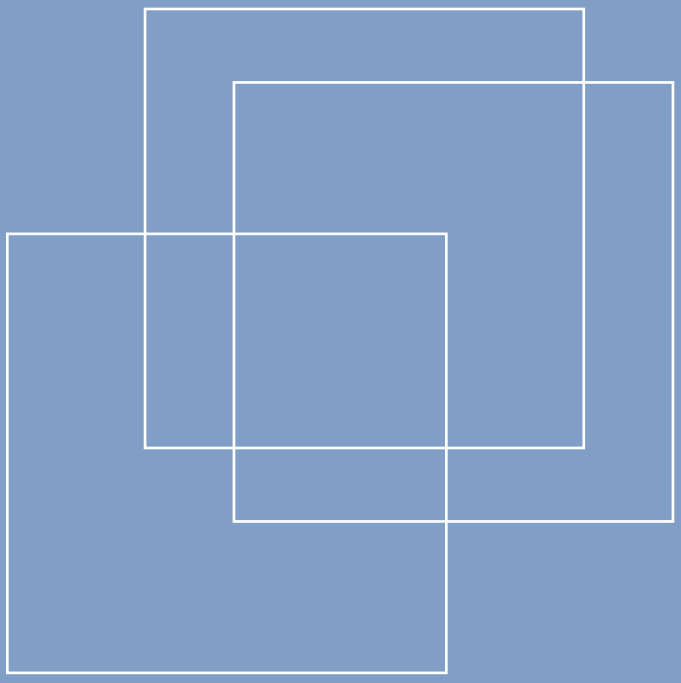
ILO Research Paper No. 12

International Labour Office

Labour market reforms in the Euro area:

A DSGE approach

Giorgio Presidente



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Abstract

Empirical work on the impacts of labour market institutions has produced mixed results. Much of this literature is based on reduced form regressions that are subject to severe econometric and measurement issues. This paper develops a framework to study the impact of labour market institutions in the context of a DSGE model. The advantage of using a DSGE model is that one can observe the general equilibrium outcomes of truly exogenous shifts in labour market policy. In addition, this class of models are flexible, can be easily estimated and one can undertake policy simulations and counterfactual exercises. After inspecting the short and long run response of key variables to several labour market reforms, an application to the Euro area reveals that between 1970 and 2003, changes in labour market institutions had only a limited impact on the volatility of output, inflation and unemployment. These results stand in contrast to theories attributing to excessive regulation for the rise and persistence of European unemployment. In addition, they suggest that labour market frictions are at most of marginal interest for central banks.

Keywords: Unemployment, labour market institutions, DSGE, Bayesian estimation

JEL classification: E240; J20

1 Introduction

There are several issues about labour market institutions on which theory and evidence are inconclusive. For example, what is the impact of an increase in firing costs on unemployment? If increasing the cost of dismissal provides an incentive for firms to retain workers even during difficult times, it might also make them reluctant in hiring because of the scarce flexibility of adjusting employment.

Lack of agreement on the causal links between regulation and market performance fuels the policy debate. Several European countries have recently undertaken labour market reforms in order to reduce the high unemployment rates triggered by the financial crisis, but which particular institution should be reformed, whether it should aim at making the labour market more flexible, or increase social protection are issues still to be debated.

The point is that much of the existing literature on labour market institutions is based on reduced form equations. These studies often regress the unemployment rate on some index of labour market institutions and use proxies for shocks that are likely to impact the labour market. For example, Nickell and Layard (1999) discuss extensively the impact of several labour market institutions on output and unemployment. Based on a panel of OECD countries, they conclude that unions and the social security system are the only institutions having a significant impact on the economy. Unfortunately, their evidence is far from conclusive, since one can easily find papers contradicting their results.[1]

Another influential study on labour market institutions is by Blanchard and Wolfers (2000). They propose a simple theory of unemployment based on the interaction between structural shocks and labour market institutions: following an adverse shock, countries with "rigid" labour markets will experience higher and more persistent unemployment. As simple and appealing as it stands, their work has an important role in the literature, because it conciliates theories attributing shocks to the heterogeneous evolution of unemployment in the OECD, with those pointing to excessive labour market regulation. But how robust can their evidence be considered? Blanchard (2007) puts it succinctly: "... *asking these panel data regressions to tell us conclusively about causal effects of institutions, shocks, and interactions of shocks and institutions, on unemployment is beyond what they can deliver. Causality is next to impossible to establish, as many institutional changes are triggered by labour market developments.*" Furthermore, data on labour market institutions consist of indexes that are supposed to summarize in a single number complex regulations and thus they are unlikely to deliver all the relevant information. On a more general ground, reduced form regressions cannot take into account general equilibrium effects put in place by changes of institutions.

For these reasons, this paper follows a different approach. It develops an otherwise standard DSGE model with a rich characterization of the labour market, modeling explicitly key labour market institutions that are believed to have a significant impact on the economy. These are: i) firing costs; ii) active labour market policies; iii) labour taxes; iv) union strength, and v) unemployment benefits. This paper departs from most of the existing literature in modeling labour market institutions as stochastic process, rather than simply as parameters. It does so for two main reasons. First, by treating institutions as shocks, it is possible to compute impulse response functions to *truly exogenous* changes in labour market regulation. As emphasized by Blanchard (2007), this is not possible by adopting a reduced form approach. Second, using a DSGE model allows to shed some light on the general equilibrium effects triggered by changes in institutions, effects which cannot be disentangled in standard regression analysis.

[1] A survey of the literature on labour market institutions is beyond the scope of this paper. However, see for example Lazear (1990) and Bentolila and Bertola (1990) for contradicting results.

The analysis conducted in this paper is complementary to the work of Zanetti (2011), which studies the propagation of shocks in labour markets characterized by firing costs and unemployment benefits, and the long run behavior of the model that follows their change. However, he focuses on firing costs and unemployment benefits, without considering the impact of several other institutions, such as labour taxes and unions. Moreover, by treating firing costs and unemployment benefits as parameters, he is not able to assess the *direct* impact of institutions on unemployment and other variables. This can be relevant for the political economics of the model. Even if not explicitly considered here, such an exercise might provide insights on the short and long term cost and benefits associated to a reform, and so on its political viability. Another issue that is possible to explore within this setting is how the qualitative and quantitative response of unemployment depends on the persistence of the shocks to labour market institutions. In some sense, the persistence of such shocks can be interpreted as the *credibility* of a reform. For example, a very transitory shock to firing costs it is roughly equivalent to a not-credible reform of the employment protection system. Since agents hold rational expectations, they know that the firing costs will return to their pre-shock (pre-reform) value in a few periods only.

Christoffel, Kuester and Linzert (2009) in their study of optimal monetary policy in an estimated DSGE model consider several labour market institutions in a stylized way. For example, they consider exogenous shocks to separation rate as a proxy for firing costs. In contrast, this paper models explicitly the process of endogenous separation and how it is affected by firing costs, leading to a richer and more realistic analysis. The impact of search frictions on inflation has been extensively studied by Krause, Lopez-Salido and Lubik (2008a, 2008b). However, they ignore labour market institutions which potentially have an impact on inflation. An improvement in this direction is made by Thomas and Zanetti (2009), which explicitly considers the effect of reforming employment protection legislation and the unemployment insurance system on inflation. However, they ignore a number of other institutions and do not address the direct impact of changes in regulation on the labour market.

The framework developed in this paper allows to conduct several experiments. The theory is developed in Section 2. Section 3 uses a calibrated version of the model to study how changes in labour market institutions affect the steady state. Firing costs and labour taxes increase output and decrease unemployment in the long run, while unemployment benefits and higher bargaining power of workers have the opposite effect. We then treat labour market institutions as stochastic processes. Section 4 looks at the impulse response functions of the model after temporary and persistent shocks. The main finding is that whether the change in policy is expected to long-last, or be in place for a few periods only, it makes a large difference in terms of unemployment. Section 5 estimates the model on the Euro area with Bayesian methods, assesses the behavior of the model and performs a variance decomposition. It finds that only a fraction of unemployment, output and inflation's fluctuation is due to labour market reforms, while the variance of output and inflation are almost exclusively explained by "standard" structural shocks. Section 6 concludes.

2 The model

The model used in this paper is essentially the same as in Thomas and Zanetti (2009), with only a minor difference discussed below. Their model has the advantage of being very tractable, but at the same time rich enough to study the impact of the selected labour market institutions.[2] The economy is populated by four types of agents: a large household, a competitive intermediate goods producer, a monopolistically competitive final goods producer, and the government. The government is assumed to undertake both

[2] In particular, exhibiting endogenous separation allows to study the impact of firing costs.

fiscal and monetary policy. The proceeds of taxation finance government expenditure and unemployment benefits. The household is composed by individuals that consume the final good and can be either employed or unemployed. Each worker has an idiosyncratic productivity level and earns a wage that is a function of such productivity. An unemployed member of the household receives unemployment benefits. In the model there are two types of taxes: one is paid by the intermediate goods firm (payroll tax) and the other by the worker (income tax). The intermediate goods firm uses only labour as a production factor and has a reservation productivity level below which it finds profitable to fire the worker and to pay the firing cost. Wages are collectively bargained between unions and firms. To what extent unions are able to appropriate the economic surplus deriving from each job match depends on its institutional power. The intermediate goods are purchased by the final goods producer, which repackages them and resells them to the household.[3] The final goods market is characterized by monopolistic competition and price stickiness. The labour market is subject to search frictions.

The timing of the model is as follows. At the beginning of each period, agents learn about the realization of all shocks. Then, intermediate producers chooses i) how many vacancies need to be posted to achieve the optimal number of workers, and ii) the minimum productivity threshold to be imposed on the workers. Once hiring has taken place, idiosyncratic productivity realizes and layoff, determination of wages and production take place. Before the beginning of the next period, there is an exogenous separation happening with a constant probability. Given the structure of the model, some members of the household might be initially hired, but then displaced within the same period because it is not productive enough. As a consequence, they will not engage in production and they will not earn the production wage. Rather, they will join the pool of searching workers and get unemployment insurance. There are also other possibilities, for example Zanetti (2011) assumes that all new matches begins with the highest idiosyncratic productivity level. Which one of the two is more appropriate in this context is probably a matter of choice. However, given that precarious contracts, short-term employment and unpaid internships are widely used in Europe, this paper adopts the former view.

2.1 Matching

Matching between vacancies, v_t, and the stock of searching workers at the beginning of period t, u_t, takes place through a constant returns to scale function.

$$m_t = \sigma_t^m u_t^{\gamma} v_t^{1-\gamma}$$

where $\gamma \in (0,1)$ and σ_t^m describes the efficiency of matching and we will interpret it as the effectiveness of active labour market policies. Given the matching function we define, respectively, the probability of filling a vacancy for the firm and the probability of finding a job for the worker,

$$q_t = \frac{m_t}{v_t} \qquad\qquad s_t = \frac{m_t}{u_t}$$

2.2 Intermediate goods firm

There is a representative intermediate goods firm employing n_t workers. Workers have idiosyncratic productivity levels, not known by the firm at the time of hiring. Idiosyncratic productivity is i.i.d. across time and workers, and it is governed by the cumulative distribution function $G(z)$ with p.d.f. $G'(z) = g(z)$. Firms produce output according to,

$$y_t = A_t n_t \int_{z_t^R} z \frac{g(z)}{1 - G(z_t^R)} \, \mathrm{d}z$$

[3] Having two separated typologies of firms is a well known artifact which makes the model more tractable.

where A_t is an aggregate productivity shock. The variable z_t^R is a threshold productivity level below which the firm finds profitable to destroy a job match. Employment from the perspective of the firm evolves according to,

$$n_t = \left[1 - G(z_t^R)\right](\rho n_{t-1} + q_t v_t)$$

where, $1 - \rho$ is an exogenous probability of separation. It can be shown that the Bellman equation describing the value of a job match with productivity z for the firm is given by

$$J_t(z) = p_t^w A_t z - (1 + \tau_t^f) w_t(z) + \rho\beta E_t \Lambda_{t,t+1} \left[\int_{z_{t+1}^R} J_{t+1}(z') g(z') \, \mathrm{d}z' - G(z_{t+1}^R) F_{t+1} \right]$$

This equation says that in the current period, the value of each worker is given by its contribution to production, where p_t^w represents the real price of the intermediate good (but also real marginal costs for the final goods producer), minus the wage paid net of payroll taxes. In the next period, if the match is not exogenously destroyed, (event occurring with probability ρ) two things can happen: if the idiosyncratic productivity z' is again above the threshold, the match will deliver a future value $J_{t+1}(z')$, otherwise the firm will fire him and pay the firing cost, F (event occurring with probability $G(z^R)$). The term $\beta\Lambda_{t,t+1}$ represents the discount factor of the firm. Similarly, the Bellman equation describing the value of posting a vacancy for the firm is

$$V_t = -\chi - q_t + q_t \left[\int_{z_t^R} J_t(z) g(z) \, \mathrm{d}z - G(z_t^R) F_t \right] + (1 - q_t)\beta E_t \Lambda_{t,t+1} V_{t+1}$$

In this equation, χ represents the cost of posting a vacancy. The value of posting a vacancy is the expected value of a job match times the probability of filling the vacancy, plus the value of such a vacancy in the next period times the probability of not filling it today. We assume that in the intermediate goods market there is free entry. Consequently, firms will post vacancies until the value of doing it becomes zero. Holding in each period, this fact delivers the condition $V_t = V_{t+1} = 0$. As a result, by combining (1) and (2), we find the hiring condition

$$\frac{\chi}{q_t} = \int_{z_t^R} \left[p_t^w A_t z - (1 + \tau_t^f) w_t(z) \right] \, g(z) \, \mathrm{d}z - G\left(z_t^R\right) F_t + \rho\beta \left(1 - G\left(z_t^R\right)\right) E_t \Lambda_{t,t+1} \left(\frac{\chi}{q_{t+1}} \right)$$

For the firm, the economic surplus of holding a productive worker in the workforce (and thus, not firing him) is given by $J_t(z) - (-F_t)$. The threshold productivity z_t^R is found by noticing that a firm will hold the worker and not fire him until when the surplus of the match yields zero rent, $J_t(z_t^R) + F_t = 0$, that implies the following separation condition

$$p_t^w A_t z_t^R - (1 + \tau_t^f) w_t(z_t^R) + \rho\beta E_t \Lambda_{t,t+1} \left(\frac{\chi}{q_{t+1}} \right) = -F_t$$

This equation states that the firm is indifferent between holding and letting produce a worker with productivity z_t^R and firing him paying the firing cost.

2.3 Final goods firm

There is a representative monopolistically competitive retailer that purchases intermediate goods and repackages, and resells them as final goods to the household. In addition, they set prices on a staggered basis as in Calvo (1983). In each period, the firm has an exogenous probability of resetting its price equal to $1 - \lambda$.[4] In case of resetting, the firm chooses the price that maximizes expected discounted

[4] Notice that $\frac{1}{1-\lambda}$ is the average time between each reset price.

profits, subject to future constraints on price setting. As it is standard in the literature, one can show that by log-linearizing the expression for the price index and for the optimal reset price, we obtain the conventional New Keynesian Philips curve relating inflation to movements in real marginal cost, p_t^w, and expected inflation

$$\hat{\pi}_t = \frac{(1-\lambda)(1-\lambda\beta)}{\lambda}(\hat{p}_t^w + \hat{\mu}_t) + \beta E_t \hat{\pi}_{t+1}$$

where hatted variables denote log-deviation from the steady state. $\hat{\mu}_t$ represents a mark-up shock. It is commonly interpreted as representing the intensity of product market competition. It has been shown, however, that it is interpretable as a wedge coming from the labour market (see Blanchard et al., 1997). This interpretation is discussed in the following sub-section.

2.4 Households

There is a representative household composed by a continuum of members with total number normalized to one. Members of the household can be either employed or unemployed and they pool all their income together to perfectly insure each others.[5] The head of the household maximizes utility over aggregate consumption.

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U(c_t)$$

The budget constraint is given by

$$c_t + \frac{B_t}{p_t} = n_t \int_{z_t^R} (1-\tau_t^w) w_t(z) \frac{g(z)}{1-G(z_{it}^R)} \, \mathrm{d}z + (1-n_t)(b_t + r) + \Pi_t - T_t + \frac{B_{t-1}}{p_t}(1+i_t)$$

The variable c_t is aggregate consumption and B_t represents nominal bonds holding. Because of the income-pooling assumption, each member consumes the same quantity and therefore the head of the family can optimize over aggregate consumption. The first term on the right hand side of the budget constraint is labour income net of taxation, the second represents the income of the unemployed. The variables b_t and r represent, respectively, unemployment benefits and "home production". There are profits Π_t, lump sum transfers T_t and the last term represents financial income. The nominal interest rate set by the monetary authority is represented by i_t. Idiosyncratic productivity is drawn only after being hired and so $u_t = 1 - \rho n_{t-1}$. In fact, $1 - n_t$ includes workers being hired but successively laid-off and they are not allowed to participate in the pool of workers twice. We make the following assumption on the hiring process: workers are screened after being hired, but wage payments are made after the screening. Therefore, it might be that some members of the household are hired and then laid off without receiving any compensation. The earlier papers on this issue have often assumed that all new matches start at the highest level of productivity. We chose the alternative way because we believe it to be more realistic in light of the precarious work contracts given to most young workers. Finally, p_t represents the price of the final good.

Denoting with $S(z)$ the Lagrange multiplier associated with the law of motion of employment from the perspective of the household

$$n_t = \left[1 - G(z_t^R)\right](\rho n_{t-1} + s_t(u_t e_t))$$

it can be shown that for a member of the household with productivity z, the net value of being employed is given by

$$S_t(z) = (1-\tau_t^w) w_t(z) - b_t - r + \beta E_t \Gamma_{t,t+1} [1 - G(z_{t+1}^R)](\rho - s_{t+1}) S_{t+1}(z')$$

[5] This assumption has become standard after Merz (1995).

In the equation, τ_t^w is the income tax. Unemployment benefits are computed as the replacement rate times the steady state average wage, $b_t = \omega_t^b \bar{w}$. Home production, r, is assumed to be instantaneously produced and to be constant.[6] The last term in brackets represents the "option value" of not being currently employed.

2.5 Government and resource constraint

The government, or monetary authority, conducts monetary policy following a simple Taylor rule

$$i_t = i_{t-1}^{\rho_i} \left(\frac{\pi_t}{\pi^*} \right)^{(1-\rho_i)\phi_\pi} \exp(\sigma_t^i)$$

The coefficient ρ_i describe the extent of policy inertia while ϕ_π the responsiveness of the nominal interest rate to deviation of inflation to some target level π^*. The shock σ_t^i represents variations in the nominal interest rate that are not explained by changes in inflation. The government uses the tax revenue to finance unemployment benefits and public expenditure, g_t. The latter is assumed to follow

$$g_t = \left(1 - \frac{1}{\epsilon_t^g} \right) y_t$$

where ϵ_t^g is stochastic. Thus, government's balance is given by

$$g_t + b_t(1 - n_t) = (\tau_t^w + \tau_t^f) w_t n_t + F_t \frac{G(z_t^R)}{1 - G(z_t^R)} n_t + T_t$$

The term $\frac{G(z_t^R)}{1-G(z_t^R)} n_t$ is the total number of workers fired in each period. We complete the description of the model by imposing the resource constraint

$$y_t = c_t + g_t + \chi q_t v_t$$

For estimation purposes, it is convenient to enter government expenditures in the resource constraint as a residual, as it is often observed in the DSGE literature.

2.6 Determination of Wages

The firm bargains over wages with a union representing the workers. Wages are chosen to maximize the joint surplus of the match, according to the Nash Bargaining rule

$$\left(J_t(z) + F_t \right)^{1-\eta_t} S_t(z)^{\eta_t}$$

The variable η_t represents the bargaining power of the workers, or equivalently union strength. The modeling choice of using a "right to manage" model of bargaining, as opposed to other specification is dictated by the wide use made of it in the literature. In particular, it constitutes a convenient choice because it makes it easier to compare results with Zanetti (2011) and Thomas and Zanetti (2009).

Substituting (1) and (3) in (5), and differentiating with respect to wages we obtain

$$\frac{\eta_t}{S_t(z)} (1 - \tau_t^w) = \frac{1 - \eta_t}{J_t(z) + F_t} (1 + \tau_t^f)$$

[6] The inclusion of home production is needed to obtain more accurate estimates of the replacement rate, as discussed in Hagedorn and Manovskii (2008).

The solution of this problem delivers the wage bill equation, expressed as the sum of the surpluses for the firm and for the worker, weighted according to their relative bargaining power

$$w_t = \frac{\eta_t}{(1+\tau_t^f)}\left\{p_t^w A_t z_t + F_t + \rho\beta E_t \Lambda_{t,t+1}\left(\frac{\chi}{q_{t+1}}\right)\right\}$$
$$+\frac{(1-\eta_t)}{(1-\tau_t^w)}\left\{b_t + r - \beta E_t\left[[1-G(z_{t+1}^R)](\rho - s_{t+1})S_{t+1}\right]\right\}$$

where

$$w_t = \int_{z_t^R} w_t(z)\frac{g(z)}{1-G(z_t^R)}\,\mathrm{d}z$$

Given the assumptions of constant returns in production, that idiosyncratic productivity is i.i.d. across workers, and that there is a continuum of workers at the firm, the law of large numbers allows us to think equivalently of the firm bargaining with each individual with idiosyncratic productivity, or to a union bargaining over average wages. The presence of taxes introduces a distortion in the bargaining power between workers and firms.

Following den Haan, Ramey and Watson (2000) we define job creation rate as the proportion of new hires on total employment, minus those vacancies reposted within the period and filled that correspond to exogenous quits

$$jc_t = \frac{m_t}{n_t} - (1-\rho)q_t$$

Similarly, the job destruction rate equals total separation minus reposted and filled vacancies relative to exogenous quits

$$jd_t = (1-\rho) + \rho G(z_t^R) - (1-\rho)q_t$$

Variation in total employment is given by the difference between the two flows

$$\frac{n_{t+1}-n_t}{n_t} = jc_t - jd_t$$

3 Long run impact of labour market reforms

This section studies the long run impact of changes in institutions by looking at the steady state of the model. The quarterly discount rate is set to $\beta = 0.99$, consistent with a steady state inflation rate of approximately 1%. As in Trigari (2009), the average markup is assumed to be of 20% over marginal costs. Normalizing the price of the final good producer to one, delivers a real marginal cost $p^w = 0.83$. The steady state government to GDP ratio is set to 20%. As in Thomas and Zanetti (2009), quarterly total separation for the Euro area is assumed to equal 3.2%. Endogenous and exogenous separation happens with equal probability, $\rho = 1 - \frac{0.032}{2}$. As in Thomas and Zanetti (2009), the matching function elasticity is specified to be $\gamma = 0.4$, and a log-normal distribution governing workers' idiosyncratic productivity is assumed. Lacking direct evidence for the parameters governing such a distribution, we impose unitary mean and shape equal to 0.1: these numbers ensure that all the endogenous variables are economically meaningful. Finally, average values of labour market institutions are computed as sample averages over the period 1970-2003.[7] We then construct artificial "Euro area labour market institutions" by computing labour force-weighted averages of the four largest Euro members, Germany, France, Italy and Spain.[8] Of the six labour market institutions considered, replacement rates and labour taxes have a direct map

[7] Data on labour market institutions are taken from CEP-OECD Institution Data in Nickell (2006).
[8] See section 5.1 for more details.

to the data: $b = 0.25$, $\tau^f = 0.21$, and $\tau^w = 0.14$. Lacking a direct link between the available index of employment protection legislation and firing costs, we proceed as follows. The OECD EPL indicators range from 0 to 6 (corresponding to the most stringent regulation). We assume that the most strict EPL would force the firm to pay a cost equal to the full wage in case of lay-off. The Euro-average is 1.04, so we compute the replacement rate as $\frac{1.04}{6} = 0.17$. Although there is some information on ALMP expenditure and coverage, there is not an obvious way to map these to matching efficiency. Therefore, matching efficiency is left as free parameter in the computation of the steady state. Finally, the parameter representing workers' bargaining power, η, is set to 0.8. Also in this case, even if information on union density or coverage is available, it is not obvious how to map it to the value of η. Although in the literature η would typically range from 0.4 to 0.6, there is no direct evidence on what a realistic value should be. Often, it is assumed $\eta = \gamma$, i.e. the Hosios condition to hold. However, here we follow Gertler, Sala and Trigari (2008) which estimate a full-fledged search and matching model with several frictions and find $\eta = 0.8$. All other parameters and steady state variables are computed by solving a 21 equations system.

Table 1: Long run impact of labour market regulation

	Benchmark	**Marginal**					**Integral**
Variable		FC	UB	PAYROLL	INCOME	BARGAIN	All
Output	2.29	2.33	2.20	2.30	2.35	2.27	2.20
Unemployment	0.18	0.17	0.21	0.18	0.16	0.19	0.20
Vacancies	0.10	0.12	0.10	0.11	0.09	0.09	0.11
Tightness	0.56	0.72	0.46	0.62	0.57	0.47	0.53
Reserv. prod.	2.23	2.21	2.28	2.23	2.20	2.24	2.28
Real wage	1.89	1.89	1.87	1.81	1.89	1.90	1.81
Job destruction	0.15	0.14	0.17	0.15	0.13	0.15	0.17
Job creation	0.18	0.17	0.21	0.18	0.16	0.19	0.22

Note: Benchmark refers to the calibrated steady state described in Section 3.

Each institution is increased by 5 percentage points. Bargaining power is increased from benchmark value ($\eta = 0.8$) to $\eta = 1$.

Table 1 shows the impact of labour market regulation on the model steady state. Under the label "marginal" the effect of increasing firing costs, unemployment benefits, payroll and income taxes by 5 percentage points is shown. In the simulation, the bargaining power of the workers is increased from 0.8 to 1, i.e. the case in which workers are paid their marginal products leaving no rent to be extracted by the firm. The last column labeled as "integral" shows the impact of a comprehensive reform in which all the institutions are increased together at the same time. Consistent with the results in Zanetti (2009), increasing firing costs from 0.17 to 0.22 increases output and lowers unemployment. Job destruction decreases reflecting the decline in reservation productivity induced by the more expensive lay-off. Job creation decreases as well, but not enough to have a negative impact on employment. This is due to the fact that the real wage remains relatively unaffected by the reform. As in Zanetti (2009), increasing the replacement rate - in our case from 0.25 to 0.30 - has opposite results. Output decreases and unemployment rises. Reservation probability increases producing an increase in job destruction. On the one hand, increasing the replacement rate increases the outside option of the worker, so that the real wage should increase. However, the fall of labour market tightness implies a higher vacancy filling probability for the firm. As a consequence, hiring costs fall and so do wages, with the latter effect dominating the former. The third column simulates an increase in payroll taxes, the contributions paid by the firm for each employed worker, from 0.21 to 0.26. Naturally, this reform increases substantially the cost of labour for the firm. As a consequence, labour demand falls and so does the real wage. However, output and employment remain substantially unchanged with respect to the benchmark case. The model seems

much more sensitive to an increase of income taxes, from 0.14 to 0.19. The reform increases output and decreases unemployment. The reason behind these trends is difficult to understand based on these results. One important aspect is that in the model labour taxes are used to finance government expenditure. Therefore, an increase in income taxation could have boosted public spending and so sustained output and employment through demand side. Increasing the bargaining power of the workers from 0.8 to 1, i.e. to the point in which wages equal the marginal product of labour, net of hiring and firing costs. After the reform, the real wage and unemployment both increase, and output falls. This is due to a decline in labour demand - as shown in a reduction of vacancies and due to the reduced surplus appropriated by the firm from each job match. Finally, the last column simulates the outcome of an "integral" reforms involving all the changes at a time. Output falls and unemployment increases, with both changes being quite significant, respectively -5% and +2%. labour market tightness falls, despite the mild increase in vacancies. Average workers productivity increases despite the increase in firing costs. Nevertheless, real wages falls. Therefore, according to the model, such reform would surely worsen welfare.

Of course, the results obtained in this section depend heavily on the parameterization and modeling choices. Thus, they should not be taken at face value. However, this exercise has shown that studying labour market reforms in a DSGE model can uncover general equilibrium effects producing outcomes that are different from what conventional wisdom would suggest. This is because the effect of labour market institutions is often thought in terms of partial equilibrium: shedding light on the general equilibrium effects of labour market reforms should be central to the research agenda of those interested in the labour market.

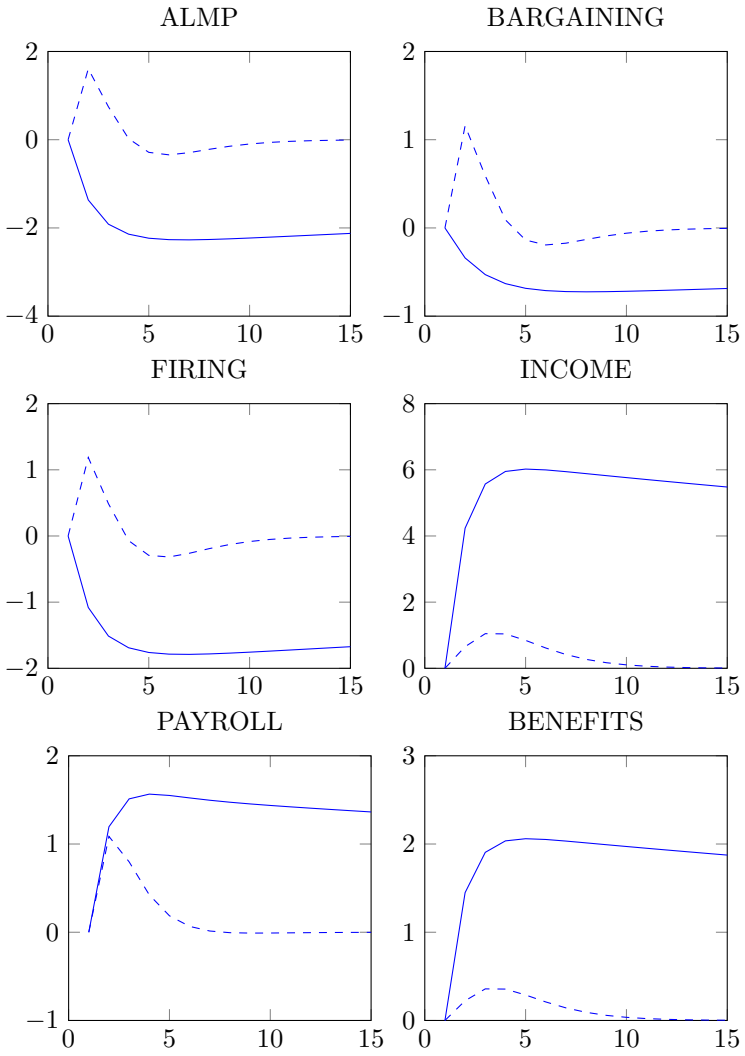
4 Short run impact of labour market reforms

In the previous section, we studied the impact of "marginal" and "integral" labour market reforms on the long run equilibrium of the model. This section, investigates the dynamic response of the unemployment rate after shocks to labour market institutions. To do so, each labour market institution is modeled as an autoregressive stochastic process and the response of unemployment is analyzed through impulse response analysis. This exercise is interesting for two main reasons. The first reason is related to the political economy of the model. Although not explicitly considered here, the political viability of a reform can be assessed by observing the behavior of key variables after a change of institutions. For example, suppose that after an increase of firing costs, unemployment would initially rise but eventually decline. This kind of reform would obviously be less popular as compared to one in which unemployment would immediately decrease and then stay permanently low. In other words, by examining the transition path between two steady states, we want to infer something about the viability of the reform. The second way in which this exercise can be useful is to assess how unemployment reacts to permanent, as opposed to transitory policy shocks. It is tempting to interpret the two kinds of shock as two reforms characterized by different degrees of *credibility*. For example, a transitory shock is a change in policy that is expected to be reversed in a relatively short time period. This might be due to political reasons (e.g. the credibility of the government in place), or reasons linked to the economic outlook (such as in case of an increase in unemployment insurance following an economic downturn). In practice, this amounts to running impulse response functions with two different autoregressive (AR) coefficients for the policy shocks. The transitory case corresponds to AR coefficients of magnitude 0.5, while the "quasi-permanent" case to coefficients of magnitude 0.99. Actually, changes in labour market institutions are usually thought as permanent. However, following Krause and Lemke (2006), we approximate them as having an AR coefficient very close to unity. This strategy has the advantage of approximating the permanent case as an AR coefficient close to one implies

$$Ex_{t+s} \approx x_t$$

for $s < \infty$, but at the same time it does not require to rewrite the system to accommodate a stochastic trend.

Figure 1: Impulse response functions of unemployment to changes in labour market institutions



Note: Dashed line: temporary change (AR coeff. 0.5). Full line: persistent change (AR coeff. 0.99)

To simulate the model, we need to specify the missing three parameters, plus all the shock coefficients representing labour market institutions. Following Thomas and Zanetti (2009), we impose a Calvo price parameter $\lambda = 0.88$. For the Taylor rule, the response-coefficient to inflation is set $\phi_\pi = 3.15$, and a monetary policy inertia equal to $\rho_i = 0.70$. In treating labour market institutions as stochastic processes, we specify them as AR(1) processes. While the choice is admittedly arbitrary, this formulation has the advantage of being simple but at the same time able to take into account the potential persistence of labour market institutions. We use an AR coefficient of 0.5 for what is labeled "temporary change", and a coefficient equal to 0.99 for a "persistent change". Figure 1 shows the response of unemployment to 1% policy shocks for each labour market institution. The dashed line represents the transitory shock, while the full one the persistent one. The results show that whether the reform is expected to last only for a few periods only, or for a long time matters for the response of unemployment. This depends on both the consumption smoothing decisions of the households, and the employment decisions of firms. Not only the size of adjustment of unemployment changes radically in the two cases, but

even its qualitative response. An increase in replacement rate, payroll and income taxes unambiguously increase unemployment, although by much more when the change is persistent. Conversely, the sign of the response of unemployment for the other institutions depends on the size of the autocorrelation coefficient. It is tempting to interpret the persistence of these shocks as the "credibility" that a reform has. In fact, there can be cases in which a not-so-credible government would implement a reform which is widely believed to be short-lived. This would be similar — although not equivalent — to rational agents knowing that the value of the institutions would go back to its original value in, say, about four quarters.[9] Therefore, this exercise suggests that reduced form regressions of unemployment on labour market institutions that do not control for some kind of indicator of government credibility, would suffer of severe problems of omitted variable bias.

5 Sources of fluctuations in the Euro area

This section attempts to shed light on the main sources of output, unemployment and inflation fluctuation in the Euro area. In the model used here, fluctuations can be due to two kinds of different shocks. The first set of shocks includes standard macroeconomic shocks: productivity, interest rate, price markup, and to government consumption. We will refer to them simply as "structural" shocks. The second set includes the policy shocks, i.e. shocks to labour market institutions: ALMP, bargaining power, firing costs, income and payroll taxes, and unemployment benefits. Whether policy shocks generate substantial fluctuations in the model is important because it would help in: i) understanding whether the secular increase of European unemployment was due to excessive labour market regulation, as opposed to the "Anglo-Saxon" experience; ii) assessing the importance of labour market regulation for inflation and output volatility. To this extent, we estimate the model on the Euro area. If it is true that the labour market experiences differed substantially within Europe, the largest Euro area economies - Germany, France, Italy and Spain - all experienced high and persistent unemployment. At the same time, they constitute the largest countries in the area. Therefore, with some abuse of terminology, we will use the Euro area as an approximation of what is generally called "Europe" in the literature on unemployment.

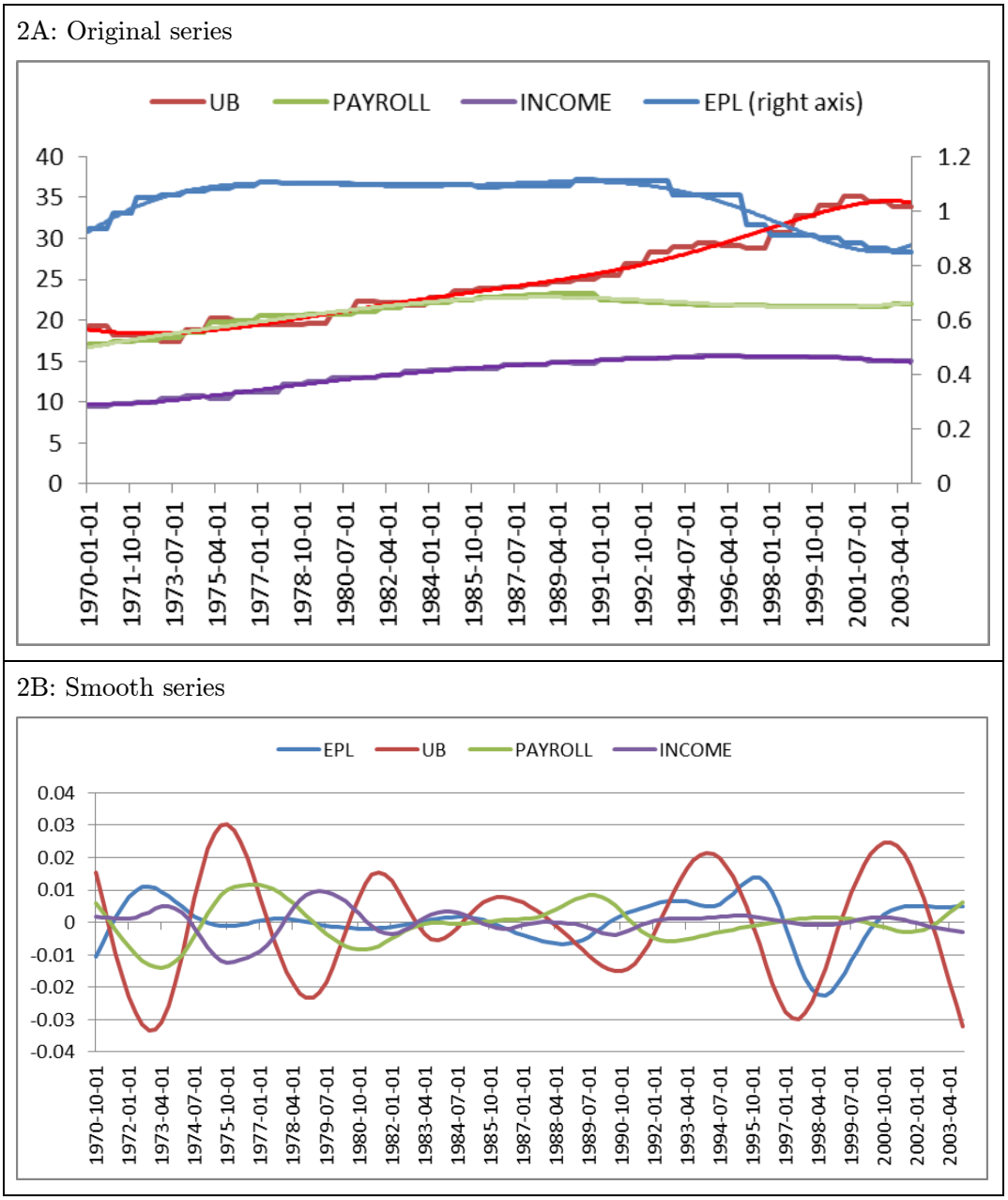
5.1 Estimation: Data and priors

The estimation strategy consists in keeping the parameters determining the steady state as in Section 3, and estimating those governing shocks and nominal side of the model. Thus, there are twenty three parameters to be estimated. Twenty of them characterize the shock processes. These are the AR coefficients of the four structural shocks (productivity, interest rate, price markup and government consumption), those of the six labour market institutions shocks (firing costs, payroll and income taxes, the replacement rate, matching efficiency, and bargaining power), the standard deviations of all shocks. The remaining three parameters are those of the Taylor rule (policy inertia and reaction to inflation), and the Calvo price parameter.

We use the following variables for the estimation: i) real GDP per working age persons; ii) the employment rate; iii) the short term nominal interest rate; iv) the year on year inflation rate; v) the real wage; vi) the replacement rate; vii) payroll taxes; viii) income taxes; ix) an index of EPL. Data for i) to v) are take from the AWM dataset[10], while data on institutions are computed from the CEP-OECD institutions data set[11]. Due to limitations of the institution data, our sample goes from 1970Q4, to 2003Q4, leaving

[9] This would be the case with an AR coefficient equal to 0.5
[10] http://www.eabcn.org/area-wide-model
[11] http://eprints.lse.ac.uk/19789/

Figure 2: Euro area labour market institutions series



Note: The smooth trend in Figure 2A is obtained with an HP-Filter with smoothing parameter equal to 100. In Figure 2B. a HP-Filter with smoothing parameter equal 1600 is used. Source: CEP-OECD institutions dataset.

us with 133 observations. Data series i) and v) are HP-filtered with smoothing parameter equal to 1600, while ii), iii) and iv) are demeaned. Data on labour market institutions has a few drawbacks. First of all, they are provided only for individual countries and not as an aggregate for the Euro area. Therefore, we compute artificial series for vi) to ix) by computing averages weighted by the size of the labour force in the largest four Euro countries, Germany, France, Italy and Spain. Another issue is that data on institutions have annual frequency, while the model is calibrated to quarterly frequency. To deal with this problem, for each institution we extend the annual series to quarterly frequency by keeping the value at the beginning of the year constant for each of the corresponding four quarters. Then, we filter the series with an arbitrary smoothing parameter (equal to 100) until obtaining a smooth trend as shown in

Figure 2A. Since these series display fluctuations that are much larger than those of the other series, it seems natural to treat them as non-stationary. For this reason we then apply again the HP-Filter with smoothing parameter 1600 to isolate the business cycle frequencies. The result is shown in Figure 2B. As expected, the business cycle fluctuations of labour market institutions are of an order much smaller than the other series. The bottom part of Figure 2 shows fluctuations ranging from 3% to less than 1%. Fluctuations at the extreme of the sample are somewhat larger than in the middle, with replacement rate showing the wider changes. As for the choice of priors, we follow Gertler, Sala and Trigari (2008) in specifying i) beta distributions with mean 0.5 and standard deviation 0.15 for all AR coefficients, and ii) inverse-gamma distributions with mean 0.15 and standard deviation 0.15 for all shocks' standard deviation. Following the logic of the same authors, we specify a iii) beta distribution for the Calvo parameter with mean 0.88 and standard deviation 0.15; iv) a normal distribution with mean 3.15 and standard deviation 0.15 for the inflation coefficient of the Taylor rule, and v) a beta distribution with mean 0.7 and standard deviation 0.15 for the policy inertia parameter.

5.2 Estimation results

Table 2 summarizes priors and posterior means of the estimated parameters. The data favor a specification with very low policy inertia but a high autocorrelation coefficient for the interest rate shock. The Calvo parameter is substantially higher than what is found in Thomas and Zanetti (2009), implying that firms re-optimize once every three quarters. All structural shocks are quite persistent, with a standard deviation substantially higher than the priors. Among the structural shocks, government consumption has the highest standard deviation. This is quite common as the government spending shock acts as a residual in the resource constraint and it captures movements in the trade balance that are not included into the model. labour market institution-shocks are also very persistent, exception made for the bargaining power shock that has an AR coefficient similar to the prior, and the matching efficiency shock. This should not be surprising as these two shocks are free to adjust and they are not constrained by the data on institutions, which are very persistent in nature. The matching efficiency shock has the highest variance for the same reason. Interestingly, the bargaining power shock - usually accounting for most of wage fluctuation, is very low. In fact, in this kind of models, bargaining power shocks are always very large because they need to account for the excessive variation of the model-wage with respect to the data. We interpret this fact as follows: the inclusion of labour market institution-shocks helps standard search and matching model to reproduce the volatility of wages.

To assess the behavior of the model following "standard" structural shocks (productivity, interest rate, markup and government spending), figures 3 to 6 display the impulse response functions of several key macroeconomic variables. According to the analysis, all expansionary shocks increase output, employment and real wages. However, unemployment and vacancies are positively correlated that is, the model generates an upward-sloped Beveridge curve. As a consequence, labour market tightness is countercyclical. This is because during good times reservation productivity decreases, and so does average worker productivity. Therefore, firms have less incentives to hire, generating the positive relationship between vacancies and unemployment. A positive productivity shocks generates, in accordance with the literature, decreasing marginal costs. Job creation and job destruction rates tend to move in the same direction over the business cycle and to be roughly of the same order of magnitude. Job destruction however tends to reach its extreme value with a lag of about three to four quarters, whereas job creation does so immediately on impact.

Table 2: Priors and posteriors of the estimated parameters

Parameter	Prior (mean, sd)	Posterior mean	90% Interval
Policy inertia ρ_{in}	beta (0.7, 0.15)	0.158	[0.089, 0.221]
Response to inflation r_{π}	normal (3.15, 0.15)	3.460	[3.199, 3.725]
Calvo price λ	beta (0.88, 0.15)	0.690	[0.595, 0.811]
AR coefficient			
Unemployment benefits ρ_b	beta (0.5, 0.15)	0.936	[0.909, 0.968]
Firing costs ρ_f	beta (0.5, 0.15)	0.943	[0.918, 0.969]
Payroll taxes ρ_{τ^f}	beta (0.5, 0.15)	0.949	[0.929, 0.974]
Income taxes ρ_{τ^w}	beta (0.5, 0.15)	0.931	[0.904, 0.961]
Bargaining power ρ_{η}	beta (0.5, 0.15)	0.503	[0.220, 0.755]
ALMP ρ_{almp}	beta (0.5, 0.15)	0.872	[0.829, 0.909]
Productivity ρ_a	beta (0.5, 0.15)	0.883	[0.828, 0.936]
Interest rate ρ_i	beta (0.5, 0.15)	0.962	[0.938, 0.995]
Markup ρ_{μ}	beta (0.5, 0.15)	0.937	[0.905, 0.968]
Government spending ρ_g	beta (0.5, 0.15)	0.942	[0.905, 0.977]
Standard deviation			
Unemployment benefits σ_b	inv. gamma (0.15, 0.15)	0.425	[0.385, 0.472]
Firing costs σ_f	inv. gamma (0.15, 0.15)	0.169	[0.152, 0.187]
Bargaining power σ_{η}	inv. gamma (0.15, 0.15)	0.129	[0.047, 0.228]
Payroll taxes σ_{τ^f}	inv. gamma (0.15, 0.15)	0.124	[0.110, 0.135]
Income taxes σ_{τ^w}	inv. gamma (0.15, 0.15)	0.101	[0.091, 0.111]
ALMP σ_{almp}	inv. gamma (0.15, 0.15)	1.258	[0.158, 1.408]
Productivity σ_a	inv. gamma (0.15, 0.15)	0.357	[0.320, 0.390]
Interest rate σ_i	inv. gamma (0.15, 0.15)	0.667	[0.566, 0.739]
Markup σ_{μ}	inv. gamma (0.15, 0.15)	0.286	[0.245, 0.321]
Government spending σ_g	inv. gamma (0.15, 0.15)	6.967	[3.279, 13.084]

Figure 3: Impulse response functions of selected variables: one standard deviation productivity shock

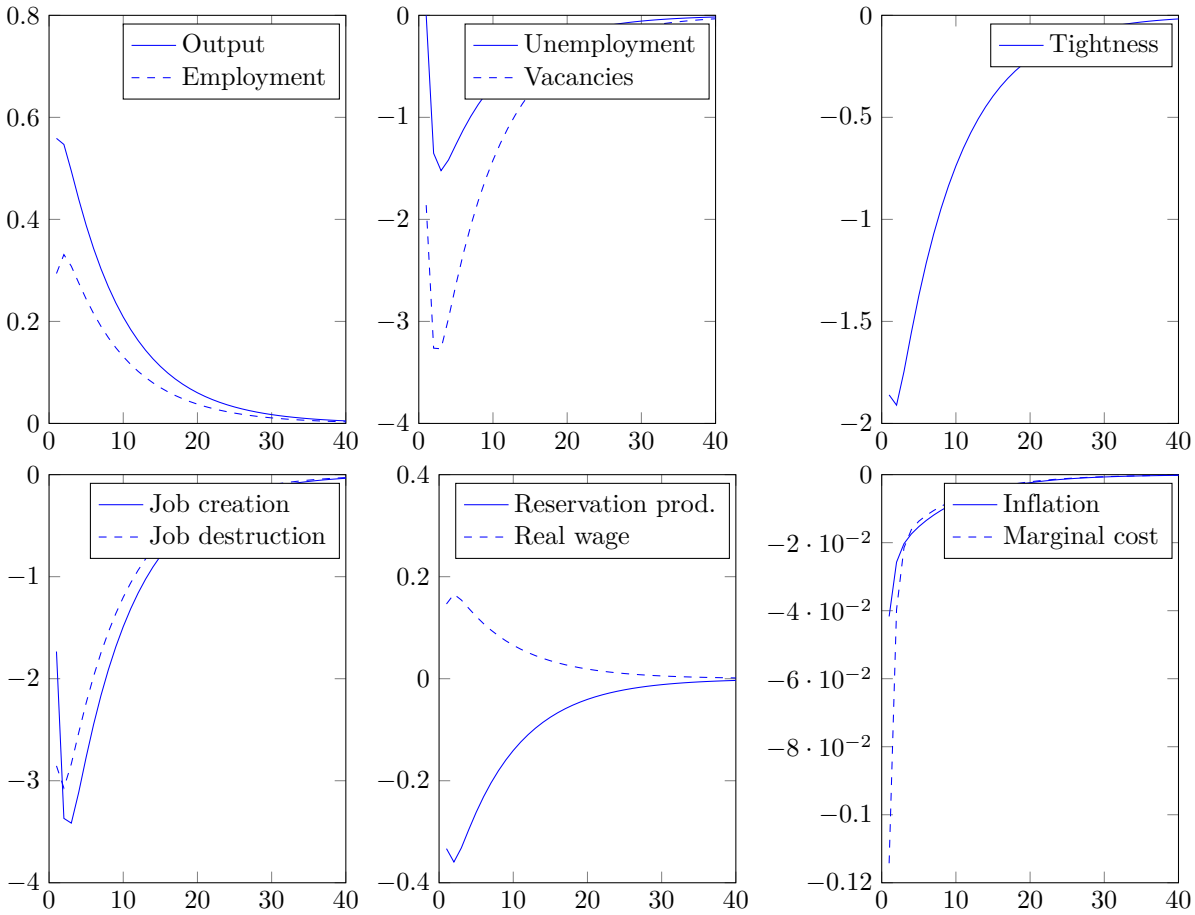


Figure 4: Impulse response functions of selected variables: one standard deviation interest rate shock

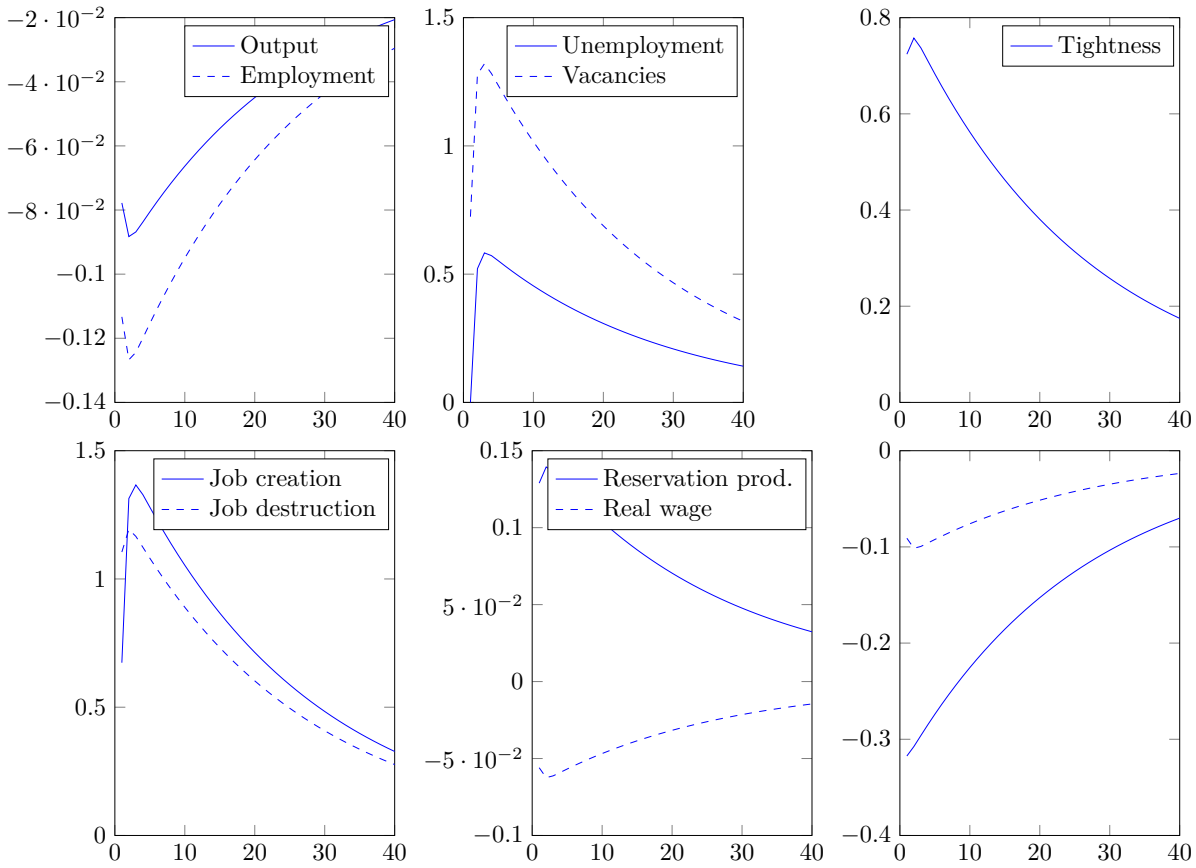


Figure 5: Impulse response functions of selected variables: one standard deviation markup shock

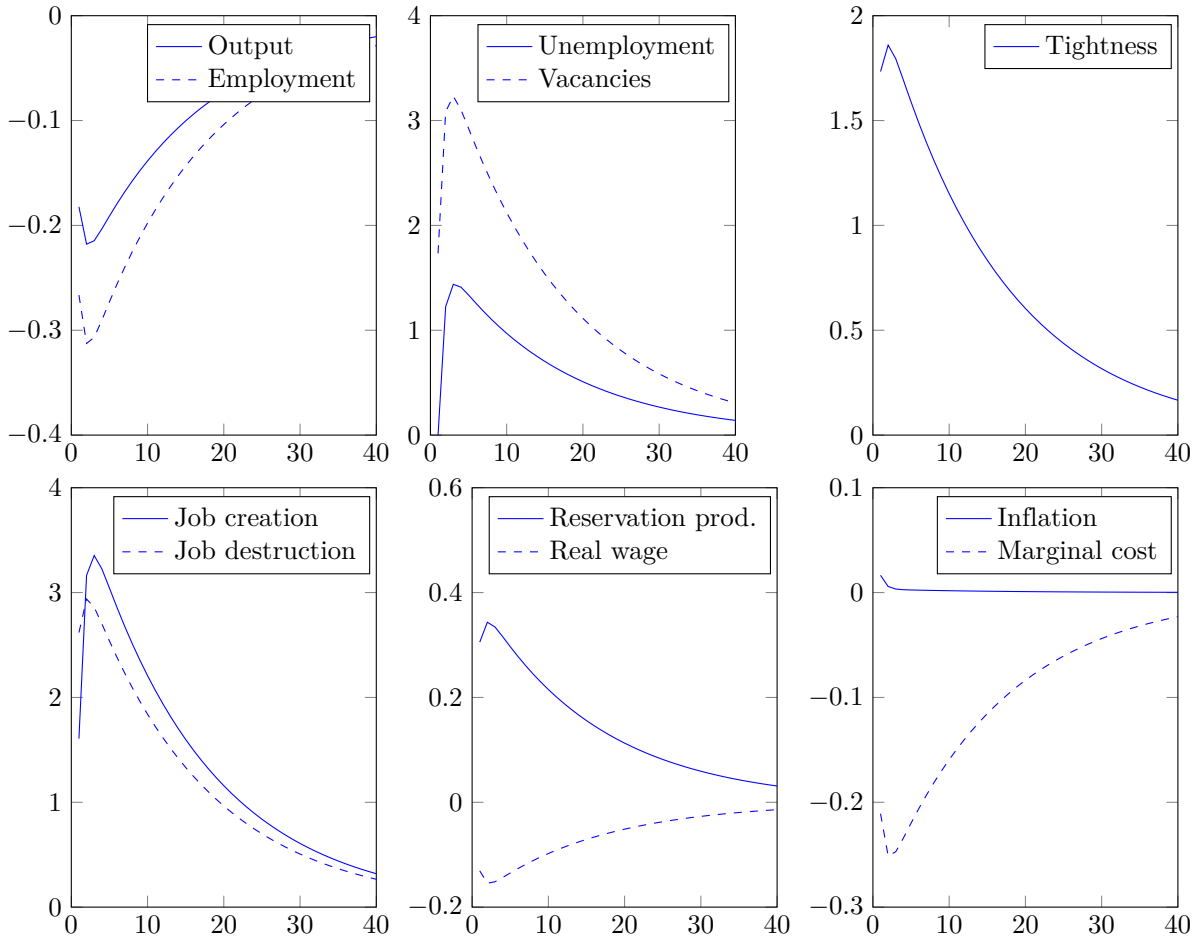
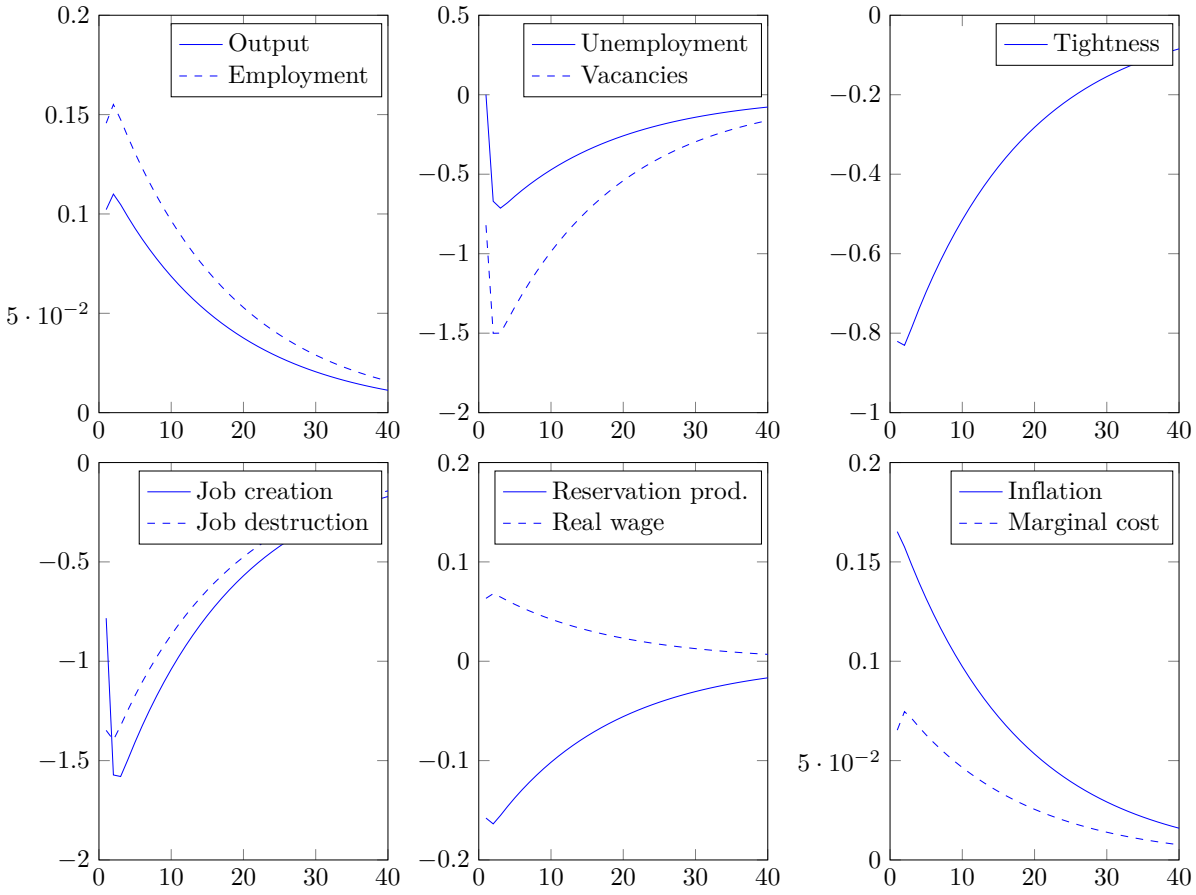


Figure 6: Impulse response functions of selected variables: one standard deviation government spending shock



5.3 Decomposing the volatility of unemployment, output and inflation in the Euro area

Unemployment increased in almost all OECD countries during the 1970s, but then it decreased in some countries (like the "USA"), while it remained high in others (such as Germany, France, Italy and Spain, that we call the "Euro area"). Why did this happen? Such a question generated a heated debate which divided scholars into two main factions: on one hand there are those argue that the Euro area was hit by several and persistent shocks during the 1980s and 1990s, while the US was not. The other faction believes that it was change in labour market regulation in the Euro area that increased the structural level of unemployment, as opposed to the US where flexible labour market institutions made prices absorbing the adverse shocks and let unemployment decrease to its equilibrium level.[12] This section uses variance decomposition techniques to shed light on the relative merit of these two views. One of the interesting features of treating labour market institutions as stochastic processes is precisely that: to be able to distinguish between standard macroeconomic shocks and changes in regulation to account for the historical variation of unemployment.

[12] See for example Nickell (2003) and Saint Paul (2004)

The results are summarized in the top panel of Table 3. The first row presents the unconditional variance decomposition of unemployment over the sample (1970Q4 - 2003Q4). It says that only 30 % of total unemployment fluctuation was due to changes in labour market institutions, in particular to unemployment benefits and changes in the bargaining power of workers. The 70% left is due to standard macro shocks with productivity and interest rate shocks being the most important. Inspecting the conditional variance decomposition at one quarter, one year and five years ahead, it is evident how in the short run, changes in unemployment are mostly due to demand factors, captured by the interest rate shock. Some role is played by changes in matching efficiency — the effectiveness of ALMPs, and firing costs. As the horizon increases, supply factors gain importance, together with unemployment benefits and the bargaining shock. Since the bargaining power shocks is very important to explain wage dynamics, one can interpret this result as showing the role of wage rigidity in preventing the adjustment of prices following a productivity shock, a mechanism already proposed by Bruno and Sachs (1985). It is remarkable how the results obtained with this exercise are in line with those in Nickell and Layard (1999), who operate in a very different framework.

The second issue under examination is whether changes in labour market regulation had a significant impact on inflation and output volatility. This exercise is motivated by the fact that labour market institutions create frictions in the labour market affecting marginal costs and thus the pricing decisions of firms. As a consequence, they might contribute to the variability of output and inflation. Thomas and Zanetti (2009) performed a similar exercise - although using different techniques - but assessing only the impact of changes in firing costs and unemployment benefits. Since there is not theoretical reason to believe that other institutions should not be as important, we conduct the exercise including a more comprehensive set of institutions. From the central and bottom panel of Table 3, it is immediately evident that inflation and output volatility is almost entirely due to macro shocks, rather than changes in labour market regulation. The variance of inflation is explained by cost push factors, represented by the markup shock, and to a less extent by changes in government consumption. This is true unconditionally and conditional on every time period. The variance of output is explained by shocks to interest rate and productivity. Bargaining power shocks play a minor role only, especially in the long run. That firing costs and unemployment benefits do not significantly contribute to the variance of inflation was already showed in Thomas and Zanetti (2009). However, this exercise shows that the even other important institutions such as ALMP, labour taxes and institutions affecting the bargaining power of workers are equally unimportant and that to a large extent, the results extend to output volatility.

Table 3: Unconditional and conditional (1, 4 and 20 periods ahead) variance decomposition of unemployment, inflation and output.

Unempl.	PROD	INRATE	MARKUP	GCONS	ALMP	PAYROLL	INCOME	FIRING	BARGAIN	UBENEF
-	34.27	16.50	6.13	6.13	0.41	3.28	1.09	0.00	24.95	7.25
1	0.00	70.14	0.00	6.53	8.43	5.67	0.00	9.23	0.00	0.00
4	44.77	20.21	3.08	4.66	0.25	2.61	0.74	0.00	18.26	5.44
20	36.14	17.34	4.98	5.83	0.37	3.23	1.02	0.00	24.04	7.03
Inflation	PROD	INRATE	MARKUP	GCONS	ALMP	PAYROLL	INCOME	FIRING	BARGAIN	UBENEF
-	0.63	0.26	83.94	15.13	0.00	0.00	0.00	0.01	0.02	0.01
1	3.28	1.29	74.79	20.27	0.00	0.03	0.02	0.06	0.20	0.07
4	1.69	0.66	77.56	19.95	0.00	0.01	0.01	0.02	0.07	0.02
20	0.78	0.32	81.84	17.01	0.00	0.00	0.00	0.01	0.03	0.01
Output	PROD	INRATE	MARKUP	GCONS	ALMP	PAYROLL	INCOME	FIRING	BARGAIN	UBENEF
-	37.68	39.99	2.65	2.74	0.07	1.53	1.10	0.00	10.84	3.39
1	42.88	46.67	0.90	1.56	0.02	0.79	0.57	0.02	4.97	1.63
4	42.48	43.53	1.18	1.79	0.03	1.07	0.69	0.01	6.98	2.24
20	38.53	40.78	2.13	2.56	0.06	1.48	1.02	0.00	10.23	3.22

6 Conclusions

This paper builds a DSGE model with a rich characterization of the labour market and models explicitly key labour market institutions. The model is used to simulate the short and long run outcomes of several labour market reforms. This environment allows to study the general equilibrium response of unemployment to truly exogenous changes in regulation, a difficult endeavor to achieve with reduced form regressions. Firing costs and labour taxes increase output and decrease unemployment in the long run, while unemployment benefits and higher bargaining power of workers have the opposite effect. In the short run, whether the change in policy is expected to last, or to be in place for a few periods only makes a large difference in terms of unemployment. After estimating the model on the Euro area, a variance decomposition reveals that most of the historical volatility of unemployment, output and inflation is due to structural shocks, rather than changes in regulation. This evidence suggests that the rise and persistence of European unemployment was due to macroeconomic shocks, rather than to a progressive tightening of labour market regulation. In addition, according to the results, central banks should not worry too much about labour market regulation.

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