of flexible labour markets, active labor market policies (ALMPs), and austerity rules as potentially virtuous way-out from deep crises, such as the Great Recession.

Elsewhere (Dosi et al., 2017c,b, 2018), we have already shown that more flexibility of the labour market in terms of wage adjustments and hiring/firing rules are likely to make the system more fragile and be detrimental in both the short- and the long-run in terms of unemployment rates, GDP growth, inequality. Here we have explored the extent to which such effects can be reversed, or at least mitigated, by ALMPs. They cannot. So, neither more efficient matching on the labour market, nor government sponsored skill-enhancing programs are enough when workers face adverse labour demand. Passive labor market policies, sustaining aggregate demand, are better suited to mitigate inequality and to foster long-run growth.

In all that, adding some deregulation in the credit conditions in presence of flexible labour markets further adds to the fragility of the system as revealed by e.g. the amount of bad loans that the economy accumulates.

However, the deadly mixture are flexible labour markets, *no matter if in presence of ALMPs*, and austerity policies, such as those mimicking the European and Stability Growth Path and the Fiscal Compact. Here, the damages of labour market flexibility combine with the damages of austerity: long-run growth is permanently reduced, exhibiting a super-hysteretic behaviour, unemployment rates increases by an order of magnitude as compared to a Fordist baseline, and income distribution worsens. Indeed, precisely the opposite to the predictions of the flexibility plus austerity advocates.

### Acknowledgements

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# Appendices

## Appendix A

### Capital- and consumer-good sectors and technical change

The technology of capital-good firms is $(A_i^\tau, B_i^\tau)$. $A_i^\tau$ is the labour productivity of the machine-tool manufactured by $i$ for the consumption-good sector, while $B_i^\tau$ is the labour productivity to produce the machine. Superscript $\tau$ denotes the technology vintage being produced/used. Given the monetary average wage $w_{i,t}$ paid by firm $i$ in the capital-good industry, the unit cost of production is:

$$c_{i,t} = \frac{w_{i,t}}{B_i^\tau}. \tag{12}$$

Prices $p_{i,t}$ are defined using a fixed mark-up $\mu_1 \in \mathbb{R}^+$ rule as:

$$p_{i,t} = (1 + \mu_1)c_{i,t}. \tag{13}$$

Firms in the capital-good industry "adaptively" strive to increase their market shares and their profits by improving technology via innovation and imitation. Firms invest in R&D a fraction $\nu \in (0, 1]$ of their past sales $S_{i,t-1}$:

$$RD_{i,t} = \nu S_{i,t-1}. \tag{14}$$

R&D activity is performed by workers exclusively devoted to this activity, whose demand is:

$$L_{i,t}^{R\&D} = \frac{RD_{i,t}}{w_{i,t}}. \tag{15}$$

Firms split their R&D efforts (and workers) between innovation ($IN_{i,t}$) and imitation ($IM_{i,t}$) activities according to the parameter $\xi \in [0, 1]$:

$$IN_{i,t} = \xi RD_{i,t}, \tag{16}$$

$$IM_{i,t} = (1 - \xi)RD_{i,t}. \tag{17}$$

Innovation is a two-step process. The first one determines whether a firm obtains or not access to an innovation – irrespectively of whether it is ultimately a success or a failure – through a draw from a Bernoulli distribution with parameter:

$$\theta_{i,t}^{in} = 1 - e^{-\zeta_1 IN_{i,t}} \tag{18}$$

being $\zeta_1 \in (0, 1]$. If a firm innovates, it may draw a new machine-embodying technology $(A_{i,t}^{in}, B_{i,t}^{in})$ according to:

$$A_{i,t}^{in} = A_{i,t}(1 + x_{i,t}^A) \tag{19}$$

$$B_{i,t}^{in} = B_{i,t}(1 + x_{i,t}^B) \tag{20}$$

where $x_{i,t}^A$ and $x_{i,t}^A$ are two independent draws from a Beta$(\alpha_1, \beta_1)$ distribution, $(\alpha_1, \beta_1) \in \mathbb{R}^{2+}$ over the fixed support $[\underline{x}_1, \bar{x}_1] \subset \mathbb{R}$.

Imitation also follows a two-step procedure. The access to imitation come from sampling a Bernoulli with parameter:

$$\theta_{i,t}^{im} = 1 - e^{-\zeta_2 IM_{i,t}} \tag{21}$$

and $\zeta_2 \in (0, 1]$. Firms accessing the second stage are able to copy the technology $(A_i^{im}, B_i^{im})$ of one of the competitors. Imitation of technologically-closer competitors is more likely. Finally, they select the machine to produce according to the rule:

$$\min \left[ p_{i,t}^h + bc_{(A_i),t}^h \right], \quad h = \tau, in, im \tag{22}$$

where $b \in \mathbb{R}^+$ is a payback-like parameter.

Firms in consumption-good sector do not conduct R&D, instead they access new technologies acquiring new machines for their existing capital stock $\Xi_{j,t-1}$. Firms invest according to expected demand $D^e_{j,t}$, computed by an adaptive rule:

$$D^e_{j,t} = g(D_{j,t-1}, ..., D_{j,t-h}), \quad 0 < h < t \tag{23}$$

where $D_{j,t-h}$ is the actual demand faced by firms at time $t-h$ ($h \in \mathbb{N}^*$ is a parameter and $g : \mathbb{R}^h \to \mathbb{R}^+$ is the expectation function, here an unweighted moving average over $h = 4$ periods). The corresponding desired level of production $Q^d_{j,t}$, considering the actual inventories from previous period $N_{j,t-1}$, is:

$$Q^d_{j,t} = (1 + \iota)D^e_{j,t} - N_{j,t-1} \tag{24}$$

being $N^d_{j,t} = \iota D^e_{j,t}$ the desired inventories and $\iota \in \mathbb{R}^+$, a parameter.

If the desired capital stock $K^d_j$ – computed as a linear function of the desired level of production $Q^d_{j,t}$ – is higher than the current one, firms invest $EI^d_{j,t}$ to expand their production capacity:

$$EI^d_{j,t} = K^d_{j,t} - K_{j,t-1}. \tag{25}$$

Firms also invest $SI^d_{j,t}$ to replace older machines by more productive vintages according to a fixed payback-like ($b > 0$) rule, substituting machines $A^\tau_i \in \Xi_{j,t}$ according to the operational cost disadvantage as well as the price of new machines:

$$RS_{j,t} = \left\{ A^\tau_i \in \Xi_{j,t} : \frac{p^*_{i,t}}{c^{A^\tau_i}_{j,t} - c^*_{j,t}} \leq b \right\} \tag{26}$$

where $p^*_{i,t}$ is the new machine price and $c^*_{j,t}$, the unit cost of production upon the new machines. Given the stock of machines $\Xi_{j,t}$, firms compute average productivity $\pi_{j,t}$ and average unit cost of production $c_{j,t}$, based on the average unit labour cost of production $w_{j,t}$ associated with each machine of vintage $\tau$ in its capital stock:

$$c^{A^\tau_i}_{j,t} = \frac{w_{j,t}}{A^\tau_i}. \tag{27}$$

Consumption-good prices are set applying a variable markup $\mu_{j,t}$ on average unit costs:

$$p_{j,t} = (1 + \mu_{j,t})c_{j,t}. \tag{28}$$

Mark-up changes are regulated by the evolution of firm market shares ($f_{j,t}$):

$$\mu_{j,t} = \mu_{j,t-1}\left(1 + \upsilon \frac{f_{j,t-1} - f_{j,t-2}}{f_{j,t-2}}\right) \tag{29}$$

with $\upsilon \in (0, 1)$. Firm market shares evolve according to a replicator dynamics:

$$f_{j,t} = f_{j,t-1}\left(1 + \chi \frac{E_{j,t} - \bar{E}_t}{\bar{E}_t}\right), \quad \bar{E}_t = \frac{1}{F^2_t} \sum_j E_{j,t} f_{j,t-1}, \tag{30}$$

where the firms relative competitivity $E_{j,t}$ is defined based on the individual normalized prices $p'_{j,t}$, unfilled demands $l'_{j,t}$ and product qualities $q'_{j,t}$:

$$E_{j,t} = -\omega_1 p'_{j,t-1} - \omega_2 l'_{j,t-1} - \omega_3 q'_{j,t-1}, \tag{31}$$

being $(\omega_1, \omega_2, \omega_3) \in \mathbb{R}^2+$ parameters. Unfilled demand $l_{j,t}$ is the difference between the demand $D_{j,t}$ the firm gets and its production $Q_{j,t}$ plus inventories $N_{j,t}$, if positive:

$$l_{j,t} = \max\left[D_{j,t} - (Q_{j,t} + N_{j,t}), 0\right]. \tag{32}$$

Product quality is defined as the average of the log skills $s_{\ell,t}$ of the firm's workers:

$$q_{j,t} = \frac{1}{L_{j,t-1}} \sum_{\ell \in \{L_{j,t-1}\}} \log\left[s_{\ell,t-1}\right]. \tag{33}$$

Prospective firms in both sectors decide on entry based on the number $F^z_{t-1}$ ($z = 1, 2$) and the financial conditions of incumbents. The number of entrants in sector $z$ is defined as:

$$b^z_t = max\left[(o\pi^z_t + (1-o)MA^z_t)\, F^z_{t-1}, 0\right], \qquad z = 1, 2, \tag{34}$$

being $o \in [0, 1]$ a mix parameter and $\pi^z_t$ a random draw from a uniform distribution on the fixed support $[\underline{x}^z_2, \bar{x}^z_2]$ representing the idiosyncratic component in the entry process. The sectoral market attractiveness $MA^z_t$ is evaluated based on the dynamics of firms' balance sheets:

$$MA^z_t = MC^z_t - MC^z_{t-1} \qquad \text{(bounded to } [\underline{x}_2, \bar{x}_2]), \tag{35}$$

defined as the (log) ratio between the aggregate sectoral stocks of liquid assets $NW^z_{t-1}$ (bank deposits) and debt $Deb^z_{t-1}$ (bank loans):

$$MC^z_t = \log NW^z_{t-1} - \log Deb^z_{t-1}. \tag{36}$$

## Labour market and search-and-match process

Labour demand in the consumption-good sector $L^d_{j,t}$ is determined by desired production $Q^d_{j,t}$ and the average productivity of current capital stock $A_{j,t}$:

$$L^d_{j,t} = \frac{Q^d_{j,t}}{A_{j,t}}. \tag{37}$$

In the capital-good sector, instead, $L^d_{i,t}$ considers orders $Q_{i,t}$ and machine-production productivity $B_{i,t}$.

The job search, wage determination and firing processes differ according to the policy regime. In the Fordist regime, workers do not quit jobs and firms fire employees only under losses ($\Pi_{j,t-1} < 0$), except if exiting the market. Only unemployed workers search for jobs. Lowest skilled workers are fired first, while higher skilled workers are preferred when hiring. Wages are not bargained and firms offer a wage:

$$w^o_{j,t} = \min\left[w^o_{j,t-1}(1 + WP_{j,t}), w^{max}_{j,t}\right], \quad w^{max}_{j,t} = p_{j,t-1}A_{j,t-1}, \tag{38}$$

bounded to a break-even wage $w^{max}_{j,t}$, which is accepted by the worker if she has no better offer. The wage premium is is defined as:

$$WP_{j,t} = \psi_2 \frac{\Delta A_t}{A_{t-1}} + \psi_4 \frac{\Delta A_{j,t}}{A_{j,t-1}}, \quad \psi_2 + \psi_4 \leq 1, \tag{39}$$

being $A_t$ the aggregate labour productivity, $\Delta$, the time difference operator, and $(\psi_2, \psi_4) \in \mathbb{R}^{2+}$, parameters. $w^o_{j,t}$ is applied to all existing firm's workers.

In the Competitive regime, firms freely fire workers to accommodate production changes. Employees search for jobs while employed, quitting for better offers. When hiring or firing, firms contract first and dismissing last workers with higher skills-to-wage ratios ($s_{\ell,t}/w_{\ell,t}$). Firm-worker matching is done in an one-round bargaining process. Workers request a wage:

$$w^r_{\ell,t} = \begin{cases} w_{\ell,t-1}(1+\epsilon) & \text{if employed in t-1} \\ w^s_{\ell,t} & \text{if unemployed in t-1} \end{cases} \tag{40}$$

where $w_{\ell,t-1}$ is the current wage for the employed workers and $\epsilon \in \mathbb{R}^+$ is a parameter. Unemployed workers have a satisfying wage $w^s_{\ell,t}$:

$$w^s_{\ell,t} = \max\left[w^u_t, \frac{1}{T_s}\sum_{h=1}^{T_s} w_{\ell,t-h}\right], \tag{41}$$

being $T_s \in \mathbb{N}^*$ a parameter. Employed workers accept the best offer $w^o_{\ell,t}$ if it is higher than the current wage $w_{\ell,t}$. Unemployed workers accepts the best offer higher or equal $w^s_{\ell,t}$.

Capital-good firms hire and fire workers similarly but follow the offered wages of top-paying firms in the consumption-good sector ($\max[w^o_{j,t}]$). Government sets an indexed minimum wage to be paid by firms:

$$w^{min}_t = w^{min}_{t-1}\left(1 + \psi_2 \frac{\Delta A_t}{A_{t-1}}\right). \tag{42}$$

## Banking sector and monetary policy

There are $B$ commercial banks (subscript $k$) in the banking sector which take deposits and provide credit to firms. Firms in both production sectors may apply to banks for loans. Bank-firm pairs are set randomly and are stable along firms' lifetime. Banks allocate credit ranking firms by the ratio between net worth $NW_{z,t-1}$ and past sales $S_{z,t-1}$ ($z \in \{i, j\}$). Banks provide credit as long as their maximum supply of credit $TC_{k,t}$ is not fully distributed:

$$TC_{k,t} = \frac{NW^b_{k,t-1}}{\tau_b(1 + \beta_b Bda_{k,t-1})}, \tag{43}$$

where the parameter $\beta_b \in \mathbb{R}^+$ is the sensitivity to financial fragility $Bda_{k,t}$ and $NW^b_{k,t}$ is the bank equity defined as the accumulated net profits $\Pi^b_{k,t}$. The provision of credit depends also on the (Basel-like) capital adequacy requirement, represented by the parameter $\tau_b \in (0, 1]$, and on an idiosyncratic bank fragility proxy:

$$Bda_{k,t} = \frac{BadDebt_{k,t}}{Loans_{k,t}}. \tag{44}$$

Bank profits come from interest received on loans to firms ($Loans_{k,t}$) and on reserves at the Central Bank ($Res_{k,t}$) deducted from interest paid on deposits ($Depo_{k,t}$) and from losses from defaulted loans ($BadDebt_{k,t}$):

$$\Pi^b_{k,t} = r^{deb}_t Loans_{k,t} + r^{res}_t Res_{k,l} - r_D Depo_{k,t} - BadDebt_{k,t}, \tag{45}$$

being $r^{deb}_t = (1 + \mu_{deb})r_t$ the interest on debt calculated over the Central Bank prime rate $r_t$, $\mu_{deb} \in \mathbb{R}^+$, and $r^{res}_t = r_t/(1 + \mu_{res})$ the interest paid by the Central Bank on banks reserves, $\mu_{res} \in \mathbb{R}^+$. Firms' deposits are rewarded at the fixed rate $r_D \in \mathbb{R}^+$.

The prime rate $r_t$ is fixed according to a Taylor rule:

$$r_t = r_T + \gamma_\pi(\pi_t - \pi_T) + \gamma_U(U_T - U_t), \quad \gamma_\pi > 1, \gamma_U \geq 1, \tag{46}$$

where $\pi_t$ is the inflation rate, $U_t$ is the unemployment rate, and $r^T$, $\pi^T$, $U_T$ are the prime, inflation and unemployment target rates, respectively. Therefore the ensuing interest rate structure is:

$$r^D \leq r^{res}_t \leq r_t \leq r^{debt}_t. \tag{47}$$

## Consumption and model closure

Workers fully consume their income (if possible) and do not get credit. Desired aggregate consumption $C^d_t$ depends on the income of both employed and unemployed workers plus the desired unsatisfied consumption from previous periods ($C^d_{t-1} - C_{t-1}$):

$$C^d_t = \sum_\ell w_{\ell,t} + G_t + (C^d_{t-1} - C_{t-1}) \tag{48}$$

The effective consumption $C_t$is bound by the real production $Q^2_t$ of the consumption-good sector:

$$C_t = \min(C^d_t, Q^2_t), \quad Q^2_t = \sum_j Q_{j,t}. \tag{49}$$

The model applies the standard national account identities by the aggregation of agents' stocks and flows. The aggregate value added by capital- and consumption-good firms $Y_t$ equals their aggregated production $Q_t^1$ and $Q_t^2$, respectively (there are no intermediate goods). That is equal to the sum of the effective consumption $C_t$, the total investment $I_t$ and the change in firm's inventories $\Delta N_t$:

$$Q_t^1 + Q_t^2 = Y_t = C_t + I_t + \Delta N_t. \tag{50}$$

For further details, see Dosi et al. (2010), Dosi et al. (2015) and Dosi et al. (2017c).

# Appendix B

| Symbol | Description | Value | Min. | Max. | $\mu^*$ | Direct | Interaction |
|---|---|---|---|---|---|---|---|
| **Policy** | | | | | | | |
| $\phi_T$ | Target unemployment subsidy rate on average wage | 0.40 | 0.00 | 1.00 | 0.031 | – | – |
| $\gamma_\pi$ | Taylor rule sensitivity to inflation | 1.0 | 0.1 | 10.0 | 0.056 | – | – |
| $\gamma_U$ | Taylor rule sensitivity to unemployment | 0.10 | 0.01 | 1.00 | 0.012 | – | – |
| $\pi_T$ | Target inflation rate (taylor rule) | 0.02 | 0.01 | 0.10 | 0.074 | – | – |
| $\Gamma$ | Share of unemployed under Govt. training | 0.00 | 0.00 | 1.00 | 0.015 | 0.0046 | 0.0017 |
| $\Gamma_{cost}$ | Unit cost of Govt. training (wage fraction) | 0.10 | 0.01 | 0.20 | 0.054 | 0.0021 | 0.0017 |
| $r_T$ | Target prime interest rate | 0.01 | 0.01 | 0.10 | 0.085 | – | – |
| $r_{adj}$ | Adjustment step of prime interest rate | 0.005 | 0.001 | 0.010 | 0.035 | – | – |
| $U_T$ | Target unemployment rate (taylor rule) | 0.05 | 0.01 | 0.10 | 0.072 | – | – |
| $deb_{rule}$ | Maximum public debt rule (GDP fraction) | 0.6 | 0.3 | 1.0 | 0.058 | – | – |
| $def_{rule}$ | Maximum public deficit rule (GDP fraction) | 0.03 | 0.01 | 0.05 | 0.013 | – | – |
| $tr$ | Tax rate | 0.15 | 0.00 | 0.30 | 0.030 | – | – |
| **Credit market** | | | | | | | |
| $\beta_b$ | Bank sensitivity to financial fragility | 1.00 | 0.50 | 2.00 | 0.035 | – | – |
| $\mu_{deb}$ | Mark-up of interest on debt over prime rate | 0.30 | 0.10 | 0.50 | 0.043 | 0.0006 | 0.0019 |
| $\mu_{res}$ | Mark-up of interest on reserves to prime rate | 0.70 | 0.50 | 1.00 | 0.047 | – | – |
| $\tau_b$ | Minimum bank capital adequacy rate | 0.13 | 0.05 | 0.30 | 0.057 | 0.0053 | 0.0017 |
| $\Lambda$ | Prudential limit on loans as sales multiple | 2 | 1 | 4 | 0.071 | – | – |
| $\Lambda_{min}$ | Fixed floor for Prudential limit on loans | 20000 | 0 | 100000 | 0.063 | – | – |
| $r_D$ | Interest rate on bank deposits | 0.00 | 0.00 | 0.01 | 0.061 | – | – |

(continue...)

| Symbol | Description | Value | Min. | Max. | $\mu^*$ | Direct | Interaction |
|---|---|---|---|---|---|---|---|
| **Labour market** | | | | | | | |
| $\epsilon$ | Minimum desired wage increase (employed workers) | 0.020 | 0.005 | 0.200 | 0.065 | – | – |
| $\omega$ | Number of firms to apply for job (employed) | 0 | 1 | 20 | 0.064 | 0.0005 | 0.0016 |
| $\omega_{un}$ | Number of firms to apply for job (unemployed) | 5 | 1 | 20 | 0.060 | 0.0011 | 0.0016 |
| $\psi_2$ | Aggregate productivity pass-trough | 1.00 | 0.95 | 1.05 | 0.015 | – | – |
| $\psi_4$ | Firm-level productivity pass-trough | 0.50 | 0.00 | 1.00 | 0.060 | – | – |
| $\tau_G$ | Skills accumulation rate of workers in training | 0.005 | 0.001 | 0.100 | 0.050 | – | – |
| $\tau_T$ | Skills accumulation rate of employed workers | 0.010 | 0.001 | 0.100 | 0.138 | 0.0017 | 0.0016 |
| $\tau_U$ | Skills deprecation rate of unemployed workers | 0.010 | 0.001 | 0.100 | 0.072 | 0.0043 | 0.0017 |
| $T_r$ | Number of periods before retirement (work life) | 120 | 60 | 240 | 0.142 | 0.0009 | 0.0017 |
| $T_s$ | Number of wage memory periods | 0 | 1 | 8 | 0.010 | – | – |
| **Technology** | | | | | | | |
| $\eta$ | Maximum machine-tools useful life | 20 | 10 | 40 | 0.062 | – | – |
| $\nu$ | R&D investment propensity over sales | 0.04 | 0.01 | 0.20 | 0.168 | 0.0004 | 0.0016 |
| $\xi$ | Share of R&D expenditure in imitation | 0.50 | 0.20 | 0.80 | 0.097 | 0.0028 | 0.0016 |
| $b$ | Payback period for machine replacement | 3 | 1 | 10 | 0.048 | 0.0015 | 0.0016 |
| $dim_{mach}$ | Machine-tool unit production capacity | 40 | 10 | 100 | 0.028 | – | – |
| $(\alpha_1, \beta_1)$ | Beta distribution parameters (incumbent) | $(3, 3)$ | $(1, 1)$ | $(5, 5)$ | $(0.045, 0.121)$ | $(-, 0.0163)$ | $(-, 0.0016)$ |
| $(\alpha_2, \beta_2)$ | Beta distribution parameters (entrant) | $(2, 4)$ | $(1, 1)$ | $(5, 5)$ | $(0.152, 0.190)$ | $(0.0874, 0.2589)$ | $(0.0016, 0.0019)$ |
| $(\zeta_1, \zeta_2)$ | Search capabilities for innovation/imitation | $(0.30, 0.30)$ | $(0.10, 0.10)$ | $(0.60, 0.60)$ | $(0.126, 0.034)$ | $(0.0023, -)$ | $(0.0013, -)$ |
| $[\underline{x}_1, \bar{x}_1]$ | Beta distribution support (innovation process ) | $[-0.15, 0.15]$ | $[-0.3, 0.1]$ | $[-0.1, 0.3]$ | $(0.044, 0.150)$ | $(-, 0.0041)$ | $(-, 0.0013)$ |

(continue...)

| Symbol | Description | Value | Min. | Max. | $\mu^*$ | Direct | Interaction |
|---|---|---|---|---|---|---|---|
| **Industrial dynamics** | | | | | | | |
| $\gamma$ | Share of new customers for capital-good firm | 0.50 | 0.20 | 0.80 | 0.049 | – | – |
| $\iota$ | Desired inventories share | 0.10 | 0.00 | 0.30 | 0.069 | 0.0028 | 0.0013 |
| $\mu_1$ | Mark-up in capital-good sector | 0.05 | 0.01 | 0.20 | 0.067 | 0.0000 | 0.0013 |
| $o$ | Weight of market conditions for entry decision | 0.50 | 0.00 | 1.00 | 0.036 | – | – |
| $\omega_1$ | Competitiveness weight for price | 1.00 | 0.20 | 5.00 | 0.024 | – | – |
| $\omega_2$ | Competitiveness weight for unfilled demand | 1.00 | 0.20 | 5.00 | 0.076 | 0.0006 | 0.0015 |
| $\omega_3$ | Competitiveness weight for quality | 1.00 | 0.20 | 5.00 | 0.052 | – | – |
| $\chi$ | Replicator dynamics coefficient | 1.00 | 0.20 | 5.00 | 0.061 | – | – |
| $\upsilon$ | Mark-up adjustment coefficient | 0.04 | 0.01 | 0.10 | 0.022 | – | – |
| $u$ | Planned utilization by consumption-good entrant | 0.75 | 0.50 | 1.00 | 0.055 | – | – |
| $x_5$ | Max technical advantage of capital-good entrant | 0.30 | 0.00 | 1.00 | 0.380 | 0.5354 | 0.0026 |
| $exit_1$ | Min orders to stay in capital-good sector | 1 | 1 | 5 | 0.025 | – | – |
| $exit_2$ | Min share to stay in consumption-good sector | $10^{-5}$ | $10^{-6}$ | $10^{-3}$ | 0.022 | – | – |
| $[\Phi_1, \Phi_2]$ | Min/max capital ratio for consumption-good entrant | $[0.10, 0.90]$ | $[0.00, 0.50]$ | $[0.50, 1.00]$ | $(0.034, 0.093)$ | $(-, 0.0004)$ | $(-, 0.0015)$ |
| $[\Phi_3, \Phi_4]$ | Min/max net wealth ratio for capital-good entrant | $[0.10, 0.90]$ | $[0.00, 0.50]$ | $[0.50, 1.00]$ | $(0.024, 0.034)$ | $(-, -)$ | $(-, -)$ |
| $[\underline{x}_2^1, \bar{x}_2^1]$ | Entry distribution support/limit (capital-good) | $[-0.15, 0.15]$ | $[-0.3, 0.1]$ | $[-0.1, 0.3]$ | $(0.024, 0.051)$ | $(-, -)$ | $(-, -)$ |
| $[\underline{x}_2^2, \bar{x}_2^2]$ | Entry distribution support/limit (consumption-good) | $[-0.15, 0.15]$ | $[-0.3, 0.1]$ | $[-0.1, 0.3]$ | $(0.024, 0.026)$ | $(-, -)$ | $(-, -)$ |
| $[F_{min}^1, F_{max}^1]$ | Min/max number of capital-good firms | $[10, 100]$ | $[10, 20]$ | $[20, 100]$ | $(0.095, 0.254)$ | $(0.0011, 0.0000)$ | $(0.0015, 0.0015)$ |
| $[F_{min}^2, F_{max}^2]$ | Min/max number of consumption-good firms | $[50, 500]$ | $[50, 200]$ | $[200, 500]$ | $(0.028, 0.020)$ | $(-, -)$ | $(-, -)$ |
| **Initial conditions** | | | | | | | |
| $\mu_0^2$ | Initial mark-up in consumption-good sector | 0.20 | 0.10 | 0.50 | 0.086 | 0.0004 | 0.0015 |
| $B$ | Number of banks | 10 | 1 | 20 | 0.032 | – | – |
| $F_0^1$ | Initial number of capital-good firms | 20 | 10 | 100 | 0.022 | – | – |
| $F_0^2$ | Initial number of consumption-good firms | 200 | 50 | 500 | 0.027 | – | – |
| $K_0$ | Initial capital stock in consumption-good sector | 800 | 200 | 3000 | 0.028 | – | – |
| $L_0^S$ | Number of workers | 250000 | 50000 | 1000000 | 0.027 | – | – |
| $NW_0^b$ | Initial net wealth (capital) of banks | 1000000 | 500000 | 5000000 | 0.018 | – | – |
| $NW_0^1$ | Initial net wealth of capital-good firms | 10000 | 2000 | 50000 | 0.051 | 0.0034 | 0.0015 |
| $NW_0^2$ | Initial net wealth of consumption-good firms | 5000 | 2000 | 50000 | 0.069 | 0.0041 | 0.0015 |
| $Sav_0$ | Initial consumer savings (initial demand) | 1100000 | 50000 | 5000000 | 0.031 | – | – |

**Table 10:** Model parameters and initial conditions, calibration values, minimum-maximum range for sensitivity analysis, Morris elementary effects $\mu^*$ statistic and Sobol decomposition direct and interaction effects indexes. Competitive FC policy-specific configuration. Sensitivity analysis statistics relative to average unemployment in period$[200, 400]$.

| Parameter | Description | Fordist | Competitive | | |
|---|---|---|---|---|---|
| | | | Unemp. Benefits | Training | Un.Ben.+Train. |
| $\phi_T$ | Target unemployment subsidy rate on average wage | 0.40 | 0.20 | 0.00 | 0.20 |
| $\omega$ | Number of firms to apply for job (employed) | 2 | $5, 50, 100$ | 5 | 5 |
| $\tau_b$ | Minimum bank capital adequacy rate | 0.13 | 0.08 | 0.08 | 0.08 |
| $\Gamma$ | Share of unemployed under Govt. training | 0 | 0 | 0.5 | 0.5 |
| $\Lambda$ | Prudential limit on loans as sales multiple | 2 | 3 | 3 | 3 |
| $T_s$ | Number of wage memory periods | 0 | 4 | 4 | 4 |
| $tr$ | Tax rate | 0.015 | 0.010 | 0.010 | 0.010 |

**Table 11:** Regime-specific parameter values.

| | Workers | Capital-good firms | | Consumption-good firms | | Banks | | Govt. + Central Bank | | $\sum$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | current | current | capital | current | capital | current | capital | current | capital | |
| Wages | $+W_t^1 + W_t^2$ | $-W_t^1$ | | $-W_t^2$ | | | | | | 0 |
| Consumption | $-C_t$ | | | $+C_t$ | | | | | | 0 |
| Investment | | $+I_t$ | | | $-I_t$ | | | | | 0 |
| Govt. expenditure | $+G_t + G_t^{train}$ | | | | | $+G_t^{bail}$ | | $-G_t - G_t^{train} - G_t^{bail}$ | | 0 |
| Bonuses, workers | $+B_t^2$ | | | | $-B_t^2$ | | | | | 0 |
| Profits, firms | | $-\Pi_t^1$ | $+\Pi_t^1$ | $-\Pi_t^2$ | $+\Pi_t^2$ | | | | | 0 |
| Profits, bank | | | | | | $-\Pi_t^b$ | $+\Pi_t^b$ | | | 0 |
| Profits, C. Bank | | | | | | | | $-\Pi_t^{cb}$ | $+\Pi_t^{cb}$ | 0 |
| Govt. deficit | | | | | | | | $+Def_t$ | $-Def_t$ | 0 |
| Loans interest | | $-r_{t-1}^d Deb_{t-1}^1$ | | $-r_{t-1}^d Deb_{t-1}^2$ | | $+r_{t-1}^d Loans_{t-1}$ | | | | 0 |
| Deposits interest | | $+r^D NW_{t-1}^1$ | | $+r^D NW_{t-1}^2$ | | $-r^D Depo_{t-1}$ | | | | 0 |
| Reserves interest | | | | | | $+r_{t-1}^{res} Res_{t-1}$ | | $-r_{t-1}^{res} Res_{t-1}$ | | 0 |
| Taxes | | $-Tax_t^1$ | | $-Tax_t^2$ | | $-Tax_t^b$ | | $+Tax_t$ | | 0 |
| Change in loans | | | $+\Delta Deb_t^1$ | | $+\Delta Deb_t^2$ | | $-\Delta Loans_t$ | | | 0 |
| Change in deposits | | | $-\Delta NW_t^1$ | | $-\Delta NW_t^2$ | | $+\Delta Depo_t$ | | | 0 |
| Change in reserves | | | | | | | $-\Delta Res_t$ | | $+\Delta Res_t$ | 0 |
| $\sum$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0* | 0* |

**Table 12:** Stock-and-flow consistency: transaction flow matrix.
(*) Government (public) debt is stable the long run.

# What if supply-side policies are not enough? The perverse interaction of flexibility and austerity

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**Abstract**

In this work we develop a set of labour market and fiscal policy experiments upon the labour and credit augmented "Schumpeter meeting Keynes" agent-based model. The labour market is declined under two institutional variants, the "Fordist" and the "Competitive" set-ups meant to capture the historical transition from the Fordist toward the post "Thatcher-Reagan" period. Inside these two regimes, we study the different effects of supply-side active labour market policies (ALMPs) vs. demand-management passive labour market ones (PLMPs). In particular, we analyse the effects of ALMPs aimed at promoting job search, and at providing training to unemployed people. Next, we compare the effects of these policies with unemployment benefits simply meant to sustain income and therefore aggregate demand. Considering the burden of unemployment benefits in terms of public budget, we link such provision with the objectives of the European Stability and Growth Pact. Our results show that (i) an appropriate level of skills is not enough to sustain growth when workers face adverse labour demand; (ii) supply-side policies are not able to reverse the perverse interaction between flexibility and austerity; (iii) PLMPs outperform ALMPs in reducing unemployment and workers' skills deterioration; and (iv) demand-management policies are better suited to mitigate inequality and to improve and sustain long-run growth.

**Keywords:** Industrial-relation Regimes, Flexibility, Active Labour Market Policies, Austerity, Agent-based models

**JEL codes:** C63, E24, H53, J88

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*I Daniel Blake demand my appeal date [for benefits] before I starve. And change that shite music on the phones!* [I Daniel Blake, by Ken Loach 2016]

# 1 Introduction

In the wake of the most severe economic crisis after the Great Recession, a resurgent attention has been devoted to promote Active Labour Market Policies (ALMPs) as a measure supposedly apt to deal with structural unemployment. The argument goes back to the late seventies: ALMPs, it has been suggested, are a way to lubricate sclerotic labour markets reducing frictional unemployment (see from Baily and Tobin, 1977 all the way to OECD, 2013). ALMPs include (i) assistance in the job-search activity enhancing the matching process in the labour market, and (ii) training programs with the aim of supporting the process of skills development of unemployed people.[1] Conversely, passive, demand-management, labour market policies (PLMPs), usually including unemployment insurance and welfare benefits, are indeed called "passive" because they do not require any activation condition in order to be granted to the beneficiaries.

Conditional on the different regimes of governance of labour relations, how the two sets of policy measures fare in terms of macroeconomic outcomes? In the following we shall address this question within an agent-based model (ABM) framework.[2] More specifically, we develop a set of labour market and fiscal policy experiments upon the labour- and credit- augmented "Schumpeter meeting Keynes" model (K+S; Dosi et al., 2010, 2013, 2015, 2017c,b). In the proposed experiments, the labour market is declined under two broad institutional variants, the *Fordist*, which was the norm in developed economies till the eighties, and the *Competitive* regimes (further details below).

Inside the two labour market regimes, we compare the different effects of ALMPs (supply-side) vs. PLMPs (demand-side) on macroeconomic dynamics. In particular, we analyse the effects of active labour market policies directed at promoting job search and providing training to unemployed people under the two regimes. Finally, we test such labour market policies in different fiscal scenarios and in particular their interaction with austerity policies. Considering the burden of unemployment benefits upon the public budget, we link the provision of unemployment benefits with the objectives of "austerity rules" such as the European Stability and Growth Pact (SGP), namely a 3% deficit to GDP ratio and a 60% debt to GDP ratio, and in case of debt overhang we enforce the restructuring path prescribed by the European Fiscal Compact (FC).

The contribution of this work is twofold. From the modelling perspective, we interact a decentralized labour market – declined under two institutional variants – with a credit market allowing for the coupling of real and financial dynamics. From the policy perspective, we study

[1] There is a third type of ALMPs, namely public sectors job opportunities or alternatively, subsidized job opportunities in the private sectors. Nonetheless, the third type of policy schemes looks less coherent with the definition of ALMPs provided by the OECD, whereby a key role is played by the stimulus for unemployed people to participate in some form of training and job search programs.

[2] For ABM's considering decentralized labour markets and their impact on the macroeconomic conditions see Fagiolo et al. (2004), Dawid et al. (2008), Deissenberg et al. (2008), Dawid et al. (2012, 2014), Riccetti et al. (2014) and Russo et al. (2016), and Caiani et al. (2018). See Neugart and Richiardi (2012), Fagiolo and Roventini (2012, 2017) for critical surveys on labour market and macro ABM's, respectively.

the interaction between labour market and fiscal policies. Our results reject the combination of flexible labour markets and austerity policies as a reasonable way-out from deep crises. First, the upgrading of unemployed workers skills is largely insufficient when workers face adverse labour market demand, especially in the flexible Competitive regime. Second, supply-side policies do not seem to be able to reverse the negative interaction between flexibility and austerity. Conversely, third, demand-management policies resulting from unemployment benefits are better suited to mitigate income inequality, dampen output volatility, and sustain long-run growth.

The paper is organized as follows. Section 2 briefly discusses the empirical evidence and compares it to the prevailing policy discourse. Section 3 presents the model. The policy experiments on the labour market are discussed in Section 4. Section 5 performs the fiscal policy exercises. Section 6 presents the global sensitivity analysis' results. Section 7 concludes.

## 2 The empirical evidence and the policy discourse

Let us start with the empirical evidence on the effectiveness of ALMPs. The micro-econometric evidence is indeed rather controversial. A recent meta-research study by Card et al., 2015, extending the previous Card et al., 2010 to 207 research papers, of which one fifth relies on randomized controlled experiments, concludes that the effects of ALMPs are very heterogeneous. First, they vary according to the time horizon of the program evaluation, indicating that the effects of the policies are higher after 2-3 years from the completion of the program. Second, even if they tend to be counter cyclical and more effective in recessionary periods, the average effect of ALMPs on employment probability is rather weak, with an average effect of 2%, 5% and 10% for short, medium and long term programs, respectively. Finally, with reference to the type of ALMPs, while job-search assistance programs seem more cost-efficient, training programs result being more effective in increasing the employability opportunities, particularly when evaluated in the long term.

When moving from micro-econometric to macro-econometric, cross-country studies at a first look ALMPs appear to help in reducing unemployment and long term unemployment spells. However, most of these cross-country studies seem to suffer from endogeneity problems, as policies responses are not independent from the labour market conditions. Moreover, when looking at country-level case studies on activation policies conducted by the OECD, remarkable differences emerge in the degree of effectiveness according to (i) the amount of resources devoted to realize the policy interventions (share of the GDP), (ii) the way in which the schemes are implemented (e.g., how the agencies in charge are designed), (iii) the monitoring effort, (iv) the eligibility conditions, and (v) the activation regimes (Martin, 2015).

Indeed, what remain as open questions concerns the extent to which economies can rely on ALMPs alone during phases of severe downturns, and in particular how labour markets characterized by structurally-weak labour demand (e.g., the Mediterranean countries) can benefit from policies aimed at reducing market mismatch or at encouraging labour participation and search intensity. So, some empirical studies, such as Caroleo et al. (2001) suggest that participation in training programs do not increase the employability opportunities of young workers but only the probability to participate in another training program – the "training trap". This phenomenon has been documented in Southern European regions where the lack of labour demand might

hardly be solved by training programs. More generally, the existing micro-econometric studies are not able to capture the macroeconomic effects of the policy schemes, nor they are able to disentangle the influence of the specific institutional features characterizing the labour market, which are indeed a key element when evaluating the fate of the policy schemes (Larsen, 2004).

Together with the spurring of ALMPs, historically came a broader package of reforms as advocated by the *OECD Jobs Study* (OECD, 1994) meant to render labour market more respondent to supply and demand conditions. Two types of flexibility were suggested, namely numerical, i.e., reducing firing restrictions for firms, and in wage terms, i.e., making the wage-adjustment process more in line with the labour market conditions. The ensuing policy recommendation was to reduce worker bargaining power, unions coverage and institutional support like unemployment benefits and an effective minimum wage. We discuss the evidence on the (often negative) effects of such measures in Dosi et al. (2017c,b).

The "packaging" of ALMPs with reforms to increase the labour market flexibility has been frequent in the recent policy discourse, especially in Europe after the sovereign debt crises, (re) introduced by the oxymoronic *expansionary austerity* hypothesis. The term has been coined by Alesina and Ardagna (2010) but the notion dates back at least to the intellectual supporters of the disastrous policies of Hoover, in the US, and Bruning, in Germany, during the 1930's. According to this view, fiscal adjustment on the spending side promotes permanent stabilization, has lower costs in terms of output loss, and stabilizes consumer expectations in terms of future tax hikes. Overall, expansionary austerity has turned out to be a huge hoax: evidence in a positive relationship between public debt reduction and GDP growth is basically non-existent. On the contrary, recent contributions emphasize the role of *private* debt in triggering historically-deep financial crises. Jordà et al. (2016) find evidence that public debt is not harmful per se in normal times, but also that a high level of public indebtedness might just reduce the fiscal ability to counteract financial crises, due to private debt overhang. Thus, debt level is relevant just *after* financial crises occur, therefore impinging "drag" on the *recovery* path, rather than triggering the recessions. In line with these findings, Guerini et al. (2017) find evidence of the "Janus-faced nature of debt", distinguishing between the effects of private and public debts.

Notwithstanding the lack of any empirical support, the European policy stance (and recently also the Brazilian one among others) has embraced such a discourse with an ensembles of policy measures widening and deepening the Maastricht Treaty, namely the European Stability and Growth Pact (1997) and the subsequent Fiscal Compact (2012). The Mediterranean countries have been the hardest hit by such policy package. However, the policy experiment did not work well also for the European Union as a whole, with many indicators still below the pre-crisis period. On top of that, a diverging trend between Northern and Southern countries has dramatically emerged. We discuss the self-defeating impact of those policies in Dosi et al. (2015, 2016).

In the following, we bring together those two strands of what we could call the "Berlin-Chicago Consensus",[3] and analyse, first, the relative impact of ALMPs under different labour market regimes, and, second, the complementary effect of Fiscal Compact-type rules.

A closely related empirical question concerns the labour market effects of credit availability

[3]See Fitoussi and Saraceno (2013) for a discussion of the theoretical and empirical flaws of the "Washington-Berlin Consensus", as well as its negative impact on the macroeconomic performance of European economies.

and the impact of credit crunches. Recent studies have linked the relation between the changing lending conditions and the flows in the labour market. At least since the paper by Bernanke (1983), and particularly after the 2008 crisis, the transmission channels between credit and the dynamics of the real economy have been finally investigated. Two main transmission channels have been emphasized. First, the one propagating via households indebtedness, which goes from housing prices burst, stressed household balance sheets, reduced consumption of non tradable goods and houses, with the ensuing employment losses largely affecting non-tradable, construction and manufacturing sectors in highly leveraged economies (Mian and Sufi, 2012; Charles et al., 2016). This dynamics is beyond the scope of this work. However, the second channel originating from firms indebtedness, going through the deteriorating effect of bad lending practices toward the balance sheets of firms (particularly small and medium ones) which once become financially constrained, incur in massive lay-offs (Chodorow-Reich, 2014), is not.

To explain the slow recovery path registered in the Western economies, both in output and employment, one shall evaluate not only the cyclical components attributable to the crises, as the debt overhang, but also the role played by the *structural* elements. In particular, factors like the slack in the productivity path (Fernald et al., 2017), the reduced firms entry rate, and the slow down in capital accumulation (Siemer, 2014), which are pre-crisis patterns that have emerged before the 2008 burst of the housing prices. Indeed, the two-way interaction between cyclical and long-term phenomena is one of the major challenges to the analysis of the macroeconomic dynamics. That, of course, involves the (possibly endemic) presence of hysteresis in the labour market, a documented finding during the Great Recession (Yagan, 2017; Jaimovich and Siu, 2012). Indeed, hysteretic effects plausibly extend to all macro phenomena involving some form of dynamic increasing returns or coordination externalities, as we discuss in Dosi et al. (2018). However, their precise forms and degrees crucially depend also on the institutional architectures of economic interactions, including of course labour market and credit ones, and on policies. This is indeed the focus of the analysis that follows.

# 3 The model

We build a general *disequilibrium*, stock-and-flow consistent, agent-based model, populated by heterogeneous workers, firms and banks which behave according to boundedly rational rules. More specifically, we extend the credit-augmented "Schumpeter meeting Keynes" (K+S) model (Dosi et al., 2010, 2013, 2015, 2017a) with explicitly decentralizing the interactions among firms and workers in the labour market (Dosi et al., 2017b,c), further adding endogenous processes affecting of workers' skills dynamics. Together with an explicit credit market, this set-up allows an in-depth analysis of the determinants of labour demand, wages and ultimately GDP growth and income distribution.

The three-sector economy in the model is composed of four populations of heterogeneous agents, $L^S$ consumers/workers, $F_t^1$ capital-good firms, $F_t^2$ consumption-good firms, $B$ banks, plus the Government and the Central Bank.[4] The basic structure of the model is depicted in Figure 1. Capital-good firms invest in R&D and produce heterogeneous machine-tools whose pro-

[4]The subscript $t$ stands for time, agent specific variables are denoted by a subscript $\ell$ in case of workers, $i$ for capital-good firms, $j$ for consumption-good firms, and $k$ for banks.

ductivity stochastically evolves over time. Consumption-good firms combine machines bought from capital-good firms and labour in order to produce products for consumers. There is a banking sector represented by a fixed number of banks that take deposits and provide loans to firms to finance production and investment plans. Workers submit job applications to a (limited) random subset of firms. Firms hire according to their individual adaptive demand expectations. The Government levies taxes on firms and banks profits, pays unemployment benefits, provide training for unemployed and imposes a minimum wage, according to the policy setting, absorbing excess profits and losses from the Central Bank and keeping a relatively stable debt in the long run.

In the following, we first summarize the functioning of the capital-good, consumption-good and banking sectors of our economy, and then present the labour market dynamics, detailing the skills accumulation and deterioration mechanisms and the policy experiments configuration. In Appendix A, we briefly present the firms', workers', banks', Central Bank and Government behavioural rules (for details, see Dosi et al., 2010, Dosi et al., 2015 and Dosi et al., 2017c). The model main variables, its configurations, the parameter set-ups and the main results of the sensitivity are presented in Appendix B.

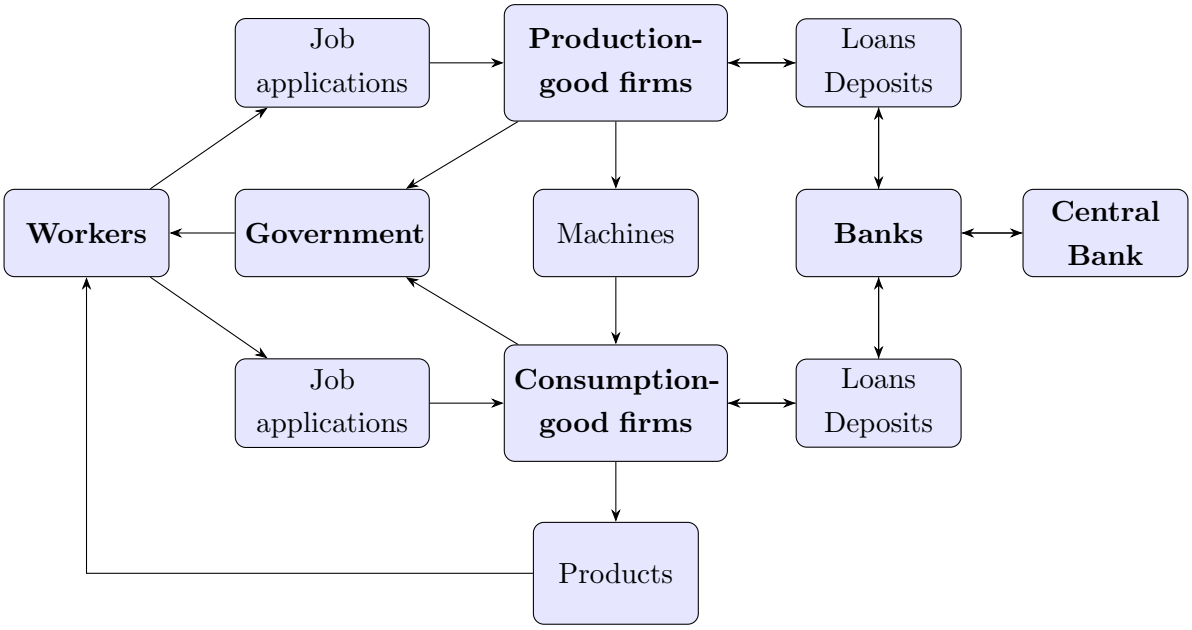



**Figure 1:** The model overall structure. Boxes in bold style represent the model's agents.

### 3.1 The capital- and consumption-good sectors

The capital-good industry is the locus where innovation is endogenously generated in the model. Capital-good firms develop new machine-embodied techniques or imitate the ones of their competitors in order to produce and sell more productive and cheaper machinery. On demand, they supply machine-tools to consumption-good firms, producing with labour as the only input. Firms have access to bank loans to cover liquidity problems up to a limit. The capital-good market is characterized by imperfect information and Schumpeterian competition driven by technological innovation. Machine-tool firms signal the price and productivity of their machines

to their current customers as well to a subset of potential new ones, and invest a fraction of past revenues in R&D aimed at searching for new machines or copy existing ones. Prices are set using a fixed mark-up over (labour) costs of production.

Consumption-good firms produce a quality-differentiated single good employing capital (composed by different "vintages" of machine-tools) and labour under constant returns to scale. Desired production is determined according to adaptive (myopic) demand expectations. Given the actual inventories, if the current capital stock is not sufficient to produce the desired output, firms order new machines to expand their installed capacity, paying in advance – drawing on their retained past profits or, up to some limit, on bank loans. Moreover, they replace old machines according to a payback-period rule. As new machines embed state-of-the-art technologies, the labour productivity of consumption-good firms increases over time according to the mix of vintages of machines in their capital stocks. Consumption-good firms choose in every period their capital-good supplier comparing the price and the productivity of the machines they are aware of. Firms then fix their prices applying a variable mark-up rule on their production costs, trying to balance profit margins and market shares. More specifically, firms increase their mark-up and price whenever their market share is expanding and vice versa. Imperfect information is also the normal state of the consumption-good market so consumers do not instantaneously switch to the most competitive producer. Market shares evolve according to a (quasi) replicator dynamics: more competitive firms expand, while firms with relatively lower competitiveness levels shrink, or exit the market.

The process of entry-exit is entirely endogenous in both sectors. Firms leave the market whenever their market shares get close to zero or their net assets turn negative (bankruptcy). Conversely, the number of entrants stochastically depends on the number of incumbents and on the prevailing financial conditions. When the sectoral liquidity-to-debt ratio is shrinking new firms find it easier to enter, and vice versa.

### 3.2 The banking sector and monetary policy

The structure of the credit market closely follows the one presented in Dosi et al. (2015). The banks collect deposits from firms and evaluate the provision of loans on request. Firms in both sectors hold a fixed relationship with a (randomly chosen) single bank. The supply of credit is bounded by each bank's capital and Basilea-type regulatory capital-adequacy constraints. The available credit is allocated by each bank according to a pecking order where demanding clients are ranked by the liquidity-to-sales ratio. Credit rationed firms are not be able to fully accomplish their investment plans.

The Central Bank may fix the prime interest rate ($r_t$) using a single or dual mandate Taylor rule, depending on the policy set up. Parts of banks' deposits are held by the central bank as compulsory reserves. There is an interest rate structure according to which there is corridor binding the interest rate fixed by the central bank between the interest rate on deposits $r_D$, the lower bound, and the interest rate on loans ($r_t^{deb}$), the upper bound: $r_D \leq r_t^{res} \leq r_t \leq r_t^{deb}$. The interest rate on reserves ($r_t^{res}$) and loans are defined according to mark-down and mark-up rules, respectively, given the prime interest rate. Central bank bail-outs the banking system when total net worth turns negative.

### 3.3 The labour market and skills dynamics

The labour market in the model implements a fully-decentralized search and hiring process between workers and firms (more in Dosi et al., 2017b,c). The aggregate supply of labour $L^S$ is fixed and all workers are available to be hired in any period. When unemployed, workers submit a certain number of job applications to firms. Employed workers may apply or not for better positions, according to the institutional set up. Larger firms have a proportionally higher probability of receiving job applications, which are organized in separated, firm-specific application queues. The labour market is characterized by imperfect information as firms only observe workers skills and wage requests and workers are aware only of the wage offers they may receive.

Firms decide about their individual labour demand based on the received orders (capital-good sector), the expected demand (consumption-good sector), and the expected labour productivity levels. Considering the number and the productivity of the already employed workers, firms decide whether to (i) hire new workers, (ii) fire part of the existing ones, or (iii) keep the existing labour force. Each hiring firm defines a unique wage offer for the applicant workers, based on its internal conditions and the received applications. Workers select the best offer they get from the firms to which they submitted applications, if any. If already employed, depending on the institutional regime, they might quit the current job if a better wage offer is received. There are no further rounds of bargaining between workers and firms in the same period. Thus, firms have no guarantee of fulfilling all the open positions, and no market clearing is ever guaranteed. Moreover, there are no firing or hiring transaction costs.

### 3.4 Policy experiments

In the foregoing we describe the policy experiments we undertake in order to study the different effects of ALMPs vs. PLMPs. The two supply-side policy schemes we implement in the K+S model are: **ALMP 1** involving the support to the worker job-search activity with the aim of reducing mismatches in the labour market, and **ALMP 2** based on training program targeting the improvement of the skills of unemployed people.

#### 3.4.1 ALMP 1: reducing mismatches and enhancing job search

To study the effect of the support in the job search activity, we compare the model properties under different degrees of informational imperfection in the workers job application process. In particular, we are interested in the impact on the matching process between firms and workers in terms of open positions vacancy and hiring rates.

In the model, the search and matching process occurs through the following steps. First, each firm gets in probability a fraction of the candidate workers in its application queue $\{\ell^s_{j,t}\}$, proportional to firm market share $f_{j,t}$:

$$\mathrm{E}(L^s_{j,t}) = \left(\omega(1-U_{t-1}) + \omega_{un}U_{t-1}\right) L^S f_{j,t-1}, \tag{1}$$

where $L^S$ is the (fixed) total labour supply, $U_t$ is the unemployment rate and $\omega, \omega_{un} \in \mathbb{R}^+$ are parameters defining the number of job application queues each seeker joins, if employed or

unemployed, respectively. Considering the set of workers in $\{\ell^s_{j,t}\}$, each firm select the subset of desired workers $\{\ell^d_{j,t}\}$ to make a job (wage) offer:

$$\{\ell^d_{j,t}\} = \{\ell_{j,t} \in \{\ell^s_{j,t}\} : w^r_{\ell,t} < w^o_{j,t}\}, \quad \{\ell^d_{j,t}\} \subseteq \{\ell^s_{j,t}\}. \tag{2}$$

Firms target workers that would accept the wage offer $w^o_{j,t}$, considering the wage $w^r_{\ell,t}$ requested by workers, if any. Each firm hires workers up to its total demand $L^d_{j,t}$ is fulfilled (or up to all workers in its queue, whichever is lower). So, the number of workers $L_{j,t}$ the firm employs, given the existing workforce $L_{j,t-1}$, is bound by:

$$0 \leq L_{j,t} \leq L^d_{j,t} \leq L^s_{j,t}, \qquad L^z_{j,t} = L_{j,t-1} + \#\{\ell^z_{j,t}\}, \quad z = d, s. \tag{3}$$

Therefore, the number of candidates in the job application queue $L^s_{j,t}$ is a critical constraint to the achievement in the matching process of the desired number of workers $L^d_{j,t}$. By the same token, as firms have heterogeneous wage offers $w^o_{j,t}$, workers increase their chances of getting a higher wage as the number of queues to which they participate increases. As the intensity of the search process is captured by the parameters $\omega$ and $\omega_{un}$, they in fact control the level of information available to the labour market participants. By varying those two parameters, in the following we shall study the impact of increasing width of job search activity. Of course, higher intensity of the search increases the information firms and workers are able to access and in principle ought to foster the efficiency of the matching process.

### 3.4.2 ALMP 2: Government-sponsored training

We extended the K+S model to account for the processes of accumulation and deterioration of workers' skills. Such processes are driven by worker-specific job tenures, assuming a learning-by-doing process when employed, a gradual deterioration of skills while unemployed. Here, we allow for the possible upgrade of the skills of unemployed workers participating in Government sponsored (re) training program. The skill level $s_{\ell,t} > 0$ of each worker $\ell$ evolves over time as a multiplicative process:

$$s_{\ell,t} = \begin{cases} (1+\tau_T)s_{\ell,t-1} & \text{if employed in } t-1 \\ (1+\tau_G)s_{\ell,t-1} & \text{if unemployed but under training in } t-1 \\ \dfrac{1}{1+\tau_U}s_{\ell,t-1} & \text{if unemployed and not under training in } t-1, \end{cases} \tag{4}$$

where $\tau_T \geq 0$ is a parameter governing the learning rate while the worker is employed, $\tau_G \geq 0$ is the learning rate of unemployed workers under training and $\tau_U \geq 0$, the corresponding parameter accounting for the skills deterioration when a worker is unemployed. As a consequence, when worker $\ell$ is employed or being trained her abilities improve over time, as she becomes more experienced in her task or acquire new skills. Conversely, unemployed workers lose skills. When a worker is hired, she immediately acquires the minimum level of skills already present in the firm (the incumbent worker with the lowest skills), if above her present level. Workers have a fixed working life: after a fixed number of periods $T_r$, workers retire and are replaced by younger ones,[5] whose skills are set to the current minimum level of employed workers.

[5] At the start of each simulation, initial workers ages are randomly draw in the integer range $[1, T_r]$ and all start from the same skills level.

Workers' skills define their individual (potential) productivity $A_{\ell,t}$:

$$A_{\ell,t} = \frac{s_{\ell,t}}{\bar{s}_t} A_i^\tau, \qquad \bar{s}_t = \frac{1}{L^S} \sum_\ell s_{\ell,t}, \tag{5}$$

where $\bar{s}_t$ is the average worker skills level, $A_i^\tau$ is the "standard" productivity of the vintage of the machinery which the worker operates, and $L^S$, the (fixed) total labour supply. Thus, the ratio $s_{\ell,t}/\bar{s}_t$, the worker normalized skills, represents her ability to produce more (if $s_{\ell,t} > \bar{s}_t$) or less than the "standard" associated with a given machine technology.[6]

The learning by tenure/doing process is well established in the literature at least since the seminal contribution of Arrow (1962). On the empirical side, for the links between job tenure, capability accumulation and firm productivity, see Zhou et al. (2011) and Lucidi and Kleinknecht (2009), among others.

Under ALMP 2, Government offers training to fraction $0 \leq \Gamma \leq 1$ of unemployed workers, randomly selected. Non-participating workers undergo a process of skills deterioration (at the $1/(1+\tau_U)$ rate) while trained ones learn at a rate $(1+\tau_G)$ rate (cf. Equation 4). In case of $\tau_G = 0$, of course the public training program just prevents skills deterioration.

The unit cost of the Government-sponsored training program is equal to a fraction $\Gamma_{cost}$ of the current average wage in the economy $\bar{w}_t$. So, the public expenditure devoted to the training activity is defined as:

$$G_t^{train} = (L^S - L_{t-1}^D)\Gamma \bar{w}_{t-1} \Gamma_{cost}. \tag{6}$$

### 3.4.3 Demand-management policies

The Government taxes firms and banks profits at a fixed rate $tr \geq 0$ and collects revenues as defined by:

$$Tax_t = \left(\Pi_t^1 + \Pi_t^2 + \Pi_t^b\right) tr, \tag{7}$$

where $\Pi_t^1$, $\Pi_t^2$ and $\Pi_t^b$ are the aggregate total profits of the capital-good, the consumer-good and the banking sectors, respectively.

The Government pays a benefit $w_t^{un}$ to unemployed workers which is a fraction of the current average wage $\bar{w}_t$:

$$w_t^{un} = \psi_T \bar{w}_{t-1} \tag{8}$$

where $0 \leq \psi_T \leq 1$ is a parameter representing the target benefit level, which can be reduced according to the applicable fiscal rules (see below). The unemployment benefit is the main tool of passive labor market policies (PLMPs). Considering the foregoing training cost $G_t^{train}$, the total public expenditure is:

$$G_t = (L^S - L_t^D) w_t^{un} + G_t^{train}. \tag{9}$$

Therefore, the public primary deficit (or surplus) is:

$$Def_t = G_t - Tax_t, \tag{10}$$

[6]Note that, in this specification, the firm-level effective productivity $A_{j,t}$ is a truly emergent property, resulting together from the technical innovation dynamics (the introduction of new vintages $A_i^\tau$), the worker skills evolution and the effective demand, which guides firms when deciding the capital stock dynamics and the employed machine mix (see Appendix A for details).

Accordingly, the stock of public debt is updated:

$$Deb_t = Deb_{t-1} + Def_t - \Pi_t^{cb} - G_t^{bail}, \tag{11}$$

where $\Pi_t^{cb}$ is the operational result (profits) of the Central Bank and $G_t^{bail}$ is the cost of rescuing (bail-out) the banking sector during financial crises, if any.

In the policy experiments, the provision of unemployment benefits will be studied under two alternative fiscal policy scenarios:

1. AS: Automatic Stabilizer. Unemployment benefits are provided without any binding constraint due to fiscal consolidation.

2. FC: Fiscal Compact. The public deficit on gross domestic product ratio ($Def_t/GDP_t$) shall not exceed 3% and the public debt on gross domestic product ratio ($Deb_t/GDP_t$) shall not exceed 60%. Whenever any of the current ratios turn binding, a restructuring procedure is enforced: the debt overhang is gradually repaid by reducing the unemployment benefits until the target(s) are met.

### 3.5 Timeline of events

In each simulation period, which can be taken to roughly represent a quarter, the following timeline of events take place:

1. Policy variables (prime rate and unemployment benefits) are fixed;
2. Total (potential) credit supply by banks to firms is determined;
3. Workers (employed, unemployed or under training) update their skills;
4. Machines ordered in the previous period (if any) are delivered;
5. Capital-good firms perform R&D and signal their machines to consumption-good firms;
6. Consumption-good firms determine their desired production, investment and workforce size;
7. Firms allocate cash-flows and (if needed) borrow from banks to operate and invest;
8. Firms send/receive machine-tool orders for the next period (if applicable);
9. Job-seeker workers send applications to firms;
10. Wages are set (indexation or bargaining) and job vacancies are partly or totally filled;
11. Firms pay wages and government pays unemployment subsidies and provides training;
12. Consumption-good market opens and the market shares are driven by competitiveness;
13. Firms and banks compute their profits, pay taxes and repay (quotas of) their debt;
14. Exit takes place, as near-zero share and bankrupt firms are eschewed from the market;
15. Aggregate variables are computed and the cycle restarts;
16. Entry occurs.

### 3.6 Alternative institutional regimes

The model is configured under two alternative institutional regimes (see Table 11 in Appendix B) which we call *Fordist* and *Competitive*.[7] Their characteristics are telegraphically sketched in Table 1.

| | Fordist (baseline) | Competitive |
|---|---|---|
| **Wage sensitivity to unemployment** | low (rigid) | high (flexible) |
| **Workers search activity** | unemployed only | unemployed and employed |
| **Labour firing restrictions** | under losses only | none |
| **Workers hiring priority** | higher skills | lower payback |
| **Workers firing priority** | lower skills | higher payback |
| **Unemployment benefits** | yes | yes (reduced) |
| **Minimum wage indexation** | full | partial |
| **Firms credit limits** | low | high |
| **Banks capital requirements** | high | low |

**Table 1:** Main characteristics of tested policy regimes.

Under the *Fordist regime*, wages are insensitive to the labour market conditions and indexed on a convex combination between economy-wide and firm-level productivity growth. There is a sort of covenant between firms and workers concerning long-term employment: firms fire only when their profits become negative, while workers are loyal to employers and do not seek for alternative jobs. When hiring and firing, firms aim to keep the more skilled workers. Labour market institutions contemplate a minimum wage fully indexed to the aggregate economy productivity and unemployment benefits are financed by taxes on profits.

Conversely, in the *Competitive regime*, flexible wages respond to unemployment in decentralized labour market dynamics, and are set by means of an asymmetric bargaining process where firms have the last say. Employed workers search for better paid jobs with some positive probability and firms freely adjust (fire) their excess workforce according to their planned production. The hiring and firing of workers by firms are based on a trade-off between skills and wages, using a simple payback-like comparison rule. The Competitive regime is also characterized by different labour institutions: minimum wage is only partially indexed to productivity and unemployment benefits (together with the associated taxes on profits) are relatively lower.

We also differentiate the two regimes in terms of the parameters governing prudential limits in the supply of credit, with the Competitive characterised by a *higher* credit limit to firms indebtedness and a *lower* minimum bank capital adequacy rate (see Appendix A for the details on the credit supply mechanism). Both variations effectively ease the credit provisions by banks to firms despite the inherent increasing in the financial fragility of these agents.

In Section 5 we experiment with a regime transition along the simulation history, capturing a set of labour-market structural reforms. This institutional shock, aimed at spurring flexibility on the relations among agents in the labour market, implies that the social compromise embodied

[7] The two regimes roughly capture two alternative *wage-labour nexus* in the language of the *Regulation Theory* (see, within a vast literature, Boyer and Saillard, 2005 and Amable, 2003).

in the Fordist regime is replace by the Competitive one. The shocks also incorporate financial deregulation in the credit market.

### 3.7 Empirical validation

The K+S model is able to generate endogenous growth and business cycles, emergent crises, and to reproduce a rich set of macro stylized facts (relative volatility, co-movements, etc.) and micro ones (firm size distributions, firm productivity dynamics, etc.) as shown in the top panel of Table 2 (more details in Dosi et al., 2010, 2013, 2015, 2017a). In addition, the labour-enhanced version of the model (Dosi et al., 2017b,c), which explicitly accounts for decentralized firm-worker interactions, robustly replicate most of the labour market empirical regularities (cf. the bottom panel of Table 2).

| Microeconomic Stylized Facts | Aggregate-level Stylized Facts |
|---|---|
| Skewed firm size distributions | Endogenous self-sustained growth with persistent fluctuations |
| Fat-tailed firm growth rates distributions | Fat-tailed GDP growth rate distribution |
| Heterogeneous productivity across firms | Endogenous volatility of GDP, consumption and investment |
| Persistent productivity differentials | Cross-correlation of macro variables |
| Lumpy investment rates of firms | Pro-cyclical aggregate R&D investment and net entry of firms in the market |
| Heterogeneous skills distribution | Persistent and counter-cyclical unemployment |
| Fat-tailed unemployment time distribution | Endogenous volatility of productivity, |
| Fat-tailed wage growth rates distributions | unemployment, vacancy, separation and hiring rates |
| | Unemployment and inequality correlation |
| | Pro-cyclical workers skills accumulation |
| | Beveridge curve |
| | Okun curve |
| | Wage curve |
| | Matching function |

**Table 2:** Stylized facts matched by the K+S model at different aggregation levels.

## 4 ALMPs experiment results

### ALMP 1: search activity and mismatches

We start by presenting the effects of different degrees of search activity and the corresponding impact on the matching process between supply and demand. In the model, there are two parameters for setting the search intensity/information level in the labour market, namely $\omega$ and $\omega_{un}$, which set the mean number of job applications sent by employed and unemployed workers to firms on each period, respectively. By changing the number of applications we mimic the effect of policies aimed at improving the job-search intensity and we analyse the consequences

upon the hiring rate and ultimately on the labour demand. Note also that we assume that such a policy can be implemented at no cost. Table 3 reports the tested configurations for both institutional regimes.[8]

| | Search activity | | |
|---|---|---|---|
| $(\omega, \omega_{un})$ | Low (Baseline) | Medium | High |
| **Fordist** | $(2, 5)$ | $(50, 50)$ | $(100, 100)$ |
| **Competitive** | $(2, 5)$ | $(50, 50)$ | $(100, 100)$ |

**Table 3:** Configuration of parameters $(\omega, \omega_{un})$ for different levels of worker job-search activity.

Figure 2 presents a performance comparison exercise in terms of (a) hiring rates (hired workers over total labour supply) and of (b) vacancy rates (unfilled positions over total labour supply) among the three different degrees of search intensity in both regimes. With reference to the Fordist case, the search intensity *does not* significantly affect either the number of hired workers or the number of unfilled positions. Conversely, moving to the Competitive set up, the higher intensity of search leads toward mildly higher hiring and vacancy rates, signalling that although the matching improves, this occurs at the cost of higher turbulence in the labour market. Notably, as shown by Figure 2(c), in the Competitive case the average worker skills level *decreases* under the high search scenario, due to the shorter tenure (time in the job) periods.

On top of that, the key metrics related to the long-run dynamics of the model, like GDP and productivity growth, unemployment, and inequality are *not* affected by the increased of search activity in both regimes, as evidenced in Table 4.[9] In fact, the only statistically relevant impact of the increased information level is a mild reduction in the (already low) unemployment level in the Fordist regime.

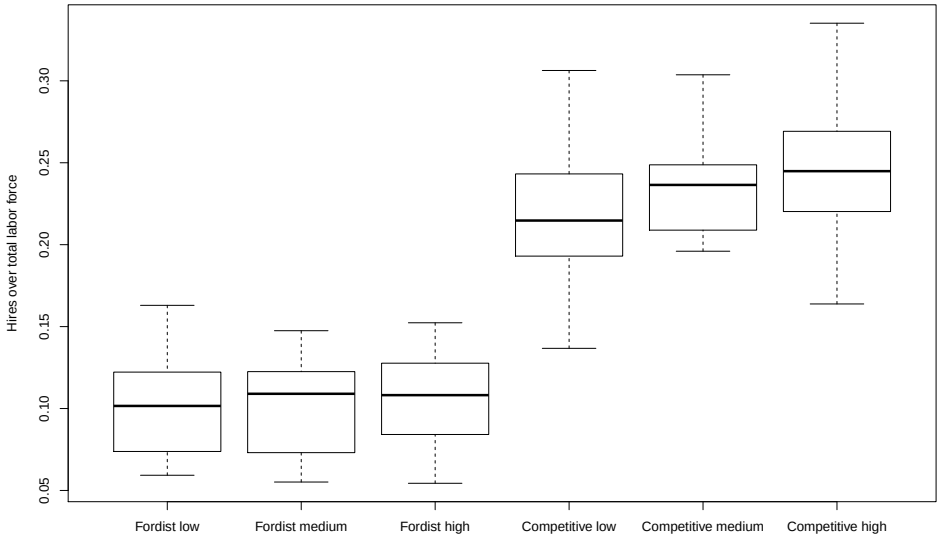
From this first battery of results it clearly emerges that job-search-enhancing ALMPs aimed at fostering efficiency in the labour market are not effective under a more rigid industrial relations regime like the Fordist, while they look more relevant in the more flexible Competitive institutional set up in terms of increasing the matching process measured in terms of hiring rate. Nonetheless, this improvement comes at the cost of additional turbulence, as shown by the increased unfilled vacancies. And at least equally important, these experiments show that this kind of policy are ineffective to boost the long-run growth. Naturally, the assessment of the impact of ALMP 1 would be even worse if one also considered the cost of its implementation.

[8]The intensity labels (low, medium, high) are just references for the chosen parameter values, admittedly extreme to allow for the exploration of scenarios closer to the complete information case. Of course, the submission of 50 or 100 job applications in a single period (quarter) would represent a very high level of search activity when compared to the empirical evidence.

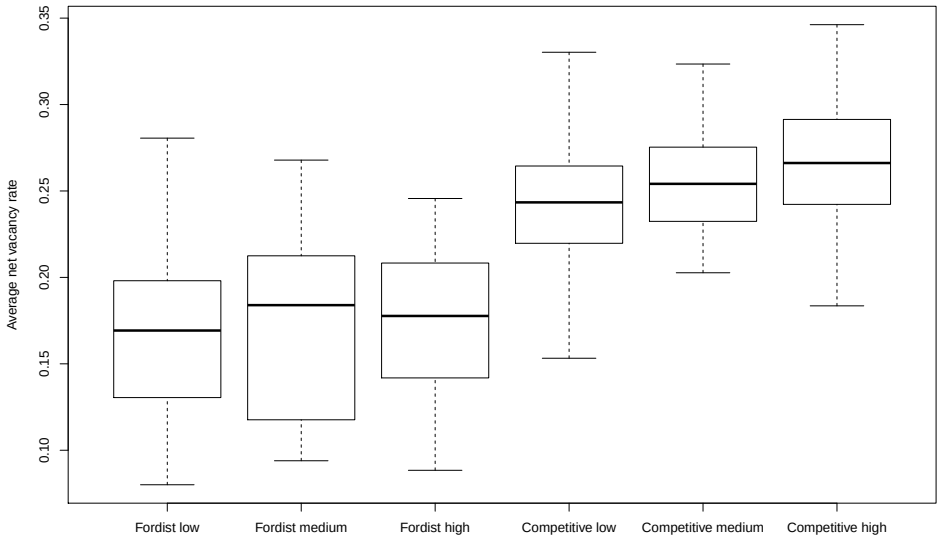
[9]This table, as well the similar ones below, compares the average results from different model configurations on several macroeconomic variables as the ratio (division) between the respective variables for each of the variants with respect to the same variable for the chosen baseline case. Also a two-means t-test is performed in each case to evaluate if the difference between the variant and the baseline is statistically significant and at which p-value level.

**Figure 2:** Performance comparison between regimes and different degrees of intensity of job search. Statistics for 50 MC runs in period $[200, 400]$. Bar: median | box: 2nd-3rd quartile | whiskers: max-min | dots: outliers.

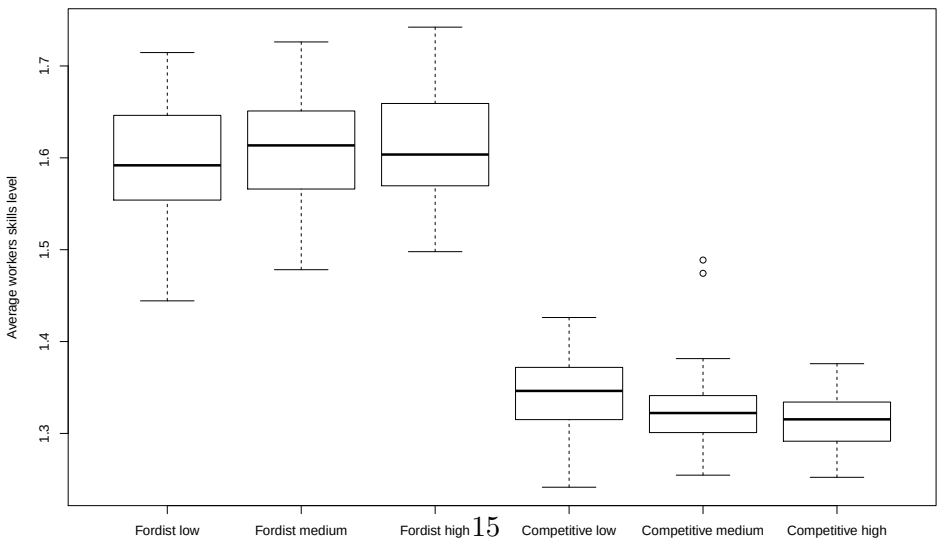
**(a)** Hiring rate




**(b)** Vacancy rate




**(c)** Workers average skills



| Fordist | Low (Baseline) | Medium | | High | |
|---|---|---|---|---|---|
| | Baseline | Ratio | p-value | Ratio | p-value |
| **GDP growth** | 0.02 | 0.94 | 0.28 | 0.99 | 0.83 |
| **Productivity growth** | 0.02 | 0.95 | 0.33 | 1.00 | 0.91 |
| **Unemployment** | 0.02 | 0.62 | 0.01 | 0.59 | 0.01 |
| **Income concentration** | 0.05 | 1.20 | 0.05 | 1.09 | 0.18 |
| Competitive | Low (Baseline) | Medium | | High | |
| | Baseline | Ratio | p-value | Ratio | p-value |
| **GDP growth** | 0.01 | 0.96 | 0.71 | 0.95 | 0.72 |
| **Productivity growth** | 0.01 | 0.95 | 0.69 | 0.97 | 0.77 |
| **Unemployment** | 0.20 | 1.01 | 0.87 | 1.03 | 0.35 |
| **Income concentration** | 0.18 | 1.01 | 0.77 | 0.99 | 0.67 |

**Table 4:** Performance comparison among three alternative scenarios in two regimes. Averages for 50 MC runs in period $[200, 400]$. p-value for a two-means t test, $H_0$: no difference between scenarios.

## ALMP 2: the effects of qualification training

Let us turn to the simulation results on the ALMP 2 experiment. The four scenarios under analysis are summarized in Table 5. They are configured in order to compare three different changes: (i) in the institutional set up from Fordist to Competitive labour relations, (ii) the provision of passive vs. active labour market policies in the Competitive regime, (iii) the combination of the two. The experiment is meant to explore whether flexible labour markets – properly "oiled" by the policy schemes – might have (at least) the same efficiency and equity outcomes of a more rigid market. Moreover, we investigate the extent to which the adopted policy scheme can "lubricate" labour market matching and, through that sustain aggregate demand. In the following, we compare the aggregate empirical regularities of the alternative configurations in terms of the efficiency and equity performances of the system.

| | Unemployment benefits | Qualification training |
|---|---|---|
| **Fordist** | ✔ | ✖ |
| **Competitive 1** | ✔ | ✖ |
| **Competitive 2** | ✖ | ✔ |
| **Competitive 3** | ✔ | ✔ |

**Table 5:** The tested ALMPs and PLMPs configuration scenarios.

We start analysing the *movement* in some regularities in the matching process. Table 6 presents the slopes for the fitted Beveridge, matching function and Okun curves.[10]

The Beveridge curve captures the degree of frictional mismatch in the labour market by connecting the vacancy to the unemployment rate. A clear *outward shift* emerge in the curves moving from the Fordist to the Competitive regimes, independently from the precise policy mixes which mirror similar historical evidence. This shift depicts a change in the efficiency of

[10]The linear fittings are performed by ordinary least-squares regression. The average $R^2$ was 0.22, indicating a reasonably good fitting to a linear model.

the matching process. This "malfunctioning" behaviour, namely a *positive* correlation between vacancy and unemployment rates, has been documented in the recent years and explained by an increasing mismatch between labour demand and labour supply.[11] The reasons generally put forward for the increase are both the cyclical components of the business cycle, and also structural changes in long-term unemployment. The latter includes changes in the composition of labour supply and the potential twisting effects of the policies schemes. Here we suggest that of particular relevance for the interpretation of the evidence is the effect exerted by the *reduction* in aggregate demand upon the labour market efficiency, via an increase in the long-term unemployment rate.

| | Fordist | Competitive | | |
|---|---|---|---|---|
| | | Un.ben. | Train. | Un.ben.&train. |
| **Beveridge curve** | -0.043 | 0.360 | 0.061 | 0.205 |
| | (0.054) | (0.044) | (0.028) | (0.046) |
| **Matching function** | 0.279 | 0.557 | 0.397 | 0.571 |
| | (0.014) | (0.042) | (0.035) | (0.037) |
| **Okun curve** | -0.202 | -0.219 | -0.192 | -0.197 |
| | (0.020) | (0.018) | (0.019) | (0.014) |

**Table 6:** Fitted coefficient (slope) of a OLS regression for selected curves. Averages for 50 MC runs in period $[200, 400]$. MC standard errors in parentheses.

Further support on the effects of the reduced aggregate demand upon the labour market matching efficiency can be inferred from the matching function curve, i.e. basically the relationship between the probability of finding a job and the vacancy/unemployment ratio. In line with the empirical evidence, the two variables are positively correlated in the four scenarios. However, the training only policy is the *least* effective alternative in a Competitive regime in order to improve matching (or to increase the curve slope), as presented in Table 6. This policy is significantly worse with respect to the two alternatives which include the continuing provision of unemployment benefits.

Finally, when analysing the Okun curve slope, the negative correlation between unemployment and GDP growth, Table 6 shows a close behaviour in the all set ups, independently from the adopted policy schemes. Again, these results hint at the detrimental effects of unemployment on output growth.

A further step in understanding the effects of the combination of a regime change and the alternative policy schemes involves the analysis of the dynamics of macroeconomic variables. Figure 3(a) presents the dynamics of the actual and the full-utilization GDP. Two of the configurations are set at time $t = 0$ under the Fordist regime without training (the lines 'Fordist' and 'Competitive + Unemployment Benefits') and the other two, under Fordist with training (the lines 'Competitive + Training' and 'Competitive + Unemployment Benefits + Training'). At $t = 100$ (dotted line) we introduce an institutional regime change to the three Competitive variants. The trajectories of the GDP (the averages of 50 Monte Carlo simulation runs) show

[11] See Bova et al. (2017) who document how 10 out of 12 of the OECD countries under examination experienced an outward shift of the Beveridge Curve during the recent crisis.

a long-run divergence between the set-ups.[12] Clearly, the worst performer is the training-only Competitive scenario (with no unemployment benefits), wherein only the supply side policy is undertaken.

A careful look at the skills dynamics presented in Figure 3(b) clarifies the effects of the training programs. Under the policy settings offering them, the average skills dynamics improves sensibly. Indeed, the training program is effectively protecting the unemployed worker skills from deterioration. Yet, it cannot compensate the increased average unemployment level and so it does not recover the Fordist skilling level. In fact, as skills accumulate under worker job tenure (see Equation 4), since the Competitive set-ups are characterized by a lower average tenure as compared to the Fordist one, the bias in favour of the latter is significant.

The detrimental effects of wage and numerical flexibility introduced by the regime change are also documented in Table 7, which shows the significant differences among the scenarios for the vacancy and the unemployment rates. Finally, note that the unemployment rate is even higher under the training-only scenario, while it is mitigated to some extent by the provision of unemployment benefits, confirming their Keynesian effects.

| | Fordist | Competitive | | | | | |
|---|---|---|---|---|---|---|---|
| | | Un.ben. | | Train. | | Un.ben.&train. | |
| | Baseline | Ratio | p-value | Ratio | p-value | Ratio | p-value |
| **GDP growth** | 0.02 | 0.79 | 0.00 | 0.73 | 0.00 | 0.88 | 0.06 |
| **Volatility of GDP growth** | 0.11 | 0.99 | 0.91 | 1.22 | 0.00 | 0.89 | 0.01 |
| **Recovery from GDP crises** | 9.30 | 1.91 | 0.00 | 2.18 | 0.00 | 2.16 | 0.00 |
| **Losses from GDP crises** | 0.98 | 4.85 | 0.00 | 7.37 | 0.00 | 4.43 | 0.00 |
| **Capacity utilization** | 0.79 | 1.03 | 0.00 | 1.02 | 0.10 | 1.03 | 0.01 |
| **Productivity growth** | 0.02 | 0.81 | 0.01 | 0.76 | 0.00 | 0.90 | 0.08 |
| **Unemployment** | 0.02 | 13.39 | 0.00 | 16.02 | 0.00 | 13.32 | 0.00 |
| **Vacancy** | 0.17 | 1.41 | 0.00 | 1.32 | 0.00 | 1.36 | 0.00 |
| **Workers skills** | 1.60 | 0.84 | 0.00 | 0.88 | 0.00 | 0.91 | 0.00 |
| **Wages dispersion** | 0.10 | 1.65 | 0.00 | 1.81 | 0.00 | 1.82 | 0.00 |
| **Income distribution** | 0.05 | 3.81 | 0.00 | 5.64 | 0.00 | 3.96 | 0.00 |
| **Mark-ups** | 0.22 | 1.00 | 0.35 | 1.02 | 0.00 | 1.01 | 0.00 |
| **Loans** | 0.57 | 15.20 | 0.31 | 1.87 | 0.01 | 1.50 | 0.01 |
| **Financial fragility** | 0.00 | 2.63 | 0.00 | 2.79 | 0.00 | 1.85 | 0.03 |

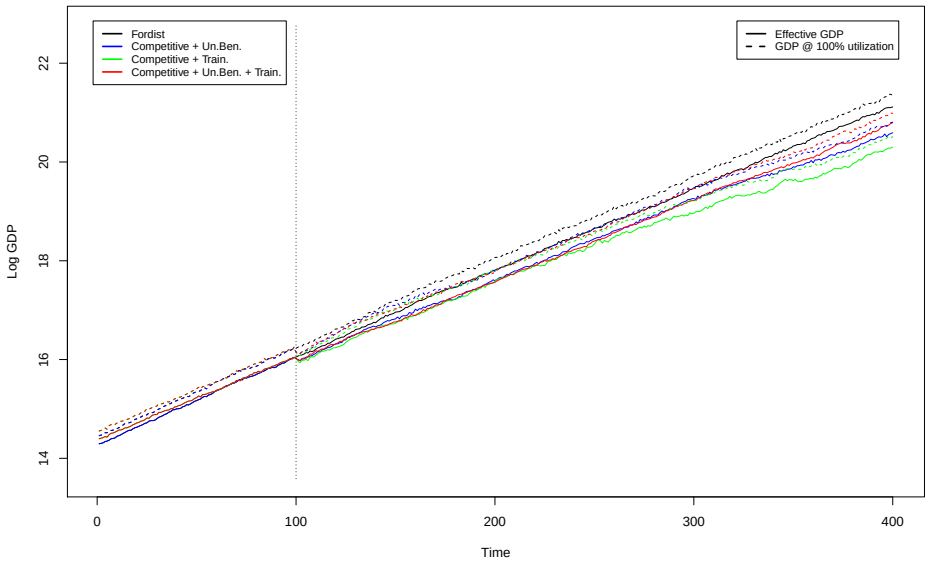
**Table 7:** Performance comparison among four alternative scenarios, selected time series. Averages for 50 MC runs in period $(200, 400)$. p-value for a two-means t test, $H_0$: no difference between scenarios.

Moving from efficiency toward equity variables, Figure 3 and Table 7 also present some metrics on income inequality. It is quite evident that in absence of unemployment benefits ALMPs are not able to mitigate the negative effects of labour market flexibility. In fact, the profit share is mildly higher in the Competitive variants. Further, a much more striking difference emerges in the income concentration measure (the Gini coefficient) which include income of both employed and unemployed workers. Figure 3(c) shows how deeply the index is affected by the

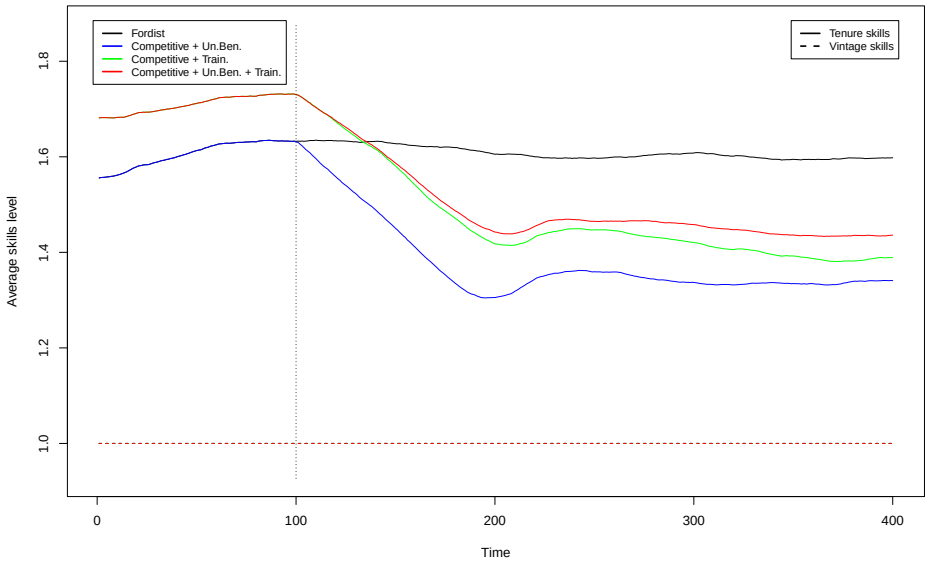
[12] Those are interesting examples of super-hysteresis. For a definition of the concept and a discussion about it, see Dosi et al. (2018).

**Figure 3:** Macroeconomic dynamics in alternative policy regimes. Lines represent 50 MC runs averages.

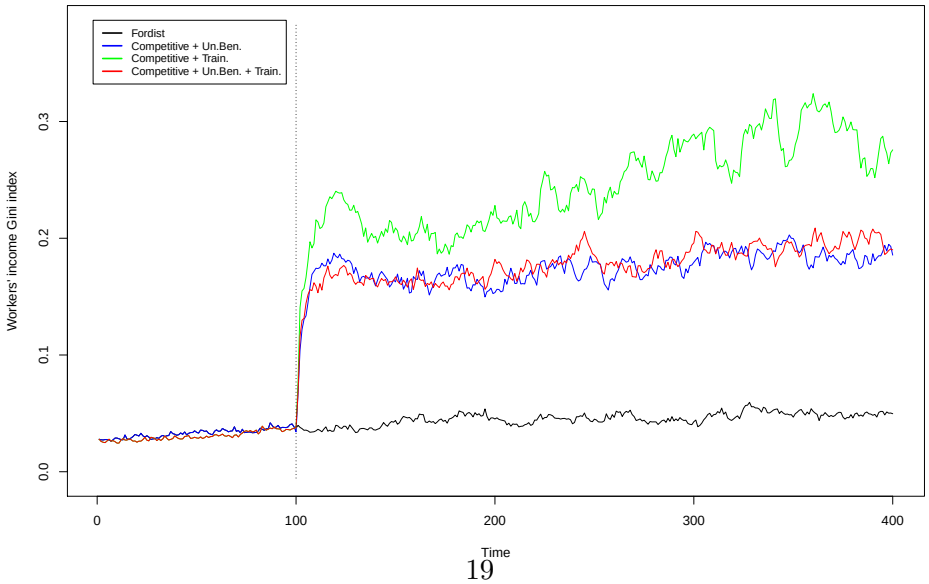
**(a)** Actual and full capacity GDP




**(b)** Average worker skills




**(c)** Income concentration



regime change, presenting a highly positive change (i.e. worsening distribution) when the supply-side-only policy is performed. Finally, when looking at inequality among employed workers (the real wages dispersion), a similar pattern appears. Those results confirm that not even the combination of supply and demand labour market policies (ALMPs and PLMPs, respectively) is able to mitigate the negative outcomes from the regime change to the Competitive one.

Let us now address the potential for hysteresis in more flexible labour markets (which we discuss at greater length in Dosi et al., 2018). Figure 4 presents the scenario performance in terms of (a) the GDP growth, (b) the GDP average losses incurred during deep crises, and (c) the average number of periods required for the GDP to recover the pre-crisis trend level. Under the Competitive variants, *even with* both ALMPs and PLMPs, the average GDP growth rate is lower. The supply-side-only scheme exhibits a much worse performance than traditional Keynesian demand-side policies. Looking at the losses of the GDP due to deep crisis (more that 3% GDP reduction) and the duration of the crises, a similar picture emerges. Losses are substantially higher under the training-only Competitive variant and recovery periods are longer. The relative performance metrics of the various policy scenarios is presented in Table 7. Overall the training-only scheme usually exhibits the worst outcomes.

The bottom-line of this second battery of experiments is that demand-side policies like unemployment benefits are better suited to foster economic growth, reduce unemployment, and mitigate inequalities. At the same time, supply side policies aimed at raising skills of unemployed workers are *not enough* to counterbalance adverse labour markets, despite their positive effect attenuating the overall worker skills deterioration.

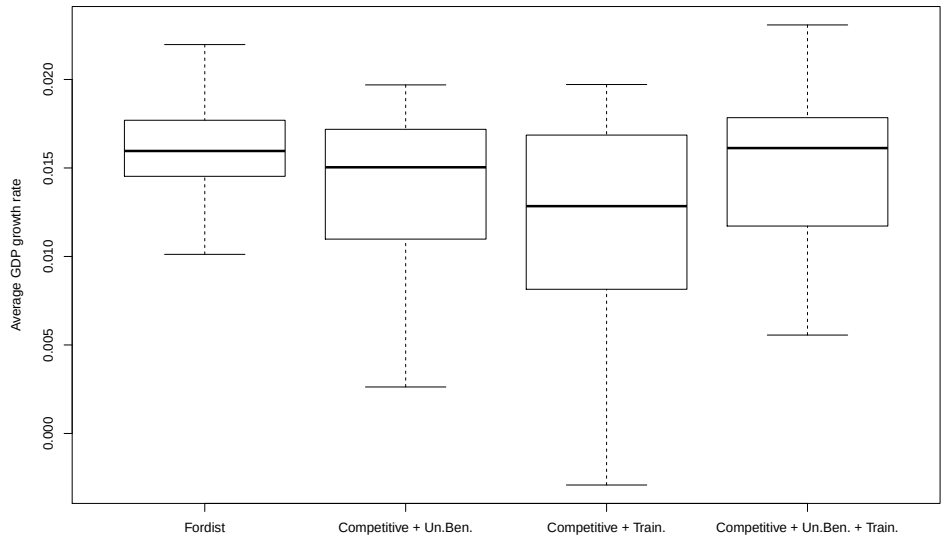
The symmetric litmus test in order to evaluate the effects of the policy schemes, whose costs affect the government budget, is to understand whether they impact on those who take part to the policy-sponsored program. In particular, with reference to (re)qualification training initiatives, the policy maker is usually interested in evaluating the impact of the program at least upon (i) the wage level, (ii) the wage growth, and (iii) the unemployment duration. Therefore, we asses the effectiveness of training-based ALMPs comparing those three metrics among the policy scenarios.

Figure 5(a) presents the worker-level wage distributions for the alternative regimes. If the training scheme would have helped trained workers in getting a higher wage compared to untrained ones, we should have observed a wage distribution shifted toward the right. However, the distributions of the three Competitive scenarios are almost overlapping, with just a positive but small impact of training. Similarly, Figure 5(b) shows wage growth dynamics: the presence and participation to the training program has no relevant influence in this respect (completely overlapping distributions). The most striking result concerns the distribution of the unemployment duration, presented in Figure 5(b). The training-only scenario (the green curve and dots) presents the most right-skewed distribution, hinting at the fact that the training scheme is *not able* to reduce the duration of unemployment spells. Indeed, here the model replicates the "training trap" phenomena mentioned in Section 2. Such an evidence also reinforces the detrimental effects of the reduced aggregate demand due to the regime change and the absence of unemployment benefits on the labour market.

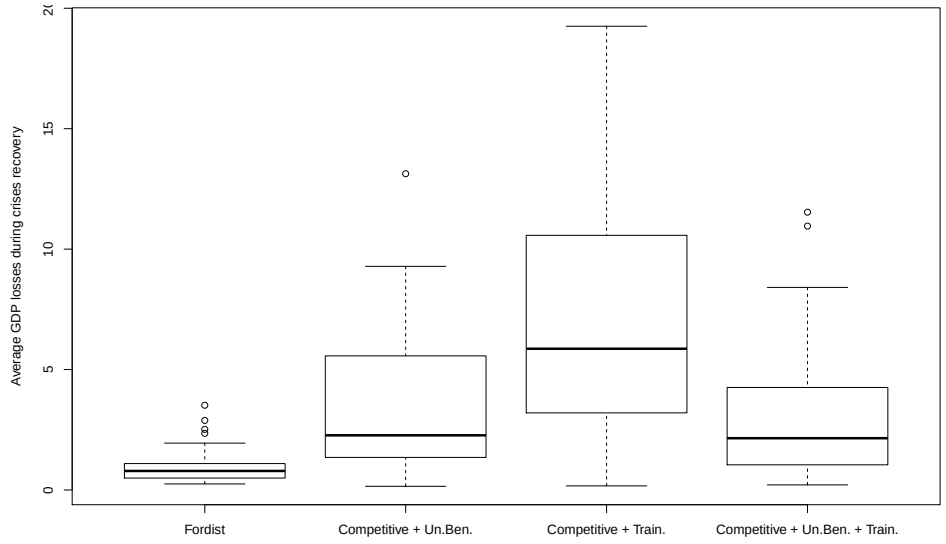
Finally, in order to evaluate the transmission mechanisms from the labour market to the credit market and their interactions, let us present some comparisons in terms of the financial

**Figure 4:** Performance comparison between policy scenarios. Statistics for 50 MC runs in period $[200, 400]$. Bar: median | box: 2nd-3rd quartile | whiskers: max-min | dots: outliers.

**(a)** GDP growth




**(b)** Losses from GDP crises




**(c)** Recovery from GDP crises

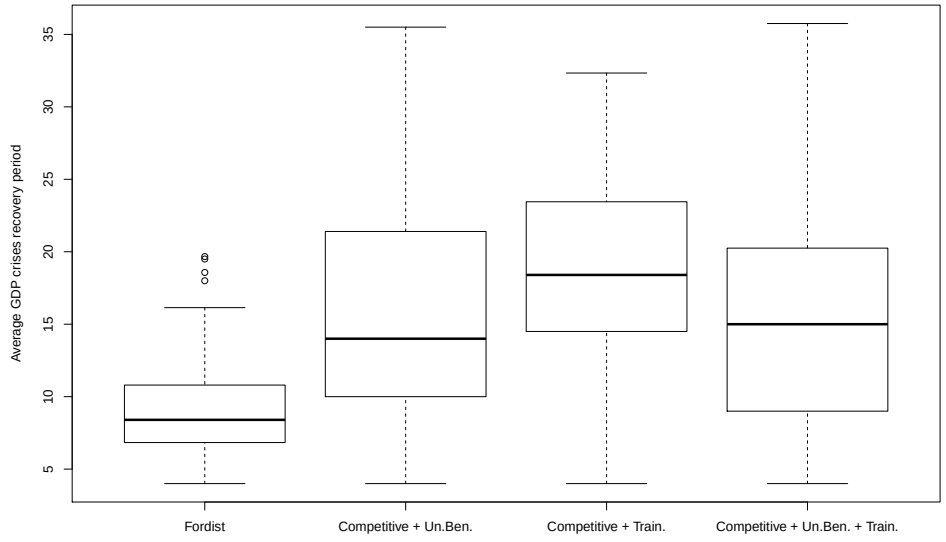
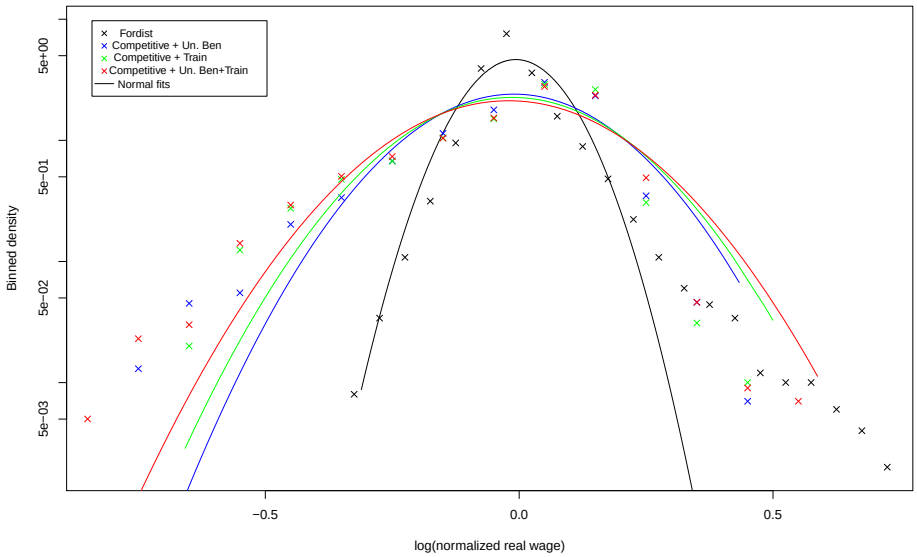
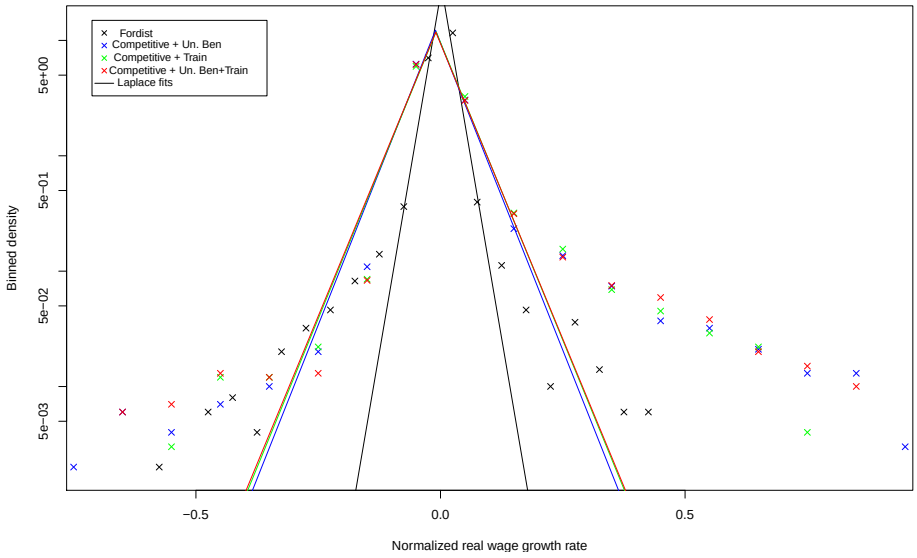


**Figure 5:** Worker-level analysis. Data pooled from 10 simulation runs in period $[200, 400]$.

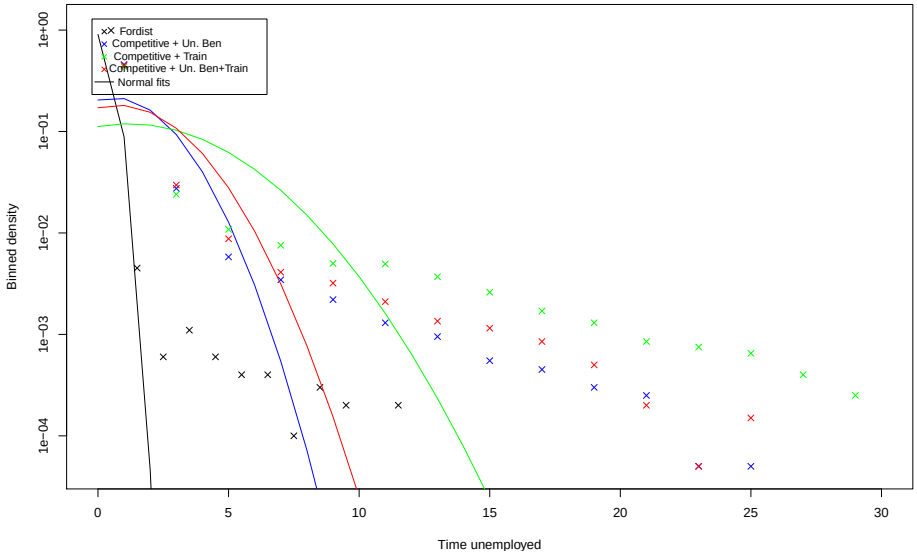
**(a)** Log-normalized real wages distribution




**(b)** [Log-normalized real wage growth distribution




**(c)** Unemployment time distribution



| | Unemp. benefits | Qualif. training | Fiscal policy |
|---|---|---|---|
| **Fordist** | ✔ | ✖ | Automatic stabilizer |
| **Competitive AS** | ✔ | ✔ | Automatic stabilizer |
| **Competitive FC** | ✔ | ✔ | Fiscal Compact |

**Table 8:** The tested fiscal rule configuration scenarios.

performance of the economy. Figure 6 shows (a) the total loans provided by banks and (b) the financial fragility of banks under the alternative scenarios. Considering the increased prudential limits and the reduced capital requirements applicable to banks after the policy regime transition at $t = 100$ (see Section 3.6), a rise in both macro variables should be expected. More interestingly, the total supply of loans and in particular the degrees of financial fragility are differently affected by the variants in the Competitive regime. The overall levels and volatility of the stock of debt kept by firms increase as the labour market policies are changed, as presented in Figure 6(a). Remarkably, the adoption of training-only policies are particularly negative for the stability of the financial system, as indicated by Figure 6(b). The message here seems clear: moving to a more flexible labour and more deregulated credit market regimes potentially augments systemic risk of the banking system, which is only mitigated by a combination of PLMPs and ALMPs.[13]

## 5 The European policy mix: flexibility and austerity

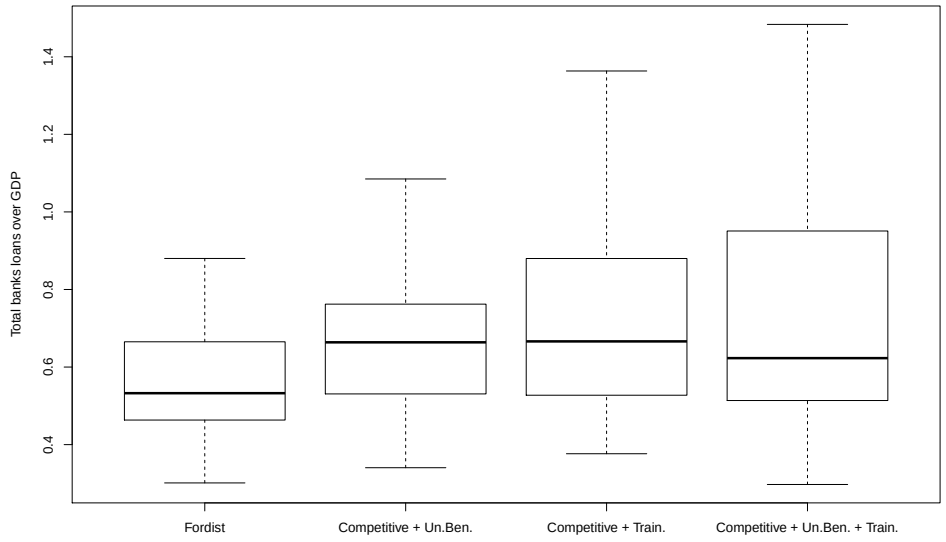
Let us move a step forward and study policy mixes between Competitive labour markets with ALMPs and fiscal austerity, testing the implementation of the full package of reforms – as several countries recently did – might affect the system. In particular, we test the best-performing variant of the Competitive regime as presented in the previous section (including both demand and supply policies) under two alternative fiscal policies. The first entails an automatic stabilizer rule (AS) wherein there is no hard limit to public expenditure, while the second applies the Fiscal Compact rule (FC) that enforces strict prescriptions for the public deficit and debt as described in Section 1. Of course, the claimed objectives of the policy schemes are (i) to improve GDP growth, (ii) the stabilization of public finance, and (iii) the smoothing of labour market mechanisms. A Fordist scenario is included for reference. Do they succeed? Table 8 illustrates the three tested configurations. In particular, let us focus on the performance of the economy when unemployment benefits have no binding constraints as compared to a set-up whereby they must be cut to comply with the FC requirements.

Figure 5 presents a concise set of the relevant metrics that describe the behaviour of the model under AS and FC fiscal rules. Figure 5(a) shows the long-term path of GDP (actual and if all available capacity is used). Not surprisingly, whenever the FC rule is binding, and so unemployment benefits are reduced, the performance of the system is *inferior as the GDP growth trajectory is permanently damaged*. This super-hysteresis phenomenon (Ball, 2014; Blanchard et al., 2015) is more present in all Competitive set-ups as compared to the Fordist baseline but is more pronounced under the FC scenario. Moreover, when comparing GDP losses in deep

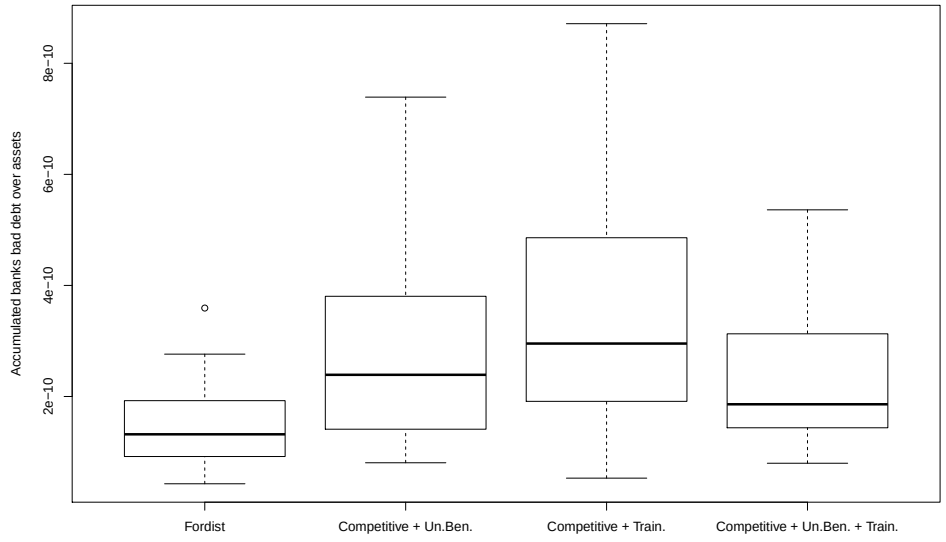
[13]Note that the macroeconomic impact of the regime change is largely attributable to changed conditions on the labour market, irrespectively of the parametrization of the credit market.

**Figure 6:** Performance comparison between policy regimes. Statistics for 50 MC runs in period $[200, 400]$. Bar: median | box: 2nd-3rd quartile | whiskers: max-min | dots: outliers.

**(a)** Loans




**(b)** Financial fragility

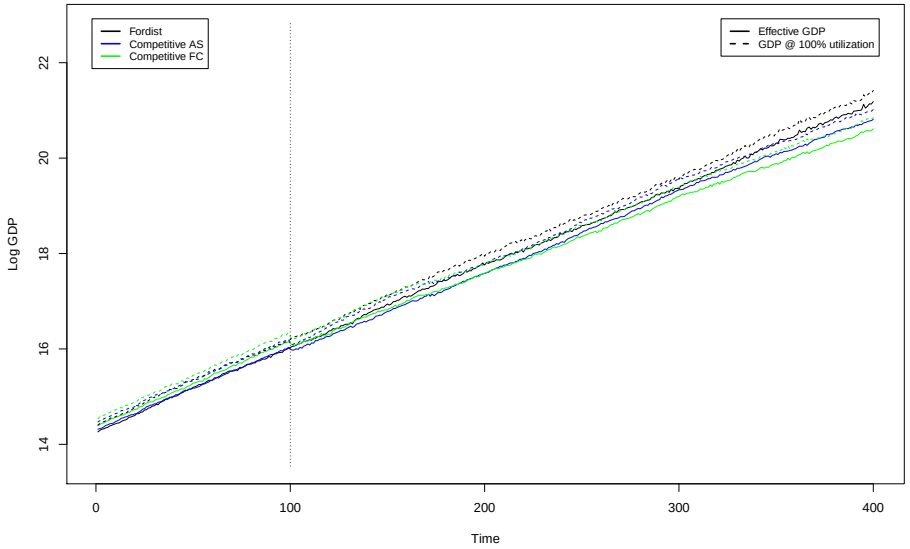


crises (Figure 5(b)), the FC rule clearly reveals the significant costs associated to "turning off" the Keynesian automatic stabilizers during some of the periods in which they are actually more required.

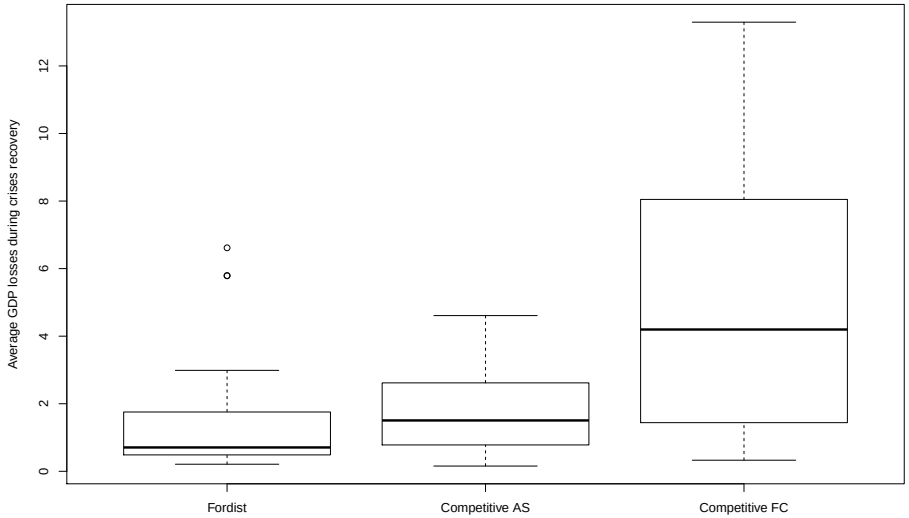
The status of public finance *does not improve* in the Competitive set ups when compared to the Fordist baseline, well the opposite. First, public deficit (see Figure 5(c)) shows the long-run sustainability problem of the Competitive AS scenario, given the explosive path of public debt revealed in Figure 5(d). Conversely, second, even when the Competitive FC is sustainable in the long run, its associated social costs might be dramatic: Figure 5(d) shows that public debt in the FC scenario only slowly converge to the Fordist case in the long run due to its short-term *self-defeating* nature. Indeed, as shown in Dosi et al. (2015, 2016), austerity policies might well be self-defeating also in the long-run, bringing the economy to the surge of the total collapse.

**Figure 7:** Macroeconomic dynamics in alternative policy regimes (a,c,d) and performance comparison (b). Lines (a,c,d) represent 50 MC runs averages. Statistics (b) for 50 MC runs in period [200, 400]. Bar: median | box: 2nd-3rd quartile | whiskers: max-min | dots: outliers.

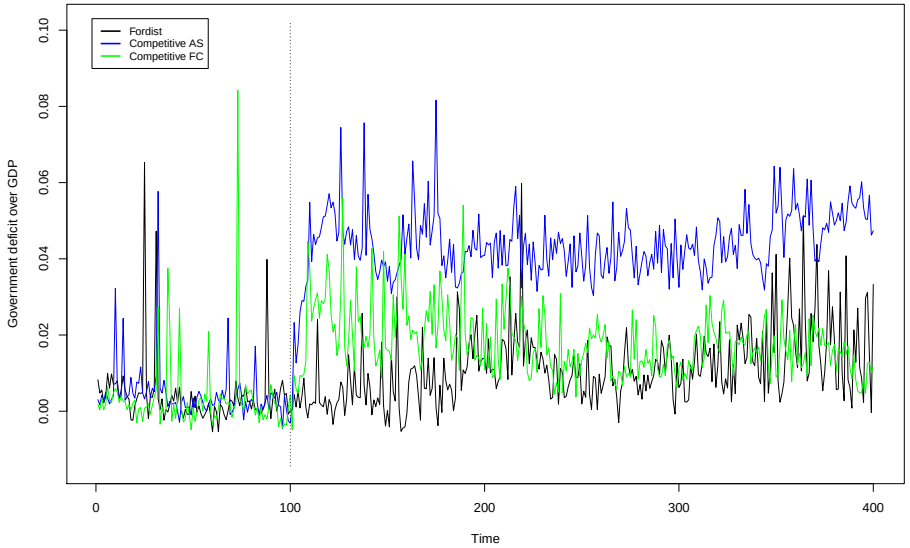
**(a)** Actual and full capacity GDP



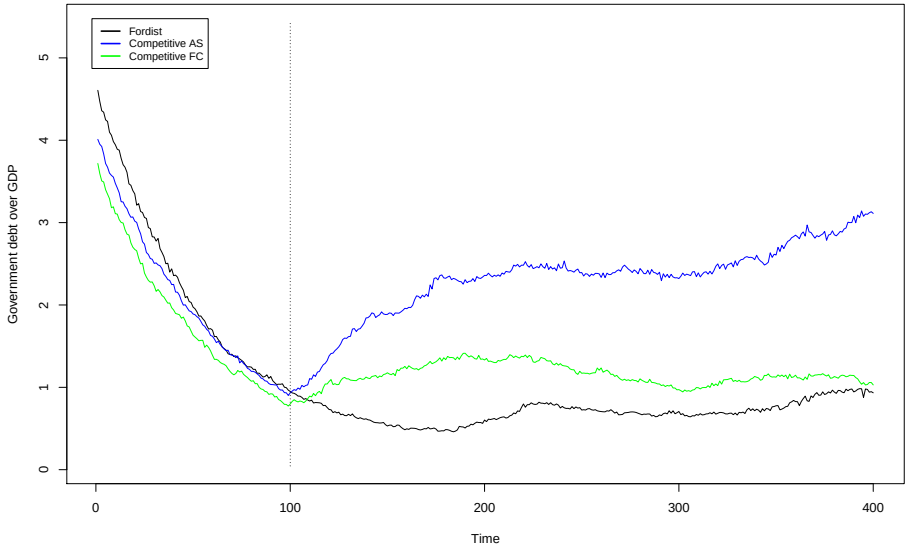

**(b)** Losses from GDP crises




**(c)** Public deficit/GDP ratio




**(d)** Public debt/GDP ratio



A set of additional relative metrics is presented in Table 9 using the Fordist case as the baseline. First and foremost, the Competitive regime under all the three tested policy settings show a clear tendency to operate on much higher unemployment and inequality levels, as already discussed above, yet more pronounced in the FC case.[14]

| | Fordist | Competitive | | | |
|---|---|---|---|---|---|
| | | AS | | FC | |
| | Baseline | Ratio | p-value | Ratio | p-value |
| **GDP growth** | 0.02 | 0.97 | 0.53 | 0.76 | 0.00 |
| **Volatility of GDP growth** | 0.12 | 0.84 | 0.00 | 1.11 | 0.07 |
| **Recovery from GDP crises** | 11.31 | 1.37 | 0.16 | 2.02 | 0.00 |
| **Losses from GDP crises** | 1.84 | 1.57 | 0.30 | 3.37 | 0.00 |
| **Inflation** | 0.00 | -6.46 | 0.00 | -2.15 | 0.02 |
| **Capacity utilization** | 0.81 | 1.00 | 0.89 | 0.98 | 0.09 |
| **Productivity growth** | 0.02 | 1.02 | 0.64 | 0.82 | 0.03 |
| **Unemployment** | 0.02 | 10.09 | 0.00 | 12.12 | 0.00 |
| **Vacancy** | 0.15 | 1.52 | 0.00 | 1.47 | 0.00 |
| **Workers skills** | 1.86 | 0.84 | 0.00 | 0.82 | 0.00 |
| **Wages dispersion** | 0.11 | 1.66 | 0.00 | 1.74 | 0.00 |
| **Income distribution** | 0.05 | 3.34 | 0.00 | 4.71 | 0.00 |
| **Mark-ups** | 0.22 | 1.02 | 0.00 | 1.03 | 0.00 |

**Table 9:** Performance comparison among automatic-stabilizer and austerity policies, selected time series. Averages for 50 MC runs in period $(200, 400)$. p-value for a two-means t test, $H_0$: no difference between scenarios.

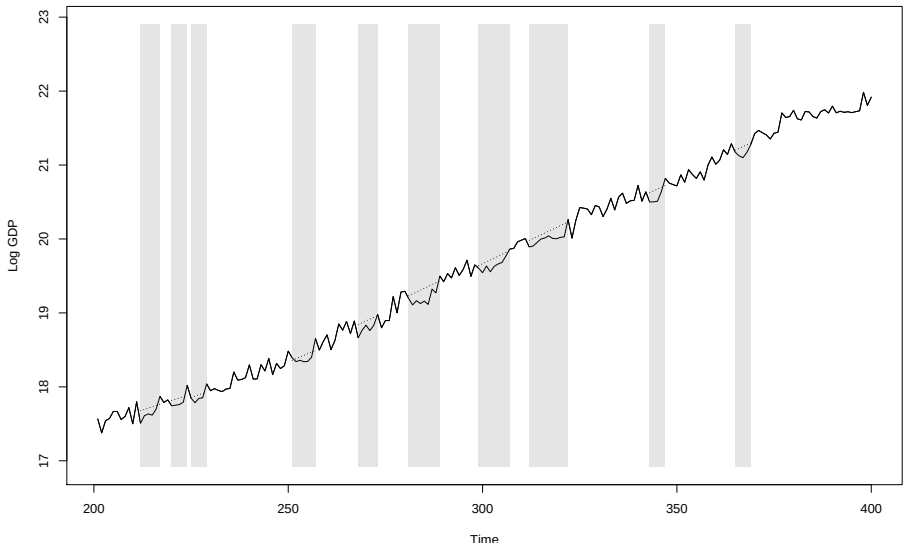
A last but not least result from Table 9 shows that not only the average cost and time to recover from big crises are substantially increased under the FC rule, but also the frequency of large downturns is significantly augmented. Figure 8 presents some graphical representative samples of this phenomena, marking in grey the recovery periods after all crises in which the GDP shrinks at least 3% and plotting with dotted lines the pre-crisis growth trend.[15] The difference in terms of hysteresis among the three set ups is rather pronounced. The Fordist regime presents frequent but mild fluctuations whose recovery periods are usually short, as measured by the length of the grey areas. In comparison, the Competitive AS sample exhibits deeper crises and longer recoveries. Note, however, that in this case the dashed lines have similar slopes, indicating that the "growth potential" is being (more or less) preserved during the crises. This situation changes in the FC sample, with even stronger and more lasting crises, wherein more frequently the dashed line slope changes, indicating the highest level of hysteresis and consequently the long-lasting, recession-shaped, lower GDP growth rates.

[14] As a side note, but also in line with the empirical track, both Competitive scenarios operate under a significantly lower (consumer) inflation rate.

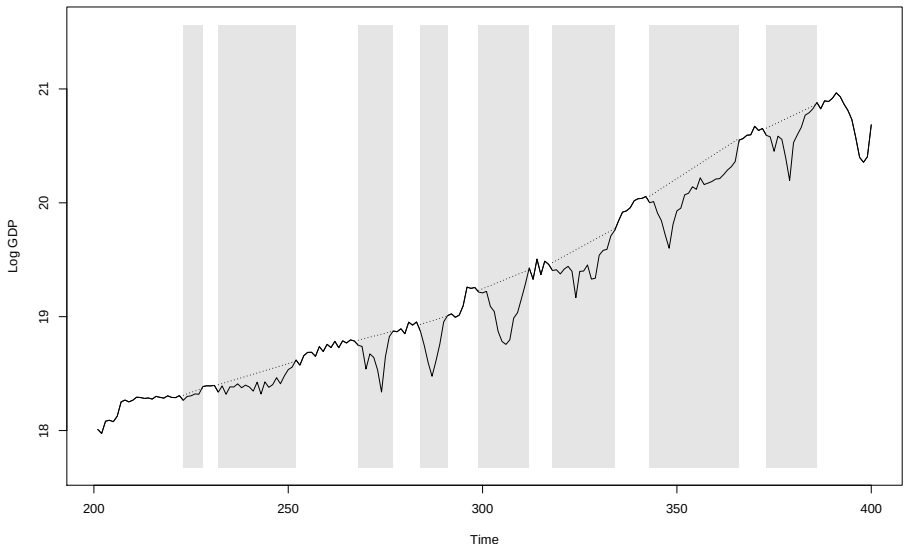
[15] The plots are selected from the 50 Monte Carlo runs used for statistics gathering in each of the tested configurations.

**Figure 8:** GDP long-term trend recovery after crisis. Selected runs in period $[200, 400]$. Dashed line: pre-crisis trend | grey boxes: trend recovery period.

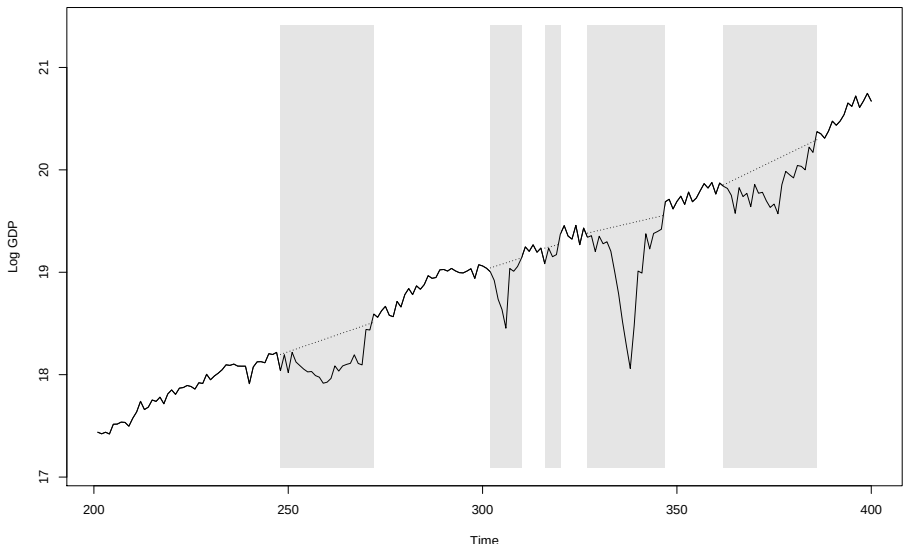
**(a)** Fordist




**(b)** Competitive AS




**(c)** Competitive FC



# 6 Sensitivity analysis

We performed a global sensitivity analysis (SA) to explore the effects of alternative model parametrizations, to warrant the robustness of our results adressing the frequent criticism of ABMs concerning the importance of the model structural properties vs. "lucky" parameter configurations.[16] The SA exercise is performed in the period $t \in [200, 400]$ for a set of metrics relevant to the current discussion, namely the unemployment ($\bar{U}$), vacancy ($\bar{V}$) and hiring ($\bar{L}_{entry}$) average rates and the workers skills average level ($\bar{s}$).[17] All the model's parameters, their "calibration" values, as well the key SA tests statistics, are detailed in Table 10 (Appendix B).

The sensitivity analysis is performed on the most extreme Competitive scenario *cum* Fiscal Compact but the main properties hold under all Competitive scenarios. Out of the 79 parameters and initial conditions in this K+S version, as a first step we reduce the relevant parametric dimensionality, by means of a Morris elementary effects screening procedure (EE). This is important because it allows discarding from the in-depth analysis those parameters and initial conditions (the "factors") which do not significantly affect the selected model metrics, if any.[18] The EE analysis indicates that $\bar{U}$ is the metric sensitive to the larger number of factors (19) while $\bar{s}$ is the least sensitive, as no factor presented a statistically relevant effect on it. $\bar{L}_{entry}$ and $\bar{V}$ are in an intermediate situation with 15 and 8 influential factors, respectively.[19] In total, 24 unique *relevant* factors were identified after discarding duplicates.

In order to better understand the effect of each of the 24 relevant factors over the selected metrics, directly or in interaction, in the second step we perform a Sobol Variance Decomposition (SVD).[20] Because of the relatively high computational cost to produce the SVD using the original model, a simplified version of it – a meta-model – is estimated using the Kriging method and employed for the SA.[21] The meta-model is estimated by numerical maximum likelihood using a set of observations sampled from the original model using a high-efficiency, nearly-orthogonal Latin hypercube design of experiments (Cioppa and Lucas, 2007).

[16] For technical details on the global sensitivity analysis methodology applied here, see Dosi et al. (2017d). On the empirical validation of agent-based models, see also Fagiolo et al. (2017).

[17] Other relevant metrics, like the macro aggregates growth rates, the hysteresis losses, the inequality measures, and the industrial performance indicators were already evaluated in previous papers based on the labour-augmented K+S model and are not be replicated here. The general results from these past analyses indicate a relatively small dependence of the qualitative model results on the chosen parametrization, in most cases.

[18] Briefly, EE proposes both a specific design of experiments, to efficiently sample the parametric space under a multi-path, one-factor-at-a-time strategy, and some absolute importance statistics, to evaluate direct and indirect (nonlinear/non-additive) effects of parameters on the model results as well their statistical significance (Morris, 1991, Saltelli et al., 2008).

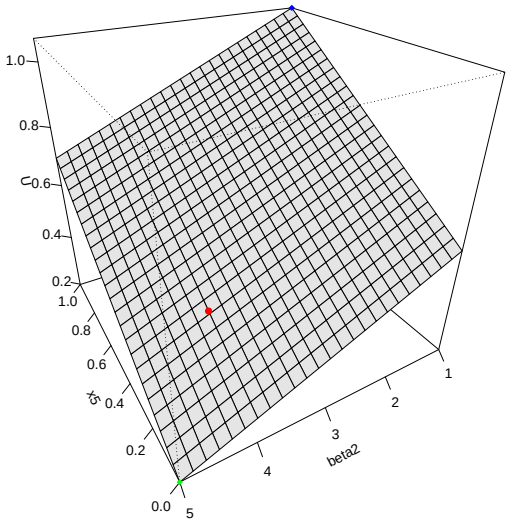
[19] The selection criteria includes the top 80% EE contributors at 5% significance.

[20] SVD is a variance-based, global SA method consisting in the decomposition of the variance of the chosen model metric into fractions according to the variances of the factors selected for analysis, better dealing with nonlinearities and non-additive interactions than EE or traditional local SA methods. It allows to precisely disentangle both direct and interaction quantitative effects of the factors on the chosen metrics over the entire parametric space (Sobol, 1993, Saltelli et al., 2008).

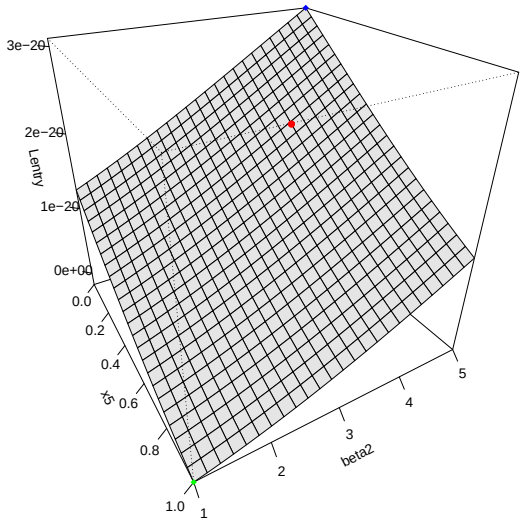
[21] In summary, the Kriging meta-model "mimics" our original model using a simpler, mathematically-tractable approximation, fitted over a sample of the original model response surface. Kriging is a spatial interpolation method that under fairly general assumptions provides the best linear unbiased predictors for the response of complex, non-linear computer simulation models (Rasmussen and Williams, 2006, Salle and Yildizoglu, 2014).

**Figure 9:** Global sensitivity analysis: response surfaces.
Surfaces modelled using the fitted Kriging meta-model. Red dot: calibration settings | Markers: maximum (blue) and minimum (green) predicted values.

**(a)** Average unemployment rate ($\bar{U}$)




**(b)** Average hiring rate ($\bar{L}_{entry}$)




The SVD results indicated a common and small subset of just five *important* factors for the chosen metrics, except $\bar{s}$ as discussed before, mostly through direct effects and not in interaction (linear effects). Interestingly, all important factors come from the technological dynamics part of the model, in particular for the entrant firms. These factors, in order of importance, define (i) the maximum technical advantage of an entrant ($x_5 : +$), (ii) the shape of the technological opportunity space for entrant firms ($\beta_2 : -$, $\alpha_2 : +$), (iii) the upper shape of the same space for the incumbent firms ($\beta_1 : -$), and (iv) the notional upper limit of the technological search space ($\bar{x}_1 : +$). The signals in parenthesis indicate positive or negative effects on the affected metrics.

The impacts of all the tested factors in the SVD are quite mild. Just two factors, $x_5$ and $\beta_2$, account for more than 80% of the estimated meta-model effects on the metrics $\bar{U}$, $\bar{L}_{entry}$ and $\bar{V}$ ($\bar{s}$ is not significantly affected by any factor). Figure 9 presents an exploration of the Kriging meta-model response surface for the two critical factors on the two most sensitive metrics. The almost flat surfaces clearly indicate the (almost) linear interaction nature of the system response surface for the identified critical factors. Figure 9(a) renders the surface for the average unemployment rate $\bar{U}$ and show that unemployment is affected by the entry of technologically advanced firms in the market, in a classical "creative destruction" Schumpeterian sense. Indeed, this metric is very sensitive to changes in the two factors, in an additive way. Note that the presented surface corresponds to a Competitive regime configuration where "Keynesian" drivers are nearly absent. Figure 9(b) presents the response surface for the average hiring rate $\bar{L}_{entry}$.[22] Indeed, the "inclined" surface is mostly horizontal, as this metric varies very little even for the full excursion of the interacting factors. The average vacancy rate $\bar{V}$ (not shown) has the same shape and even lower sensitivity.

[22]Notice the highly stretched $z$-axis scale due to auto-scaling.

# 7 Conclusions

Are supply-side labour market policies sufficient in order to get an economy going out of a big recession? The plain answer is negative. Indeed, our results debunk the discourse advocating the combination of flexible labour markets, active labor market policies (ALMPs), and austerity rules as potentially virtuous way-out from deep crises, such as the Great Recession.

Elsewhere (Dosi et al., 2017c,b, 2018), we have already shown that more flexibility of the labour market in terms of wage adjustments and hiring/firing rules are likely to make the system more fragile and be detrimental in both the short- and the long-run in terms of unemployment rates, GDP growth, inequality. Here we have explored the extent to which such effects can be reversed, or at least mitigated, by ALMPs. They cannot. So, neither more efficient matching on the labour market, nor government sponsored skill-enhancing programs are enough when workers face adverse labour demand. Passive labor market policies, sustaining aggregate demand, are better suited to mitigate inequality and to foster long-run growth.

In all that, adding some deregulation in the credit conditions in presence of flexible labour markets further adds to the fragility of the system as revealed by e.g. the amount of bad loans that the economy accumulates.

However, the deadly mixture are flexible labour markets, *no matter if in presence of ALMPs*, and austerity policies, such as those mimicking the European and Stability Growth Path and the Fiscal Compact. Here, the damages of labour market flexibility combine with the damages of austerity: long-run growth is permanently reduced, exhibiting a super-hysteretic behaviour, unemployment rates increases by an order of magnitude as compared to a Fordist baseline, and income distribution worsens. Indeed, precisely the opposite to the predictions of the flexibility plus austerity advocates.

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# Appendices

## Appendix A

### Capital- and consumer-good sectors and technical change

The technology of capital-good firms is $(A_i^\tau, B_i^\tau)$. $A_i^\tau$ is the labour productivity of the machine-tool manufactured by $i$ for the consumption-good sector, while $B_i^\tau$ is the labour productivity to produce the machine. Superscript $\tau$ denotes the technology vintage being produced/used. Given the monetary average wage $w_{i,t}$ paid by firm $i$ in the capital-good industry, the unit cost of production is:

$$c_{i,t} = \frac{w_{i,t}}{B_i^\tau}. \tag{12}$$

Prices $p_{i,t}$ are defined using a fixed mark-up $\mu_1 \in \mathbb{R}^+$ rule as:

$$p_{i,t} = (1 + \mu_1)c_{i,t}. \tag{13}$$

Firms in the capital-good industry "adaptively" strive to increase their market shares and their profits by improving technology via innovation and imitation. Firms invest in R&D a fraction $\nu \in (0, 1]$ of their past sales $S_{i,t-1}$:

$$RD_{i,t} = \nu S_{i,t-1}. \tag{14}$$

R&D activity is performed by workers exclusively devoted to this activity, whose demand is:

$$L_{i,t}^{R\&D} = \frac{RD_{i,t}}{w_{i,t}}. \tag{15}$$

Firms split their R&D efforts (and workers) between innovation ($IN_{i,t}$) and imitation ($IM_{i,t}$) activities according to the parameter $\xi \in [0, 1]$:

$$IN_{i,t} = \xi RD_{i,t}, \tag{16}$$

$$IM_{i,t} = (1 - \xi)RD_{i,t}. \tag{17}$$

Innovation is a two-step process. The first one determines whether a firm obtains or not access to an innovation – irrespectively of whether it is ultimately a success or a failure – through a draw from a Bernoulli distribution with parameter:

$$\theta_{i,t}^{in} = 1 - e^{-\zeta_1 IN_{i,t}} \tag{18}$$

being $\zeta_1 \in (0, 1]$. If a firm innovates, it may draw a new machine-embodying technology $(A_{i,t}^{in}, B_{i,t}^{in})$ according to:

$$A_{i,t}^{in} = A_{i,t}(1 + x_{i,t}^A) \tag{19}$$

$$B_{i,t}^{in} = B_{i,t}(1 + x_{i,t}^B) \tag{20}$$

where $x_{i,t}^A$ and $x_{i,t}^A$ are two independent draws from a Beta$(\alpha_1, \beta_1)$ distribution, $(\alpha_1, \beta_1) \in \mathbb{R}^{2+}$ over the fixed support $[\underline{x}_1, \bar{x}_1] \subset \mathbb{R}$.

Imitation also follows a two-step procedure. The access to imitation come from sampling a Bernoulli with parameter:

$$\theta_{i,t}^{im} = 1 - e^{-\zeta_2 IM_{i,t}} \tag{21}$$

and $\zeta_2 \in (0, 1]$. Firms accessing the second stage are able to copy the technology $(A_i^{im}, B_i^{im})$ of one of the competitors. Imitation of technologically-closer competitors is more likely. Finally, they select the machine to produce according to the rule:

$$\min \left[ p_{i,t}^h + bc_{(A_i),t}^h \right], \quad h = \tau, in, im \tag{22}$$

where $b \in \mathbb{R}^+$ is a payback-like parameter.

Firms in consumption-good sector do not conduct R&D, instead they access new technologies acquiring new machines for their existing capital stock $\Xi_{j,t-1}$. Firms invest according to expected demand $D^e_{j,t}$, computed by an adaptive rule:

$$D^e_{j,t} = g(D_{j,t-1}, ..., D_{j,t-h}), \quad 0 < h < t \tag{23}$$

where $D_{j,t-h}$ is the actual demand faced by firms at time $t-h$ ($h \in \mathbb{N}^*$ is a parameter and $g : \mathbb{R}^h \to \mathbb{R}^+$ is the expectation function, here an unweighted moving average over $h = 4$ periods). The corresponding desired level of production $Q^d_{j,t}$, considering the actual inventories from previous period $N_{j,t-1}$, is:

$$Q^d_{j,t} = (1 + \iota)D^e_{j,t} - N_{j,t-1} \tag{24}$$

being $N^d_{j,t} = \iota D^e_{j,t}$ the desired inventories and $\iota \in \mathbb{R}^+$, a parameter.

If the desired capital stock $K^d_j$ – computed as a linear function of the desired level of production $Q^d_{j,t}$ – is higher than the current one, firms invest $EI^d_{j,t}$ to expand their production capacity:

$$EI^d_{j,t} = K^d_{j,t} - K_{j,t-1}. \tag{25}$$

Firms also invest $SI^d_{j,t}$ to replace older machines by more productive vintages according to a fixed payback-like ($b > 0$) rule, substituting machines $A^\tau_i \in \Xi_{j,t}$ according to the operational cost disadvantage as well as the price of new machines:

$$RS_{j,t} = \left\{ A^\tau_i \in \Xi_{j,t} : \frac{p^*_{i,t}}{c^{A^\tau_i}_{j,t} - c^*_{j,t}} \leq b \right\} \tag{26}$$

where $p^*_{i,t}$ is the new machine price and $c^*_{j,t}$, the unit cost of production upon the new machines. Given the stock of machines $\Xi_{j,t}$, firms compute average productivity $\pi_{j,t}$ and average unit cost of production $c_{j,t}$, based on the average unit labour cost of production $w_{j,t}$ associated with each machine of vintage $\tau$ in its capital stock:

$$c^{A^\tau_i}_{j,t} = \frac{w_{j,t}}{A^\tau_i}. \tag{27}$$

Consumption-good prices are set applying a variable markup $\mu_{j,t}$ on average unit costs:

$$p_{j,t} = (1 + \mu_{j,t})c_{j,t}. \tag{28}$$

Mark-up changes are regulated by the evolution of firm market shares ($f_{j,t}$):

$$\mu_{j,t} = \mu_{j,t-1}\left(1 + \upsilon \frac{f_{j,t-1} - f_{j,t-2}}{f_{j,t-2}}\right) \tag{29}$$

with $\upsilon \in (0, 1)$. Firm market shares evolve according to a replicator dynamics:

$$f_{j,t} = f_{j,t-1}\left(1 + \chi \frac{E_{j,t} - \bar{E}_t}{\bar{E}_t}\right), \quad \bar{E}_t = \frac{1}{F^2_t} \sum_j E_{j,t} f_{j,t-1}, \tag{30}$$

where the firms relative competitivity $E_{j,t}$ is defined based on the individual normalized prices $p'_{j,t}$, unfilled demands $l'_{j,t}$ and product qualities $q'_{j,t}$:

$$E_{j,t} = -\omega_1 p'_{j,t-1} - \omega_2 l'_{j,t-1} - \omega_3 q'_{j,t-1}, \tag{31}$$

being $(\omega_1, \omega_2, \omega_3) \in \mathbb{R}^2+$ parameters. Unfilled demand $l_{j,t}$ is the difference between the demand $D_{j,t}$ the firm gets and its production $Q_{j,t}$ plus inventories $N_{j,t}$, if positive:

$$l_{j,t} = \max\left[D_{j,t} - (Q_{j,t} + N_{j,t}), 0\right]. \tag{32}$$

Product quality is defined as the average of the log skills $s_{\ell,t}$ of the firm's workers:

$$q_{j,t} = \frac{1}{L_{j,t-1}} \sum_{\ell \in \{L_{j,t-1}\}} \log\left[s_{\ell,t-1}\right]. \tag{33}$$

Prospective firms in both sectors decide on entry based on the number $F^z_{t-1}$ ($z = 1, 2$) and the financial conditions of incumbents. The number of entrants in sector $z$ is defined as:

$$b^z_t = max\left[(o\pi^z_t + (1-o)MA^z_t)\, F^z_{t-1}, 0\right], \qquad z = 1, 2, \tag{34}$$

being $o \in [0, 1]$ a mix parameter and $\pi^z_t$ a random draw from a uniform distribution on the fixed support $[\underline{x}^z_2, \bar{x}^z_2]$ representing the idiosyncratic component in the entry process. The sectoral market attractiveness $MA^z_t$ is evaluated based on the dynamics of firms' balance sheets:

$$MA^z_t = MC^z_t - MC^z_{t-1} \qquad \text{(bounded to } [\underline{x}_2, \bar{x}_2]), \tag{35}$$

defined as the (log) ratio between the aggregate sectoral stocks of liquid assets $NW^z_{t-1}$ (bank deposits) and debt $Deb^z_{t-1}$ (bank loans):

$$MC^z_t = \log NW^z_{t-1} - \log Deb^z_{t-1}. \tag{36}$$

## Labour market and search-and-match process

Labour demand in the consumption-good sector $L^d_{j,t}$ is determined by desired production $Q^d_{j,t}$ and the average productivity of current capital stock $A_{j,t}$:

$$L^d_{j,t} = \frac{Q^d_{j,t}}{A_{j,t}}. \tag{37}$$

In the capital-good sector, instead, $L^d_{i,t}$ considers orders $Q_{i,t}$ and machine-production productivity $B_{i,t}$.

The job search, wage determination and firing processes differ according to the policy regime. In the Fordist regime, workers do not quit jobs and firms fire employees only under losses ($\Pi_{j,t-1} < 0$), except if exiting the market. Only unemployed workers search for jobs. Lowest skilled workers are fired first, while higher skilled workers are preferred when hiring. Wages are not bargained and firms offer a wage:

$$w^o_{j,t} = \min\left[w^o_{j,t-1}(1 + WP_{j,t}), w^{max}_{j,t}\right], \quad w^{max}_{j,t} = p_{j,t-1}A_{j,t-1}, \tag{38}$$

bounded to a break-even wage $w^{max}_{j,t}$, which is accepted by the worker if she has no better offer. The wage premium is is defined as:

$$WP_{j,t} = \psi_2 \frac{\Delta A_t}{A_{t-1}} + \psi_4 \frac{\Delta A_{j,t}}{A_{j,t-1}}, \quad \psi_2 + \psi_4 \leq 1, \tag{39}$$

being $A_t$ the aggregate labour productivity, $\Delta$, the time difference operator, and $(\psi_2, \psi_4) \in \mathbb{R}^{2+}$, parameters. $w^o_{j,t}$ is applied to all existing firm's workers.

In the Competitive regime, firms freely fire workers to accommodate production changes. Employees search for jobs while employed, quitting for better offers. When hiring or firing, firms contract first and dismissing last workers with higher skills-to-wage ratios ($s_{\ell,t}/w_{\ell,t}$). Firm-worker matching is done in an one-round bargaining process. Workers request a wage:

$$w^r_{\ell,t} = \begin{cases} w_{\ell,t-1}(1+\epsilon) & \text{if employed in t-1} \\ w^s_{\ell,t} & \text{if unemployed in t-1} \end{cases} \tag{40}$$

where $w_{\ell,t-1}$ is the current wage for the employed workers and $\epsilon \in \mathbb{R}^+$ is a parameter. Unemployed workers have a satisfying wage $w^s_{\ell,t}$:

$$w^s_{\ell,t} = \max\left[w^u_t, \frac{1}{T_s}\sum_{h=1}^{T_s} w_{\ell,t-h}\right], \tag{41}$$

being $T_s \in \mathbb{N}^*$ a parameter. Employed workers accept the best offer $w^o_{\ell,t}$ if it is higher than the current wage $w_{\ell,t}$. Unemployed workers accepts the best offer higher or equal $w^s_{\ell,t}$.

Capital-good firms hire and fire workers similarly but follow the offered wages of top-paying firms in the consumption-good sector ($\max[w^o_{j,t}]$). Government sets an indexed minimum wage to be paid by firms:

$$w^{min}_t = w^{min}_{t-1}\left(1 + \psi_2 \frac{\Delta A_t}{A_{t-1}}\right). \tag{42}$$

## Banking sector and monetary policy

There are $B$ commercial banks (subscript $k$) in the banking sector which take deposits and provide credit to firms. Firms in both production sectors may apply to banks for loans. Bank-firm pairs are set randomly and are stable along firms' lifetime. Banks allocate credit ranking firms by the ratio between net worth $NW_{z,t-1}$ and past sales $S_{z,t-1}$ ($z \in \{i, j\}$). Banks provide credit as long as their maximum supply of credit $TC_{k,t}$ is not fully distributed:

$$TC_{k,t} = \frac{NW^b_{k,t-1}}{\tau_b(1 + \beta_b Bda_{k,t-1})}, \tag{43}$$

where the parameter $\beta_b \in \mathbb{R}^+$ is the sensitivity to financial fragility $Bda_{k,t}$ and $NW^b_{k,t}$ is the bank equity defined as the accumulated net profits $\Pi^b_{k,t}$. The provision of credit depends also on the (Basel-like) capital adequacy requirement, represented by the parameter $\tau_b \in (0, 1]$, and on an idiosyncratic bank fragility proxy:

$$Bda_{k,t} = \frac{BadDebt_{k,t}}{Loans_{k,t}}. \tag{44}$$

Bank profits come from interest received on loans to firms ($Loans_{k,t}$) and on reserves at the Central Bank ($Res_{k,t}$) deducted from interest paid on deposits ($Depo_{k,t}$) and from losses from defaulted loans ($BadDebt_{k,t}$):

$$\Pi^b_{k,t} = r^{deb}_t Loans_{k,t} + r^{res}_t Res_{k,l} - r_D Depo_{k,t} - BadDebt_{k,t}, \tag{45}$$

being $r^{deb}_t = (1 + \mu_{deb})r_t$ the interest on debt calculated over the Central Bank prime rate $r_t$, $\mu_{deb} \in \mathbb{R}^+$, and $r^{res}_t = r_t/(1 + \mu_{res})$ the interest paid by the Central Bank on banks reserves, $\mu_{res} \in \mathbb{R}^+$. Firms' deposits are rewarded at the fixed rate $r_D \in \mathbb{R}^+$.

The prime rate $r_t$ is fixed according to a Taylor rule:

$$r_t = r_T + \gamma_\pi(\pi_t - \pi_T) + \gamma_U(U_T - U_t), \quad \gamma_\pi > 1, \gamma_U \geq 1, \tag{46}$$

where $\pi_t$ is the inflation rate, $U_t$ is the unemployment rate, and $r^T$, $\pi^T$, $U_T$ are the prime, inflation and unemployment target rates, respectively. Therefore the ensuing interest rate structure is:

$$r^D \leq r^{res}_t \leq r_t \leq r^{debt}_t. \tag{47}$$

## Consumption and model closure

Workers fully consume their income (if possible) and do not get credit. Desired aggregate consumption $C^d_t$ depends on the income of both employed and unemployed workers plus the desired unsatisfied consumption from previous periods ($C^d_{t-1} - C_{t-1}$):

$$C^d_t = \sum_\ell w_{\ell,t} + G_t + (C^d_{t-1} - C_{t-1}) \tag{48}$$

The effective consumption $C_t$is bound by the real production $Q^2_t$ of the consumption-good sector:

$$C_t = \min(C^d_t, Q^2_t), \quad Q^2_t = \sum_j Q_{j,t}. \tag{49}$$

The model applies the standard national account identities by the aggregation of agents' stocks and flows. The aggregate value added by capital- and consumption-good firms $Y_t$ equals their aggregated production $Q_t^1$ and $Q_t^2$, respectively (there are no intermediate goods). That is equal to the sum of the effective consumption $C_t$, the total investment $I_t$ and the change in firm's inventories $\Delta N_t$:

$$Q_t^1 + Q_t^2 = Y_t = C_t + I_t + \Delta N_t. \tag{50}$$

For further details, see Dosi et al. (2010), Dosi et al. (2015) and Dosi et al. (2017c).

# Appendix B

| Symbol | Description | Value | Min. | Max. | $\mu^*$ | Direct | Interaction |
|---|---|---|---|---|---|---|---|
| **Policy** | | | | | | | |
| $\phi_T$ | Target unemployment subsidy rate on average wage | 0.40 | 0.00 | 1.00 | 0.031 | – | – |
| $\gamma_\pi$ | Taylor rule sensitivity to inflation | 1.0 | 0.1 | 10.0 | 0.056 | – | – |
| $\gamma_U$ | Taylor rule sensitivity to unemployment | 0.10 | 0.01 | 1.00 | 0.012 | – | – |
| $\pi_T$ | Target inflation rate (taylor rule) | 0.02 | 0.01 | 0.10 | 0.074 | – | – |
| $\Gamma$ | Share of unemployed under Govt. training | 0.00 | 0.00 | 1.00 | 0.015 | 0.0046 | 0.0017 |
| $\Gamma_{cost}$ | Unit cost of Govt. training (wage fraction) | 0.10 | 0.01 | 0.20 | 0.054 | 0.0021 | 0.0017 |
| $r_T$ | Target prime interest rate | 0.01 | 0.01 | 0.10 | 0.085 | – | – |
| $r_{adj}$ | Adjustment step of prime interest rate | 0.005 | 0.001 | 0.010 | 0.035 | – | – |
| $U_T$ | Target unemployment rate (taylor rule) | 0.05 | 0.01 | 0.10 | 0.072 | – | – |
| $deb_{rule}$ | Maximum public debt rule (GDP fraction) | 0.6 | 0.3 | 1.0 | 0.058 | – | – |
| $def_{rule}$ | Maximum public deficit rule (GDP fraction) | 0.03 | 0.01 | 0.05 | 0.013 | – | – |
| $tr$ | Tax rate | 0.15 | 0.00 | 0.30 | 0.030 | – | – |
| **Credit market** | | | | | | | |
| $\beta_b$ | Bank sensitivity to financial fragility | 1.00 | 0.50 | 2.00 | 0.035 | – | – |
| $\mu_{deb}$ | Mark-up of interest on debt over prime rate | 0.30 | 0.10 | 0.50 | 0.043 | 0.0006 | 0.0019 |
| $\mu_{res}$ | Mark-up of interest on reserves to prime rate | 0.70 | 0.50 | 1.00 | 0.047 | – | – |
| $\tau_b$ | Minimum bank capital adequacy rate | 0.13 | 0.05 | 0.30 | 0.057 | 0.0053 | 0.0017 |
| $\Lambda$ | Prudential limit on loans as sales multiple | 2 | 1 | 4 | 0.071 | – | – |
| $\Lambda_{min}$ | Fixed floor for Prudential limit on loans | 20000 | 0 | 100000 | 0.063 | – | – |
| $r_D$ | Interest rate on bank deposits | 0.00 | 0.00 | 0.01 | 0.061 | – | – |

(continue...)

| Symbol | Description | Value | Min. | Max. | $\mu^*$ | Direct | Interaction |
|---|---|---|---|---|---|---|---|
| **Labour market** | | | | | | | |
| $\epsilon$ | Minimum desired wage increase (employed workers) | 0.020 | 0.005 | 0.200 | 0.065 | – | – |
| $\omega$ | Number of firms to apply for job (employed) | 0 | 1 | 20 | 0.064 | 0.0005 | 0.0016 |
| $\omega_{un}$ | Number of firms to apply for job (unemployed) | 5 | 1 | 20 | 0.060 | 0.0011 | 0.0016 |
| $\psi_2$ | Aggregate productivity pass-trough | 1.00 | 0.95 | 1.05 | 0.015 | – | – |
| $\psi_4$ | Firm-level productivity pass-trough | 0.50 | 0.00 | 1.00 | 0.060 | – | – |
| $\tau_G$ | Skills accumulation rate of workers in training | 0.005 | 0.001 | 0.100 | 0.050 | – | – |
| $\tau_T$ | Skills accumulation rate of employed workers | 0.010 | 0.001 | 0.100 | 0.138 | 0.0017 | 0.0016 |
| $\tau_U$ | Skills deprecation rate of unemployed workers | 0.010 | 0.001 | 0.100 | 0.072 | 0.0043 | 0.0017 |
| $T_r$ | Number of periods before retirement (work life) | 120 | 60 | 240 | 0.142 | 0.0009 | 0.0017 |
| $T_s$ | Number of wage memory periods | 0 | 1 | 8 | 0.010 | – | – |
| **Technology** | | | | | | | |
| $\eta$ | Maximum machine-tools useful life | 20 | 10 | 40 | 0.062 | – | – |
| $\nu$ | R&D investment propensity over sales | 0.04 | 0.01 | 0.20 | 0.168 | 0.0004 | 0.0016 |
| $\xi$ | Share of R&D expenditure in imitation | 0.50 | 0.20 | 0.80 | 0.097 | 0.0028 | 0.0016 |
| $b$ | Payback period for machine replacement | 3 | 1 | 10 | 0.048 | 0.0015 | 0.0016 |
| $dim_{mach}$ | Machine-tool unit production capacity | 40 | 10 | 100 | 0.028 | – | – |
| $(\alpha_1, \beta_1)$ | Beta distribution parameters (incumbent) | $(3, 3)$ | $(1, 1)$ | $(5, 5)$ | $(0.045, 0.121)$ | $(-, 0.0163)$ | $(-, 0.0016)$ |
| $(\alpha_2, \beta_2)$ | Beta distribution parameters (entrant) | $(2, 4)$ | $(1, 1)$ | $(5, 5)$ | $(0.152, 0.190)$ | $(0.0874, 0.2589)$ | $(0.0016, 0.0019)$ |
| $(\zeta_1, \zeta_2)$ | Search capabilities for innovation/imitation | $(0.30, 0.30)$ | $(0.10, 0.10)$ | $(0.60, 0.60)$ | $(0.126, 0.034)$ | $(0.0023, -)$ | $(0.0013, -)$ |
| $[\underline{x}_1, \bar{x}_1]$ | Beta distribution support (innovation process ) | $[-0.15, 0.15]$ | $[-0.3, 0.1]$ | $[-0.1, 0.3]$ | $(0.044, 0.150)$ | $(-, 0.0041)$ | $(-, 0.0013)$ |

(continue...)

| Symbol | Description | Value | Min. | Max. | $\mu^*$ | Direct | Interaction |
|---|---|---|---|---|---|---|---|
| **Industrial dynamics** | | | | | | | |
| $\gamma$ | Share of new customers for capital-good firm | 0.50 | 0.20 | 0.80 | 0.049 | – | – |
| $\iota$ | Desired inventories share | 0.10 | 0.00 | 0.30 | 0.069 | 0.0028 | 0.0013 |
| $\mu_1$ | Mark-up in capital-good sector | 0.05 | 0.01 | 0.20 | 0.067 | 0.0000 | 0.0013 |
| $o$ | Weight of market conditions for entry decision | 0.50 | 0.00 | 1.00 | 0.036 | – | – |
| $\omega_1$ | Competitiveness weight for price | 1.00 | 0.20 | 5.00 | 0.024 | – | – |
| $\omega_2$ | Competitiveness weight for unfilled demand | 1.00 | 0.20 | 5.00 | 0.076 | 0.0006 | 0.0015 |
| $\omega_3$ | Competitiveness weight for quality | 1.00 | 0.20 | 5.00 | 0.052 | – | – |
| $\chi$ | Replicator dynamics coefficient | 1.00 | 0.20 | 5.00 | 0.061 | – | – |
| $\upsilon$ | Mark-up adjustment coefficient | 0.04 | 0.01 | 0.10 | 0.022 | – | – |
| $u$ | Planned utilization by consumption-good entrant | 0.75 | 0.50 | 1.00 | 0.055 | – | – |
| $x_5$ | Max technical advantage of capital-good entrant | 0.30 | 0.00 | 1.00 | 0.380 | 0.5354 | 0.0026 |
| $exit_1$ | Min orders to stay in capital-good sector | 1 | 1 | 5 | 0.025 | – | – |
| $exit_2$ | Min share to stay in consumption-good sector | $10^{-5}$ | $10^{-6}$ | $10^{-3}$ | 0.022 | – | – |
| $[\Phi_1, \Phi_2]$ | Min/max capital ratio for consumption-good entrant | $[0.10, 0.90]$ | $[0.00, 0.50]$ | $[0.50, 1.00]$ | $(0.034, 0.093)$ | $(-, 0.0004)$ | $(-, 0.0015)$ |
| $[\Phi_3, \Phi_4]$ | Min/max net wealth ratio for capital-good entrant | $[0.10, 0.90]$ | $[0.00, 0.50]$ | $[0.50, 1.00]$ | $(0.024, 0.034)$ | $(-, -)$ | $(-, -)$ |
| $[\underline{x}_2^1, \bar{x}_2^1]$ | Entry distribution support/limit (capital-good) | $[-0.15, 0.15]$ | $[-0.3, 0.1]$ | $[-0.1, 0.3]$ | $(0.024, 0.051)$ | $(-, -)$ | $(-, -)$ |
| $[\underline{x}_2^2, \bar{x}_2^2]$ | Entry distribution support/limit (consumption-good) | $[-0.15, 0.15]$ | $[-0.3, 0.1]$ | $[-0.1, 0.3]$ | $(0.024, 0.026)$ | $(-, -)$ | $(-, -)$ |
| $[F_{min}^1, F_{max}^1]$ | Min/max number of capital-good firms | $[10, 100]$ | $[10, 20]$ | $[20, 100]$ | $(0.095, 0.254)$ | $(0.0011, 0.0000)$ | $(0.0015, 0.0015)$ |
| $[F_{min}^2, F_{max}^2]$ | Min/max number of consumption-good firms | $[50, 500]$ | $[50, 200]$ | $[200, 500]$ | $(0.028, 0.020)$ | $(-, -)$ | $(-, -)$ |
| **Initial conditions** | | | | | | | |
| $\mu_0^2$ | Initial mark-up in consumption-good sector | 0.20 | 0.10 | 0.50 | 0.086 | 0.0004 | 0.0015 |
| $B$ | Number of banks | 10 | 1 | 20 | 0.032 | – | – |
| $F_0^1$ | Initial number of capital-good firms | 20 | 10 | 100 | 0.022 | – | – |
| $F_0^2$ | Initial number of consumption-good firms | 200 | 50 | 500 | 0.027 | – | – |
| $K_0$ | Initial capital stock in consumption-good sector | 800 | 200 | 3000 | 0.028 | – | – |
| $L_0^S$ | Number of workers | 250000 | 50000 | 1000000 | 0.027 | – | – |
| $NW_0^b$ | Initial net wealth (capital) of banks | 1000000 | 500000 | 5000000 | 0.018 | – | – |
| $NW_0^1$ | Initial net wealth of capital-good firms | 10000 | 2000 | 50000 | 0.051 | 0.0034 | 0.0015 |
| $NW_0^2$ | Initial net wealth of consumption-good firms | 5000 | 2000 | 50000 | 0.069 | 0.0041 | 0.0015 |
| $Sav_0$ | Initial consumer savings (initial demand) | 1100000 | 50000 | 5000000 | 0.031 | – | – |

**Table 10:** Model parameters and initial conditions, calibration values, minimum-maximum range for sensitivity analysis, Morris elementary effects $\mu^*$ statistic and Sobol decomposition direct and interaction effects indexes. Competitive FC policy-specific configuration. Sensitivity analysis statistics relative to average unemployment in period$[200, 400]$.

| Parameter | Description | Fordist | Competitive | | |
|---|---|---|---|---|---|
| | | | Unemp. Benefits | Training | Un.Ben.+Train. |
| $\phi_T$ | Target unemployment subsidy rate on average wage | 0.40 | 0.20 | 0.00 | 0.20 |
| $\omega$ | Number of firms to apply for job (employed) | 2 | $5, 50, 100$ | 5 | 5 |
| $\tau_b$ | Minimum bank capital adequacy rate | 0.13 | 0.08 | 0.08 | 0.08 |
| $\Gamma$ | Share of unemployed under Govt. training | 0 | 0 | 0.5 | 0.5 |
| $\Lambda$ | Prudential limit on loans as sales multiple | 2 | 3 | 3 | 3 |
| $T_s$ | Number of wage memory periods | 0 | 4 | 4 | 4 |
| $tr$ | Tax rate | 0.015 | 0.010 | 0.010 | 0.010 |

**Table 11:** Regime-specific parameter values.

| | Workers | Capital-good firms | | Consumption-good firms | | Banks | | Govt. + Central Bank | | $\sum$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | current | current | capital | current | capital | current | capital | current | capital | |
| Wages | $+W_t^1 + W_t^2$ | $-W_t^1$ | | $-W_t^2$ | | | | | | 0 |
| Consumption | $-C_t$ | | | $+C_t$ | | | | | | 0 |
| Investment | | $+I_t$ | | | $-I_t$ | | | | | 0 |
| Govt. expenditure | $+G_t + G_t^{train}$ | | | | | $+G_t^{bail}$ | | $-G_t - G_t^{train} - G_t^{bail}$ | | 0 |
| Bonuses, workers | $+B_t^2$ | | | | $-B_t^2$ | | | | | 0 |
| Profits, firms | | $-\Pi_t^1$ | $+\Pi_t^1$ | $-\Pi_t^2$ | $+\Pi_t^2$ | | | | | 0 |
| Profits, bank | | | | | | $-\Pi_t^b$ | $+\Pi_t^b$ | | | 0 |
| Profits, C. Bank | | | | | | | | $-\Pi_t^{cb}$ | $+\Pi_t^{cb}$ | 0 |
| Govt. deficit | | | | | | | | $+Def_t$ | $-Def_t$ | 0 |
| Loans interest | | $-r_{t-1}^d Deb_{t-1}^1$ | | $-r_{t-1}^d Deb_{t-1}^2$ | | $+r_{t-1}^d Loans_{t-1}$ | | | | 0 |
| Deposits interest | | $+r^D NW_{t-1}^1$ | | $+r^D NW_{t-1}^2$ | | $-r^D Depo_{t-1}$ | | | | 0 |
| Reserves interest | | | | | | $+r_{t-1}^{res} Res_{t-1}$ | | $-r_{t-1}^{res} Res_{t-1}$ | | 0 |
| Taxes | | $-Tax_t^1$ | | $-Tax_t^2$ | | $-Tax_t^b$ | | $+Tax_t$ | | 0 |
| Change in loans | | | $+\Delta Deb_t^1$ | | $+\Delta Deb_t^2$ | | $-\Delta Loans_t$ | | | 0 |
| Change in deposits | | | $-\Delta NW_t^1$ | | $-\Delta NW_t^2$ | | $+\Delta Depo_t$ | | | 0 |
| Change in reserves | | | | | | | $-\Delta Res_t$ | | $+\Delta Res_t$ | 0 |
| $\sum$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0* | 0* |

**Table 12:** Stock-and-flow consistency: transaction flow matrix.
(*) Government (public) debt is stable the long run.