(In)Efficient Separations, Firing Costs and Temporary Contracts*

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March 2021

Abstract

In this paper we study the allocative (in)efficiency of employment protection in relation to firing costs in a general equilibrium model with labor market frictions. The optimal firing costs depend on the level of unemployment benefits and the degree of centralized wage bargaining, two features of the labor market that induce downward wage rigidity and trigger inefficient employment separations. When restrictions on firing employees with permanent contracts are inefficiently high, the introduction of temporary contracts improves welfare but does not fully restore efficiency. A quantitative analysis for the Italian economy shows that the firing costs before the recent labor market reforms were 30% higher than the optimal level, implying a consumption loss of almost 2% in the steady state. The introduction of fixed-term jobs in the early 2000s' closed one fourth of the gap between inefficient and efficient allocation, although it led to higher unemployment rates and turnover.

JEL Classification: E32, J41, J65.

Keywords: Employment protection, temporary contracts, labor market institutions, structural reforms, general equilibrium model, search and matching.

*The views expressed herein are solely those of the author and do not necessarily reflect the views of the Bank of Italy. We thank Luigi Guiso, Sergey Kovbasyuk, Eric Mengus, Claudio Michelacci, Luigi Paciello, Juan Passadore, Andrea Polo, Andrea Pozzi, Aysegul Sahin, Fabiano Schivardi, Antonella Trigari. We owe a special thank to Salvatore Lo Bello for his thorough reading of the paper and for providing us estimates for the Italian labor market transitions. Part of this work was written when Elisa Guglielminetti was visiting the Einaudi Institute for Economics and Finance, whose hospitality is gratefully acknowledged.

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1 Introduction

In the last 30 years many large European countries have deeply reformed their labor market institutions (LMIs). Several measures have been adopted in order to reduce employment protection, often considered one of the major culprit of the poor labor market performance of rigid European economies.[1] Given the political opposition to reducing the high job security provisions granted to open-ended (regular) jobs, since the mid-'90s policymakers have liberalized the use of new flexible types of contracts. A dual labor market structure emerged, especially in countries where rigidities were more pronounced: in 2017 the share of temporary contracts out of total employment was 27% in Spain, 17% in France, and 15% in Italy. These reforms notwithstanding, unemployment not only rose sharply during the double-dip recession, but remained high for an extended period of time thereafter, bringing again structural labor market reforms at the center stage of the political agenda.

Given this evidence, the paper addresses the following two questions: first, what is the macroeconomic impact of a reduction in employment protection? And second, can temporary contracts substitute for excessive job security in regular contracts? Despite the crucial importance of these issues to orient future policy interventions, the evidence on the macroeconomic effects of employment protection is far from conclusive. The empirical identification of this impact is challenging because institutions change slowly over time and countries differ along many dimensions beyond the one under scrutiny.

In this paper we study from a theoretical point of view the macroeconomic impact of employment protection, using a tractable general equilibrium model. From an empirical point of view, we provide a quantitative evaluation (and a rationalization) of the sequence of labor market reforms that were implemented in Italy since the mid-'90s.

The model has several important features. First, it incorporates meaningful interactions between different labor market institutions, namely unemployment benefits, centralized wage bargaining, firing restrictions on regular jobs and the possibility of stipulating temporary contracts. Second, it allows taking into account the general equilibrium effects of changes in LMIs. Third, it is sufficiently simple to characterize analytically the first and the second best allocations. To keep the model tractable and derive closed-form solutions, we focus on the allocative efficiency of LMIs,

[1] According to the LABREF database managed by the European Commission, 57 out of 259 reforms (22%) carried out in Italy from 2001 to 2017 regarded job protection, being the most active area of intervention among nine policy domains. In France 17% of policy measures regarded employment protection (second most important area of intervention), in Spain 14% (third most important area). In Germany labor market reforms were instead more concentrated and implemented within broad packages; only 5% of them regarded employment protection.

abstracting from insuring motives. We show that the optimal degree of employment protection on regular contracts (EPR) crucially depends on the interaction with unemployment benefits and centralized wage bargaining, which we both take as given in our model. In principle, we could have allowed all three margins to vary and, by doing so, derive the optimal provisioning of employment protection, unemployment benefits and degree of centralization in wage bargaining, all at the same time. In practice, the model would have been intractably large and with too many moving wheels; therefore, we decided to focus on the optimal level of employment protection while taking as given the level of unemployment benefits and the degree of centralized wage bargaining. We call this notion of optimality the "constrained optimal" level of employment protection.

To investigate employment protection, we consider a setting with search and matching frictions and endogenous job destruction where firms must pay a fixed cost when they fire a regular worker (firing costs).[2] Firing costs thus discourage job destruction, which we model in a non-standard way because layoffs are decided unilaterally by the firm. As a consequence, real wage rigidities caused by centralized wage bargaining and unemployment benefits give rise to inefficient separations. We demonstrate that some separations triggered by LMIs are *socially inefficient* because they would not occur under a social planner maximizing aggregate welfare. Regarding unemployment benefits, social inefficiency arises because the worker only takes into account her private outside option, neglecting the social cost of taxes that should be levied to finance subsidies. Beyond the social inefficiency stemming from general equilibrium effects, centralized wage bargaining elicits separations which are also *privately inefficient* whenever the impossibility to renegotiate the wage leads to a layoff that could be avoided by suitable transfer schemes between the firm and the worker: this feature is consistent with the empirical evidence in Jäger, Schoefer, and Zweimüller (2019).

Although rich in ingredients, our setup is sufficiently tractable to derive analytically the constrained optimal level of employment protection. We show that: a) the relationship between firing costs and social welfare is non-monotonic and hence such optimal level exists and may be positive; b) the optimal level of protection is increasing in the degree of centralized wage bargaining and the level of unemployment subsidies, because a small amount of firing costs helps correcting the distortion induced by inefficient separations with limited detrimental effects on job creation.

We are thus able to answer the first question: a reduction in employment protection *might be* Pareto-improving *when* the initial level is higher than the optimal one, which is in turn determined by the overall institutional context.

In our quantitative exercise, we check this policy prescription and apply the model to the

[2] In this work we use the terms firing costs and layoff taxes indistinctly.

sequence of labor market reforms introduced in Italy since the mid-'90s in an attempt to get to a more flexible labor market.[3] We calibrate the model to the pre-reforms Italian labor market and then reckon the optimal firing costs in such an environment. It turns out that, given the level of centralized wage bargaining and unemployment benefits, optimal firing costs were roughly equal to 2.5 monthly wages of the average regular worker, as opposed to the higher level that was in place before the liberalization (3.5 monthly wages, according to Garibaldi and Violante 2005). Our model thus confirms the common wisdom that employment regulation in Italy was too strict before 2012. We further quantify that this departure from optimality determined a consumption loss of 1.7% compared to the second best allocation. However, political difficulties in changing such restrictions pushed policymakers to introduce flexibility at the margin by lifting restrictions in the use of temporary (fixed-term) contracts.

To understand whether this policy can effectively counterbalance an excessive job security in regular contracts we extend the model to introduce temporary contracts, that differ from the other ones because they are not subject to firing restrictions and in each period may expire with positive probability. This extended version of the model is similar to Sala, Silva, and Toledo (2012); differently from them, however, we endogenize the choice of the type of contract offered by the firm: in equilibrium firms trade-off the *ex-ante* benefits of a quick search (for permanent contracts which are more promptly accepted by workers) with the *ex-post* costs of tighter regulation on dismissals. This endogenous sorting between permanent and temporary contracts is similar to Berton and Garibaldi (2012). However in our framework job seekers do not direct search towards a specific market and may receive multiple job offers during the same quarter; this makes the model more tractable and consistent with the fact that workers usually apply to different kind of jobs (Belot, Kircher, and Muller 2018).

We assess quantitatively the effects of the introduction of temporary jobs by simulating the extended model calibrated on the post-reforms Italian economy. We find that this measure was welfare improving but it managed to close only one fourth of the gap between the inefficient pre-reforms allocation and the single–contract economy with firing costs set at their optimal level. We also show that the Italian economy with a dual labor market behaves very differently compared to a single-contract economy with reduced employment protection. The mere existence of temporary

[3] Since the mid-'90s policymakers introduced flexibility at the margin by lifting restrictions in the use of fixed-term contracts. The first partial liberalization occurred in 1997 with the Treu law (L. 196/97), followed by other reforms culminated with the Biagi law in 2003 (L. 30/2003). The employment protection on regular contracts was reduced only later: the reinstatement rules were partially relaxed in 2012 (Law 28 June 2012, n. 92). The so called "Jobs Act"(Law 10 December 2014, 183) further reduced the scope for reinstatement of workers unlawfully dismissed in firms with more than 15 employees.

contracts induces high turnover, as they are mainly used as substitutes for regular ones instead of representing stepping stones towards permanent employment. As fixed-term contracts induce more job destruction they lead to higher unemployment, although coupled with greater easiness in finding jobs. This suggests that evaluating the success of such reforms based on their effect on the unemployment rate could be misleading. At the same time, the side-effects of increased unemployment risk not included in our framework, such as loss of human capital, could undermine the benefits of a partial liberalization of the labor market.

Our work is related to the literature on the macroeconomic impact and the optimality of labor market institutions and to the literature on the consequences of a dual labor market. A key result of our paper is a non-monotonic relationship between employment protection and macroeconomic outcomes. Several works support this finding from an empirical point of view (Belot and Ours 2004, Garibaldi and Violante 2005 and Bassanini and Duval 2009)[4]. Other studies rationalize it through theoretical models: Blanchard and Portugal (2001) find an ambiguous effect of employment protection on the unemployment rate depending on the shape of the distribution and the shocks hitting the economy. Belot, Boone, and van Ours (2007) argue that there is an optimal level of firing cost which depends on the wage protocol and the redistribution scheme; Karabay and McLaren (2011) show that firing costs can be Pareto-improving when workers are risk-averse and contracts are incomplete. We contribute to this literature by providing an analytical characterization of the optimal level of employment protection in a framework where downward real wage rigidities and general equilibrium effects give rise to inefficient separations. Only few papers investigate optimal labor market policies in a dynamic general equilibrium framework with search and matching frictions. Relevant exceptions are Taschereau-Dumouchel and Schaal (2010), Arseneau and Chugh (2012) and Albertini and Fairise (2013), which consider a combination of policy instruments (unemployment benefits, minimum wages, taxation) in order to restore efficiency. We instead tackle this issue from a different perspective, focusing on the optimal level of firing costs corresponding to the implementation of a Ramsey policy which takes as given the other institutions in place. In addition, we provide a quantification of the (in)efficiencies in the pre-reforms Italian economy due to firing costs.

Most of the studies on dual labor markets are conducted in partial equilibrium, and find ambiguous effects of the flexibility introduced by temporary contracts.[5] Few studies investigate labor

[4] A comprehensive literature review of the empirical evidence on the effects of labor market institutions on unemployment and capital accumulation based on OECD data can be found in Heimberger (2019).

[5] See the classical contributions of Bentolila and Bertola (1990), Saint-Paul (1991), Bentolila and Saint-Paul (1992) Blanchard and Landier (2002) and Cahuc and Postel-Vinay (2002). For more recent contributions see Bentolila et al. (2012) and Cahuc, Charlot, and Malherbet (2016).

market duality in a dynamic general equilibrium setup as we do: Alonso-Borrego, Fernandez-Villaverde, and Galdón-Sanchez (2005) build a DSGE model with heterogeneous households and firms and show that the elimination of temporary contracts would increase productivity but reduce employment; Veracierto (2007) studies the effects of the introduction of temporary contracts and the elimination of separation costs, finding a positive long-run effects of both reforms.[6] With respect to these papers, we evaluate temporary jobs as way to restore or increase welfare considering the interaction with other labor market institutions.

The rest of the paper is structured as follows. Section 2 describes the model. Section 3 analyses the relationship between labor market institutions and social efficiency. The role of firing costs is singled out and discussed in Section 4, which further presents our quantitative exercise. In Section 5 we extend the model by introducing temporary contracts and perform additional simulations. Finally, Section 6 concludes.

2 The economic environment

In this Section we lay out the main features of the model used in the rest of the paper to derive analytical results (on the interactions between labor market institutions) and to conduct simulations in the empirical section. Notice, in particular, the mapping between model parameters that are going to be introduced in this section and various labor market institutions we are interested in:

- b parametrizes the level of unemployment benefits
- Θ_w parametrizes the degree of centralized wage bargaining
- finally, γ parametrizes the level of firing costs which summarize employment protection in this simple setup.

2.1 Households

The economy is populated by population of mass 1. We assume that agents belong to a single representative household and pool their resources; as a consequence, they are perfectly insured against idiosyncratic shocks and enjoy the same level of consumption irrespective of their working status. This is a standard assumption in this class of models (see Merz 1995 and Andolfatto 1996) and we adopt it in order to simplify the household's problem. The resulting environment is unable

[6] Alvarez and Veracierto (2012) instead employ a Lucas' type of model modified with undirected search and tenure dependent separation costs.

to capture the role of labor market institutions as insurance devices against income shocks, and consequently we restrict our analysis to efficiency considerations only. Agents consume (C_t) and invest in bonds (B_t) and do not have preferences over working hours: labor supply is thus fixed and equal to one. Hence, the representative household solves the following optimization problem:

$$
\begin{aligned}
W_t^H &= \max_{C_t, B_t} \left[\log C_t + \mathbb{E}_t \beta W_{t+1}^H\right] \\
&\text{s.t.} \;\; C_t + B_t = R_{t-1} B_{t-1} + w_{0t} n_{0t} + w_t n_t + b u_t + \Pi_t^F - \bar{T}_t \\
&\qquad \Pi_t^F = Y_t - w_{0t} n_{0t} - w_t n_t - c v_t - (1-\phi)\, G(\tilde{z}_t)\,(n_{0t} + n_t)\,\gamma \\
&\qquad \bar{T}_t = T_t - (1-\phi)\, G(\tilde{z}_t)\,(n_{0t} + n_t)\,\gamma
\end{aligned}
$$

where β is the discount rate, R_t is the interest rate on bonds and ϕ is the exogenous workers' quit rate. Households' resources consist of interests provided by bond holdings, plus labor income of newly hired workers and incumbents ($w_{0,t} n_{0,t}$ and $w_t n_t$, respectively), plus unemployment subsidies ($b u_t$, where b is the per-capita subsidy and u_t is the unemployment rate), plus firms' profits (Π_t^F) minus lump-sum taxes levied by the government ($\bar{T}_t$). In this context, by now, it is useful to notice that firms' profits are the difference between the production's output (Y_t) and the labor costs including the firing ones. As we clarify in what follows, we need to distinguish between new hired and incumbent workers because they earn a different wage. The government runs a balanced budget, financing unemployment benefits with taxes:

$$
b u_t = T_t \tag{1}
$$

According to Albertini and Fairise (2013), the variable T_t includes layoff taxes that the government collects through dismissals and a lump-sum component which adjusts automatically to finance unemployment benefits. Notice that in this model the subsidy b does not have any proper insurance motive, because unemployed workers have access to the resources of the representative household and do not suffer from any consumption loss. However it is important to take it into account because unemployment insurance is a prominent feature of developed countries and affects labor market outcomes through several channels. First, it raises worker's outside option and hence the wage. Second, it has an impact on firms' labor demand through the wage setting process. Finally, it interacts with other labor market institutions thus affecting social efficiency.

Taking the first order conditions we obtain:

$$\text{for } C_t\text{: } \lambda_t = C_t^{-1} \tag{2}$$

$$\text{for } B_t\text{: } \beta \mathbb{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} R_t \right\} = 1 \tag{3}$$

$$\text{for } \lambda_t\text{: } C_t + B_t = R_{t-1}B_{t-1} + w_{0,t}n_{0,t} + w_t n_t + bu_t + \Pi_t^F - \bar{T}_t \tag{4}$$

where λ_t is the Lagrangian multiplier on the budget constraint.

2.2 Labor market

The labor market does not clear because frictions prevent job seekers to find instantaneously an available job position, as in Diamond-Mortensen-Pissarides (DMP) search and matching model[7].

Within a period, timing is as follows. At the beginning of the period, aggregate and idiosyncratic productivity shocks realize (A_t and z_{it}, respectively). Then, exogenous separations occur and firms may decide to fire additional workers if their productivity turns out to be low. We model employment protection provisions in terms of firing costs γ paid by firms for any endogenous separation. At the same time, firms post vacancies v_t and meet job seekers (unemployed of the previous period) through an aggregate matching function. Finally, production starts and unemployment is determined.

It is important to notice that our layoff tax γ does not represent pure waste because the fiscal revenues for the Government are redistributed to households through lump-sum taxes. From the firm's point of view, however, γ represents a cost, different from severance payments which are paid directly to the worker upon dismissal. It is well-known that the cost and the transfer components can have radically different effects. Lazear (1990) showed that a pure transfer to the worker can be neutralized by an appropriate contract design. On the contrary, the transfer component may have real effects in presence of contractual frictions (Garibaldi and Violante 2005). Here we focus on the layoff cost, which is the most distortive component whose impact on employment is easier to interpret as it stems only from changes in labor demand without any shift in labor supply. Fella and Tyson (2013) show as the size (and its relevance) of severance payments may vary based on the nature of the dismissal and the use of right to reinstatement by the worker. Moreover, this setup compares more easily with the rest of the literature, which has mainly studied the impact of firing taxes.

[7] The seminal contributions date back to Diamond (1982) and Mortensen and Pissarides (1994).

Each productive match consists of a firm-worker pair and its productivity depends on aggregate technology and an idiosyncratic productivity component through a linear production function like in Mortensen and Pissarides (1994) and Menzio and Shi (2011):

$$y_{it} = A_t + z_{it} \tag{5}$$

The linear production function is convenient for its tractability as it makes the role of the idiosyncratic component very transparent and allows us to choose a distribution centered around zero. The matching process between firms and workers is governed by an aggregate matching function:

$$m(v_t, u_{t-1}) = \Phi(v_t)^{\varepsilon}(u_{t-1})^{1-\varepsilon}$$

where Φ represents the matching efficiency and ε is the elasticity of the matching function with respect to vacancies. We can thus define the probability that a vacancy meets a worker as $q_t = \frac{m_t}{v_t} = \Phi(\theta_t)^{\varepsilon-1}$ and, conversely, the probability that a worker meets a vacancy as $f_t = \frac{m_t}{u_{t-1}} = \theta_t q_t \equiv \Phi(\theta_t)^{\varepsilon}$. In these formulas θ_t stands for the labor market tightness from the firm's point of view ($\theta_t \equiv v_t/u_{t-1}$). Upon meeting, the match-specific productivity component, whose cdf is denoted by $G(z)$, starts at its maximum level ($\bar{z}$). Separations occur either for exogenous reasons (at rate ϕ) or because idiosyncratic productivity shocks drive the value of the match below zero and the firm endogenously decides to fire the worker. We indicate with δ_t the total separation rate, which takes into account both exogenous and endogenous separations and we will define in the next Section.

We now have all the elements to derive a low of motion for each working status. In any period, agents can be either unemployed (u_t), employed as newly hired workers (n_{0t}) or employed from the previous period (n_t). The laws of motion read as follows:

$$1 = n_{0t} + n_t + u_t \tag{6}$$

$$n_{0t} = f_t u_{t-1} \tag{7}$$

$$n_t = (1-\delta_t)(n_{0t-1} + n_{t-1}) \tag{8}$$

We can further define job creation and job destruction as $JC_t = n_{0t} = f_t u_{t-1}$ and $JD_t = \delta_t(1-u_{t-1})$; according to AlShehabi (2015) we compute rates of net employment change and job turnover as $NET_t = JC_t - JD_t$ and $JT_t = JC_t + JD_t$. We further introduce a measure of excess turnover:[8]

$$ET_t = JT_t - |NET_t| \tag{9}$$

This variable measures the magnitude of gross job flows in excess of net job creation. Assume that in a given period a new additional job is created: this may be the outcome of just one job created and no jobs destroyed or 1001 job created and 1000 destroyed (or any other combination of the two gross flows). In the first case the measure of excess turnover is 0, while in the second case is 2000, as this is the amount of gross job flows that have not lead to net job change. In a frictional labor market like the one we consider, excess turnover may be socially inefficient as there are costs of replacing existing workers.

2.2.1 Firms

The firm's value function from employing in the current period a worker with productivity level (z_{it}) is the following:

$$J_t(z_{it}) = y_t(A_t, z_{it}) - w_t(A_t, z_{it}) + \mathbb{E}_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} \left[(1-\phi) \max \left\{ J_{t+1}, V_{t+1} - \gamma \right\} + \phi V_{t+1} \right] \right\} \tag{10}$$

In the case of a new match, the current profit, i.e. the difference between output (y) and the wage (w), is evaluated at $\bar{z}$ since newly hired workers produce at the maximum productivity level:

$$J_{0t}(\bar{z}) = y_{0t}(A_t, \bar{z}) - w_{0t}(A_t, \bar{z}) + \mathbb{E}_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} \left[(1-\phi) \max \left\{ J_{t+1}, V_{t+1} - \gamma \right\} + \phi V_{t+1} \right] \right\} \tag{11}$$

We can define the surplus enjoyed by the firm, both for incumbent and new matches, as the difference between the value of the productive match and her outside option which includes the firing cost:

$$S_t^F(z_{it}) = J_t(z_{it}) - V_t + \gamma \tag{12}$$

$$S_{0t}^F(\bar{z}) = J_{0t}(\bar{z}) - V_t + \gamma \tag{13}$$

where the F superscript refers to the surplus accruing to the firm. Equation (12) is useful to define the productivity level $\tilde{z}_t$ below which an incumbent match becomes unprofitable and is destroyed:

$$S_t^F(\tilde{z}_t) = J_t(\tilde{z}_t) - V_t + \gamma = 0 \tag{14}$$

[8] A similar measure is used by Dell'Ariccia and Garibaldi (2005) for the study of credit market flows.

Crucially, we define this job destruction threshold looking only at the firm's surplus, as opposed to using the joint surplus, i.e. the sum of the firm's and the worker's surplus. Under flexible wages the difference is immaterial but, when we introduce wage rigidities (as we do below), this assumption means that the model is able to capture not only consensual quits (as is customary in the search and matching literature) but also true layoffs by the firm.

Having defined the job destruction threshold, the total separation rate is given by $\delta_t = \phi + (1-\phi)G(\tilde{z}_t)$, which includes both the exogenous and the endogenous component. Consequently, $(1-\delta_t) = (1-\phi)[1-G(\tilde{z}_t)]$ is the survival rate. The value of a vacancy is given by:

$$V_t = -c + q_t J_{0t}(\bar{z}) + (1-q_t)\,\mathbb{E}_t \beta \frac{\lambda_{t+1}}{\lambda_t} V_{t+1} \tag{15}$$

where c is the cost of posting a vacancy. With probability q_t the firm meets a job seeker and creates a match whose individual productivity is equal to $\bar{z}$. With probability $(1-q_t)$ the vacancy remains unfilled. Finally, the free entry condition drives the value of the vacancy to 0 ($V_t = 0$) and leads to the job creation condition:

$$\frac{c}{q_t} = J_{0t}(\bar{z}) \tag{16}$$

Equation (16) indicates that new firms enter the market up to the point where the real cost of posting a vacancy (the left hand side), which takes into account the cost and the time needed to hire a worker, is equal to the expected benefit of a productive match (the right hand side).

2.2.2 Workers

Unemployed job seekers enjoy the subsidy b and look for jobs. Given our timing assumptions, the unemployment status is defined at the end of the period. Unemployed workers can thus find a new job only in future periods. According to Trigari (2006) and Ravenna and Walsh (2008), workers value their actions in terms of the contribution these actions give to the utility of the family to which they belong. Then, the value function of an unemployed worker is

$$U_t = b + \mathbb{E}_t \beta \frac{\lambda_{t+1}}{\lambda_t} \left[f_{t+1} W_{0t+1}(\bar{z}) + (1-f_{t+1})\, U_{t+1} \right] \tag{17}$$

The value function for a worker is:

$$W_t(z_{it}) = w_t(z_{it}) + \mathbb{E}_t \beta \frac{\lambda_{t+1}}{\lambda_t} \left\{ (1-\phi) \left[\int_{\tilde{z}_{t+1}}^{\bar{z}} W_{t+1}(z') dG(z') + G(\tilde{z}_{t+1}) U_{t+1} \right] + \phi U_{t+1} \right\} \tag{18}$$

The value of a job for the worker consists of the current wage and the continuation value, which is the same irrespective of tenure; notice that for a new match the current wage is evaluated at $\bar{z}$ (see equation 19). In the next period either the worker quits the job for exogenous reasons (which happens with probability ϕ) or a new draw of the idiosyncratic component determines whether the match continues (if the draw of z is above $\tilde{z}$) or is destroyed. Differently from the firm, there is no penalty or benefit associated to endogenous separations:

$$W_{0t}(\bar{z}) = w_{0t}(\bar{z}) + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left\{(1-\phi)\left[\int_{\tilde{z}_{t+1}}^{\bar{z}} W_{t+1}(z')dG(z') + G(\tilde{z}_{t+1})U_{t+1}\right] + \phi U_{t+1}\right\} \tag{19}$$

2.2.3 Wage setting schemes

In order to study the interactions between different labor market institutions, we introduce two different wage setting schemes in the model.

In the first setting wages are renegotiated whenever a shock occurs (flexible wages) and set through Nash bargaining; this assumption is customary in this kind of models, representing a convenient way to split the surplus originated from the productive match because of frictions. Hence the worker and the firm divide the surplus according the their relative bargaining power. Denoting with η the worker's bargaining power and with $(1-\eta)$ the firm's one, the Nash bargaining conditions for incumbent and new matches are:

$$(1-\eta)\left(W_t(z_{it}) - U_t\right) = \eta\left(J_t(z_{it}) - V_t + \gamma\right) \tag{20}$$

$$(1-\eta)\left(W_{0t}(\bar{z}) - U_t\right) = \eta\left(J_{0t}(\bar{z}) - V_t + \gamma\right) \tag{21}$$

After some algebra we obtain:

$$w_t^n(z_{it}) = (1-\eta)b + \eta\left\{y_t(A_t, z_{it}) + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}c\theta_{t+1} + \gamma\left[1 - \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}(1-\phi-f_{t+1})\right]\right\} \tag{22}$$

$$w_{0t}^n(\bar{z}) = w_t^n(\bar{z}) \tag{23}$$

where the n superscript stands for Nash bargained. The wage is an increasing function of the firing cost, because the worker can use it as a threat in the bargaining game.[9]

Notice that, when wages are set through Nash bargaining, our assumption that the job destruction threshold is set by the firm is akin to defining the cut-off based on the joint surplus. Indeed,

[9] This is a standard result (see, for instance Sala, Silva, and Toledo (2012)).

efficient Nash bargaining implies that the firm's surplus is a constant share of the joint surplus, so that the idiosyncratic productivity value which drives to zero the firm's and the joint surplus is the same.

However, a key difference emerges under our second wage setting scheme, in which we assume that wages cannot be fully renegotiated at any new productivity draw. Under this wage setting scheme, we posit that the effective wage is the outcome of a two-pillar bargaining structure: the first pillar, a collective bargaining round, establishes a reference wage (w_t^*), while the second pillar, at the firm level, adjusts the wage to reflect, at least partly, the idiosyncratic productivity component.

The effective wage are thus a weighted average between the individually bargained wage in equation (22) and the reference wage:

$$w_t(z_{it}) = (1 - \Theta_w)w_t^n(z_{it}) + \Theta_w w_t^* \tag{24}$$

$$w_{0t}(\bar{z}) = (1 - \Theta_w)w_{0t}^n(\bar{z}) + \Theta_w w_t^* \tag{25}$$

The reference wage w_t^* is akin to the concept of "wage norm"emphasized by Hall (2005) that critiques the use of a sticky wages formulation because it produces an inefficiency which rational agents can neutralize.[10] We take it to be equal to the average wage in the previous period, as it was established at the centralized level based on the productivity of the average worker. Hence the parameter Θ_w captures the degree of "trade union density", whereas $(1 - \Theta_w)$ is the portion of the wage negotiated at the decentralized level. Obviously, when $\Theta_w = 0$ we are back to the flexible wage case.

Instead, as long as $\Theta_w > 0$, our setup is able to capture the distinction between a quit and a layoff, where the second one is chosen by the firm irrespective of worker's gain from the match. To gain intuition, assume that in period t the joint surplus is positive and the wage is set efficiently. Let's then consider, in period $t + 1$, a bad draw of the idiosyncratic productivity component that reduces the joint surplus to slightly positive values. If the parties can renegotiate the wage, the match will continue. However, if the wage cannot adjust, the firm's value may fall into negative territory, thus pushing her to break the relationship (since the job destruction threshold is based on the firm's value alone). This separation (a layoff by the firm) is *privately inefficient* because the value of the joint surplus is positive and both the firm and the worker would be better off by renegotiating the contract.[11]

[10] A similar wage norm is employed by Krause and Lubik (2007) and AlShehabi (2015).

[11] This type of inefficiency was criticized by Barro (1977) and led many researchers (e.g. Hall 2005) to introduce wage stickiness in a way that avoids unexploited opportunities for mutual gains from trade. In our setup, wage rigidity cannot be neutralized by alternative employment rules as in Barro (1977) because of labor market frictions. Moreover,

2.3 Aggregate resource constraint

Total output is given by the following expression:

$$Y_t = n_{0t}\left(A_t + \bar{z}\right) + n_t\left(A_t + \int_{\tilde{z}_t}^{\bar{z}} z' dG(z')\right) \tag{26}$$

where the two terms represent the expected output from new and existing jobs. Notice that the two outputs may differ because of differences in the idiosyncratic productivities: newly hired workers are on average endogenously more productive than incumbent workers. The aggregate resource constraint is thus given by:

$$Y_t = C_t + cv_t \tag{27}$$

Equation (27) states that total output must equate aggregate consumption plus the costs of posting vacancies. Notice that firing costs should not be taken into account in the aggregate resource constraint because together with lump-sum taxes balance off the unemployment benefits.

2.4 Computing equilibria

To begin with, we characterize the equilibrium in the decentralized economy described so far, i.e. the allocation that results from private agents optimal decisions taking as given the presence of various labor market institutions like unemployment benefits, centralized wage setting and employment protection. Next, we derive the first best allocation, i.e. the one that would be chosen by a social planner who maximizes households' utility subject only to the technological constraints and the employment law of motion.

2.4.1 Equilibrium in the decentralized economy

The equations presented in Sections 2.1 and 2.2 illustrate how agents take optimal private decisions in a decentralized economy. Here we collapse the main equations of the model to obtain two conditions for the labor market tightness (θ_t) and the job destruction threshold ($\tilde{z}_t$) which characterize

empirical evidence (see Jäger, Schoefer, and Zweimüller 2019) supports the existence of inefficient separations. Den Haan and Sedlaceck (2014) show as agency problems may trigger inefficient separations during downturns that are not offset by the more labor creation during booms.

the decentralized allocation:

$$\frac{c}{q(\theta_t^{dec})} = [1-\eta(1-\Theta_w)]\,(A_t+\bar{z}) + [1-\eta(1-\Theta_w)]\,\beta\mathbb{E}\frac{\lambda_{t+1}}{\lambda_t}(1-\delta_{t+1})\left[H(\tilde{z}_{t+1}^{dec})-\tilde{z}_{t+1}^{dec}\right] \tag{28}$$

$$-\eta(1-\Theta_w)\beta\mathbb{E}\frac{\lambda_{t+1}}{\lambda_t}c\theta_{t+1}^{dec} - (1-\Theta_w)(1-\eta)b - \Theta_w w^*$$

$$-\eta\,(1-\Theta_w)\left[1-\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}(1-\phi)\right]\gamma - (1-\phi)\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\gamma - \eta\,(1-\Theta_w)\,\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}f(\theta_{t+1}^{dec})\gamma$$

$$\frac{c}{q(\theta_t^{dec})} = [1-\eta(1-\Theta_w)]\,(\bar{z}-\tilde{z}_t^{dec}) - \gamma \tag{29}$$

where the superscript *dec* denotes the decentralized economy. For what follows it is useful to evaluate the two previous equations in steady state:

$$\frac{c}{q(\theta^{dec})} = [1-\eta(1-\Theta_w)]\,(A+\bar{z}) + [1-\eta(1-\Theta_w)]\,\beta(1-\delta)\left[H(\tilde{z}^{dec})-\tilde{z}^{dec}\right] \tag{30}$$

$$-\eta(1-\Theta_w)\beta c\theta^{dec} - (1-\Theta_w)(1-\eta)b - \Theta_w w^*$$

$$-\eta(1-\Theta_w)\,[1-\beta(1-\phi)]\,\gamma - \beta(1-\phi)\gamma - \eta(1-\Theta_w)\beta f(\theta^{dec})\gamma$$

$$\frac{c}{q(\theta^{dec})} = [1-\eta(1-\Theta_w)]\,(\bar{z}-\tilde{z}^{dec}) - \gamma \tag{31}$$

Equation (30) states that in equilibrium the expected cost of posting a vacancy is equal to the stream of present discounted profits that the firm derives from the match, net of the payment to the worker and the firing costs, which is fully levied on the firm. Equation (31) determines the equilibrium point where for firms it is convenient to maintain a job relationship: as soon as the productivity gain due to an incumbent worker falls below the expected cost of posting a vacancy firms are better off by breaking the match.

2.4.2 Equilibrium under a social planner

In the spirit of Hosios (1990), we compute as a benchmark the efficient allocation that would be selected by a social planner who maximizes welfare subject *only* to technological constraints and search and matching frictions, while abstracting away from the presence of LMIs such as unemployment benefits, trade union density and firing restrictions. The social planner, thus, chooses labor market tightness, unemployment and the job destruction threshold to solve the following problem:

$$
\begin{aligned}
\max_{\{\theta_t, u_t, \tilde{z}_t\}_{t=0}^{\infty}} \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t) \\
\text{s.t.} \quad & C_t = n_{0t}\left(A_t + \bar{z}\right) + n_t \left[A_t + \frac{1}{1-G(\tilde{z}_t)} \int_{\tilde{z}_t}^{\bar{z}} x g(x) dx\right] - c\theta_t u_{t-1} \\
& n_{0t} = f(\theta_t) u_{t-1} \\
& n_t = (1-\phi)\left[1 - G(\tilde{z}_t)\right]\left(n_{0t-1} + n_{t-1}\right) \\
& 1 = u_t + n_{0t} + n_t \\
& f(\theta_t) = \Phi \theta_t^{\varepsilon}
\end{aligned}
$$

By computing the planner's FOCs and simplifying we obtain two conditions characterizing labor market tightness and the job destruction threshold for the optimal allocation in steady state:

$$
\frac{c}{q(\theta^{opt})} = \varepsilon\left(A + \bar{z}\right) + \varepsilon\beta(1-\delta)\left[H(\tilde{z}^{opt}) - \tilde{z}^{opt}\right] - (1-\varepsilon)\beta c \theta^{opt} \tag{32}
$$

$$
\frac{c}{q(\theta^{opt})} = \varepsilon(\bar{z} - \tilde{z}^{opt}) \tag{33}
$$

where the *opt* superscript denotes the centralized economy and $H(\tilde{z}) = \frac{1}{1-G(\tilde{z})} \int_{\tilde{z}}^{\bar{z}} x g(x) dx$ is the expected value of the idiosyncratic productivity component conditional on being above the threshold.

3 Labor market institutions and social efficiency

In this Section we want to derive some analytical results about how institutional features of the labor market affect allocative efficiency in our model. The way to do it is to compare the first best allocation encoded in equations (32)-(33) with the competitive equilibrium encoded in equations (30)-(31) in which agents discount the presence of various LMIs. In this way we can study how such institutions affect labor demand and the aggregate allocative efficiency.[12] It is well-known from Hosios (1990) that in partial equilibrium and in absence of additional distortions besides search and matching frictions, the decentralized allocation is optimal if the worker's (firm's) bargaining

[12] We focus on allocative efficiency - instead of looking more directly at welfare - because our model is not suitable to analyze welfare implications stemming from insurance motives, given our assumption that agents pool resources and insure themselves against the risk of losing their job.

power is equal to the elasticity of the matching function to unemployment (vacancies).[13] Since our aim is to identify the specific contribution of LMIs to social efficiency, from now on we assume that the Hosios condition holds, implying $\varepsilon = 1 - \eta$.

As a first pass, in this Section we set firing costs to zero, since this enables us to derive clear-cut results on the efficiency effects of having unemployment benefits and trade union density in our model. In the next Section we will then re-introduce firing costs as a way to compensate some of the inefficiencies generated by the other two LMIs.

We will analyze, first, how LMIs alter the job creation margin (i.e the degree of labor market tightness θ) and, second, their effect on the job destruction margin ($\tilde{z}$). Let's then start by rewriting the equation characterizing the job creation margin in the decentralized equilibrium in its steady state version - equation (30) - and where we set $\gamma = 0$, while allowing for the presence of unemployment benefits and wage stickiness originated by unions:

$$\frac{c}{q(\theta^{dec})} = [1-(1-\varepsilon)(1-\Theta_w)](A+\bar{z}) + [1-(1-\varepsilon)(1-\Theta_w)]\beta(1-\delta)\left[H(\tilde{z}^{dec}) - \tilde{z}^{dec}\right]$$
$$-(1-\varepsilon)(1-\Theta_w)\beta c\theta^{dec} - (1-\Theta_w)\varepsilon b - \Theta_w w^* \quad (30')$$

By comparing equations (32) and (30') we notice that the Hosios condition is not sufficient to ensure efficiency when there are unemployment subsidies and wage rigidities. Let us first focus on unemployment benefits when wages can be fully renegotiated ($\Theta_w = 0$). In this case in the right hand side of equation (30') appears the additional term $-(\varepsilon b)$. For a given cost of posting a vacancy c, the only way to restore an equilibrium is to have a higher job filling rate (q_t) - and thus a looser labor market - in the left hand side. After some computations we find that, for any value of Θ_w, the net effect on the job creation margin is always negative:

$$\frac{\partial\theta^{dec}}{\partial b} = -\frac{(1-\Theta_w)\varepsilon f(\theta^{dec})}{c(1-\varepsilon)\left[1+\beta f(\theta^{dec})(1-\Theta_w)\right]} \leq 0 \quad (34)$$

Hence, unemployment subsidies reduce job creation below its optimal level ($\theta^{dec} < \theta^{opt}$). The intuition is that b raises the outside option of the worker and puts an upward pressure on wages, thus discouraging firms' from creating new jobs. On the other side, the subsidy does not increase the total resources available to the household because in general equilibrium it has to be financed by taxation. This represents an important difference with Hosios (1990) and subsequent works

[13] The so-called Hosios condition ensures that entry and exit externalities exactly balance each other.

which do not take into account general equilibrium effects.[14]

Turning to the impact of collective bargaining coverage (Θ_w), by taking the total derivative of equation (30') we find that its impact on job creation is positive. Once we replace the definition of w^*, we obtain:

$$\frac{\partial \theta^{dec}}{\partial \Theta_w} = \frac{f(\theta^{dec})\left\{\left[\bar{z} - H(\tilde{z}^{dec})\right] + \beta\,(1-\delta)\left[H(\tilde{z}^{dec}) - \tilde{z}^{dec}\right]\right\}}{c\,[1+\beta f(\theta^{dec}))(1-\Theta_w)]} \geq 0 \tag{35}$$

To understand the previous effect, consider the case where wages are fully rigid: in this case firms pay all workers the same wage w^*, corresponding to the Nash bargained wage for a worker with average productivity. This would allow firms to save on newly hired workers, who are more productive than the average incumbent worker, thus fostering job creation.

We now turn our attention to the job destruction margin, and examine how unemployment benefits and trade union density affect it when $\gamma = 0$ and the Hosios condition holds. We compare the threshold conditions for the decentralized and the first best allocation:

$$\bar{z} - \tilde{z}^{dec} = \frac{c}{[1-(1-\varepsilon)\,(1-\Theta_w)]\,q(\theta^{dec})} \tag{31'}$$

$$\bar{z} - \tilde{z}^{opt} = \frac{c}{\varepsilon q(\theta^{opt})} \tag{33'}$$

Let us first consider the effect of unemployment benefits: even though b does not show up in equation (31'), it has an indirect impact through job creation ($\theta^{dec} < \theta^{opt}$), lowering the right hand side of equation (31') below that of equation (33'). We can thus compute the overall effect of b on the job destruction threshold:

$$\frac{\partial \tilde{z}}{\partial b} = \frac{(1-\Theta_w)\varepsilon}{[1+\beta f(\theta^{dec})(1-\Theta_w)]} \geq 0 \tag{36}$$

It follows that in presence of unemployment benefits the job destruction cut-off is inefficiently high ($\tilde{z}^{dec} > \tilde{z}^{opt}$).

Finally, consider the impact of trade union density (Θ_w) on the job destruction threshold. On the one hand, the direct effect is positive, as Θ_w reduces the right hand side of equation (31'), implying a higher value of $\tilde{z}^{dec}$; on the other hand, the indirect impact is negative, because of the reduction in the job filling probability established in equation (35). After some computations we find that, all in all, the net effect is always positive:

[14]Indeed, if the government could run an infinite deficit, in absence of wage rigidities the social optimum and the decentralized condition would coincide.

$$\frac{\partial \tilde{z}}{\partial \Theta_w} = \frac{(1-\varepsilon)\left\{(\bar{z}-\tilde{z})\beta f(\theta^{dec})(1-\Theta_w) + [1-\beta(1-\delta)]\left[H(\tilde{z}^{dec}) - \tilde{z}^{dec}\right]\right\}}{[1-(1-\varepsilon)(1-\Theta_w)][1+\beta f(\theta^{dec})(1-\Theta_w)]} \geq 0 \tag{37}$$

This implies that a higher degree of wage rigidity increases job destruction because firms and workers have only limited ability to renegotiate wages.

In conclusion, unemployment benefits have an unambiguous negative impact on employment as they reduce job creation and increase job destruction. On the other side, trade union density determines a higher turnover by raising both job creation and job destruction. We summarize the previous discussion in Proposition 1:

Proposition 1 *In presence of positive unemployment benefits and/or wage rigidities, the so-called Hosios condition is not sufficient to ensure social efficiency for the decentralized economy. In particular,*

1. *Positive unemployment benefits determine a sub-optimal low level of job creation ($\theta^{dec} < \theta^{opt}$) and a sub-optimal high level of job destruction ($\tilde{z}^{dec} > \tilde{z}^{opt}$)*

2. *Wage rigidities determine a sub-optimal high level of both job creation and job destruction ($\theta^{dec} > \theta^{opt}$ and $\tilde{z}^{dec} > \tilde{z}^{opt}$)*

From this analysis we conclude that both unemployment benefits and wage stickiness determine a sub-optimal high level of job destruction, generating separations which are *socially inefficient*. As far as unemployment subsidies are concerned, the social inefficiency derives from the general equilibrium consideration that households need to refund the government the full amount spent for subsidizing the unemployed. Besides, the centralized wage bargaining structure generates separations that are also *privately inefficient* because they could be neutralized by appropriate side payments between the firm and the worker. In this case, the source of inefficiency derives firms taking firing decisions on the basis of their own surplus instead of the total one. Can employment protection be Pareto–improving in such a context? Firing restrictions help reducing excessive job destruction but may also hinder job creation; hence their effects seem *a priori* ambiguous. In the next Section we address this question.

4 Can firing costs restore efficiency in this economy?

In this Section we are going to re-introduce employment protection (i.e. firing costs) and investigate whether they could potentially be used to restore efficiency in an economy plagued by a sub-optimal level of employment stemming from the existence of unemployment subsidies and wage stickiness. Given that there are good reasons (not modeled in the present context) that justify the existence of subsidies for unemployed people and a key role for unions in the wage bargaining process, our objective is to find the optimal level of firing costs *conditional* on these other institutions; we label this notion of optimality, the *constrained optimal* level of firing costs.

We make progress on this issue in two ways: in the next sub-section we derive analytically the constrained optimal level of firing costs by solving a suitable Ramsey problem. In the following quantitative experiment, we put the model to work on a case study. We calibrate the model to replicate the labor market institutions prevailing in Italy before the sequence of structural reforms that were put in place to foster more labor market flexibility; we then use simulations to empirically reckon how big were the inefficiencies induced by LMIs in this Italian case.

4.1 The constrained optimal level of firing costs

To characterize the "second best" allocation, we solve the Ramsey problem of a social planner who takes into account the constraints due to agents' choices in the decentralized economy, which are affected by LMIs. Other papers like Arseneau and Chugh (2012) and Jung and Kuester (2015) find the second best allocation in an economy characterized by search and matching frictions, studying the optimal combination of payroll taxes, unemployment benefits and layoff taxes. Here we adopt a different approach: the planner cannot choose the optimal combination of LMIs, instead he takes as given the level of unemployment benefits and the degree of wage stickiness, choosing the best possible allocation that can be implemented only by changing γ. Formally:

$$
\begin{aligned}
\max_{\{\theta_t, u_t, \tilde{z}_t, \gamma\}_{t=0}^{\infty}} \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t) \\
\text{s.t.} \quad & C_t = n_{0t} \left(A_t + \bar{z} \right) + n_t \left[A_t + \frac{1}{1 - G(\tilde{z}_t)} \int_{\tilde{z}_t}^{\bar{z}} x g(x) dx \right] - c\theta_t u_{t-1} \\
& n_{0t} = f(\theta_t) u_{t-1} \\
& n_t = (1 - \phi) \left[1 - G(\tilde{z}_t) \right] \left(n_{0t-1} + n_{t-1} \right) \\
& 1 = u_t + n_{0t} + n_t \\
& f(\theta_t) = \Phi \theta_t^{\varepsilon} \\
& \frac{c}{q(\theta_t)} = \left[1 - \eta (1 - \Theta_w) \right] \left(\bar{z} - \tilde{z}_t \right) - \gamma \\
& J_t(\tilde{z}_t) - V_t + \gamma = 0
\end{aligned}
$$

Notice that the last two constraints reflect the optimal decisions taken by firms in the decentralized economy that are not taken into account when computing the first best allocation (see Section 3): one is the job creating condition and the other is the implicit definition of the job destruction cut-off (equations 28 and 29). The problem can be expressed in its primal form by considering the last two conditions jointly, so that we are able to replace the firing costs and maximize directly over the other choice variables.

By computing the planner's first order conditions and after some algebra, we get the following condition evaluated in steady state:

$$
\begin{aligned}
\frac{c}{q(\theta^{sec})} = & \left\{ 1 - \Psi \left[- \frac{\left\{ \left[1 - (1 - \varepsilon)(1 - \Theta_w) \right] \left[1 - \beta (1 - \phi) \right] - (1 - \varepsilon)(1 - \Theta_w) \beta f(\theta^{sec}) \right\}}{\left[1 - (1 - \varepsilon)(1 - \Theta_w) \right]} \gamma \right. \right. \\
& \left. \left. - \beta \theta^{sec} q\left(\theta^{sec}\right) \left(\bar{z} - \tilde{z}^{sec} \right) + \frac{\beta c \theta^{sec} + \Theta_w w_t^* + \varepsilon (1 - \Theta_w) b}{\left[1 - (1 - \varepsilon)(1 - \Theta_w) \right]} \right] \right\}^{-1} \times \\
& \left\{ \left[\varepsilon \left(A + \bar{z} \right) + \varepsilon \beta (1 - \delta) \left[H(\tilde{z}^{sec}) - \tilde{z}^{sec} \right] - (1 - \varepsilon) \beta c \theta^{sec} \right] + \left[\beta (1 - \delta) \frac{c}{q(\theta^{sec})} - \varepsilon \beta (1 - \delta) \left(\bar{z} - \tilde{z}^{sec} \right) \right] \right\}
\end{aligned} \tag{38}
$$

where *sec* denotes the second-best allocation, Ψ is a convolution of other terms[15] and we have imposed the Hosios condition ($\eta = 1 - \varepsilon$) to make more transparent the connection with the first-best allocation.

[15] $\Psi = \dfrac{(1 - \phi)(1 - u) g(\tilde{z})(1 - \varepsilon) \left\{ \left\{ \left[1 - (1 - \varepsilon)(1 - \Theta_w) \right] \left[1 - \beta(1 - \phi) \right] - (1 - \varepsilon)(1 - \Theta_w) \beta f(\theta) \right\} + (1 - \Theta_w) q(\theta) \theta \left(1 + \frac{\varepsilon q(\theta)}{c} \gamma \right) \right\}}{\left[\left\{ \left[1 - (1 - \varepsilon)(1 - \Theta_w) \right] \left[1 - \beta(1 - \phi) \right] - (1 - \varepsilon)(1 - \Theta_w) \beta f(\theta) \right\} - 1 + (1 - \delta) \right] u q(\theta) \theta \left[1 - (1 - \varepsilon)(1 - \Theta_w) \right]}.$

Notice that if the Ramsey planner had the possibility of attaining exactly the social planner's solution, equation (38) would revert to the first-best job creating condition (equation 32) when the term in first braces is equal to one. In fact when the economy is at the first best, the last term in the second braces is equal to zero by equation (33). We can thus get more intuition about the optimal level of firing costs by deriving the value of γ which makes the term in the first braces of equation (38) equal to one. After some algebra we obtain:

$$\begin{aligned}\gamma^* = &\frac{[1-(1-\varepsilon)(1-\Theta_w)]}{\{[1-(1-\varepsilon)(1-\Theta_w)][1-\beta(1-\phi)]-(1-\varepsilon)(1-\Theta_w)\beta f(\theta^{sec})\}}\times \\ &\left[\frac{\beta c\theta^{sec}+\Theta_w w^*+\varepsilon(1-\Theta_w)b}{1-(1-\varepsilon)(1-\Theta_w)}-\beta\theta^{sec}q(\theta^{sec})(\bar{z}-\tilde{z}^{sec})\right]\end{aligned} \tag{39}$$

Equation (39) gives the approximate optimal level of firing costs as a function of the other LMIs.[16] It can be shown that in absence of unemployment benefits and trade union density ($b = \Theta_w = 0$) the optimal level of γ is zero. Furthermore, by computing the partial derivatives we obtain the following

Proposition 2 *The optimal level of firing costs which implements the second-best allocation is:*

1. *equal to zero in absence of unemployment benefits and trade union density ($b = \Theta_w = 0$)*
2. *monotonically increasing in the amount of unemployment benefits b $\left(\frac{\partial\gamma^*}{\partial b} > 0\right)$*
3. *monotonically increasing in trade union density Θ_w $\left(\frac{\partial\gamma^*}{\partial\Theta_w} > 0\right)$*

We can thus conclude that firing costs can be used by the planner to correct for the inefficient separations induced by unemployment benefits and wage rigidities or, in other words, to reduce the excessive job destruction due to the presence of these two LMIs.

4.2 An application to the Italian labor market

In this section we apply the model to an empirical case study. Our application refers to Italy, a country which underwent a sequence of structural labor market reforms in the last 30 years. We identify three sub-periods based on the evolution of LMIs in Italy. The first sub-period corresponds to the decade 1985-1995, when virtually all contracts were open-ended and characterized by a high

[16]Notice that equation (39) represents one of the two solutions which make the term in the first braces of equation (38) equal to one. Another solution arises by imposing $\Psi = 0$, which however yields a negative value of firing costs. Since $\gamma \geq 0$ is the only plausible solution, we only consider that represented by (39).

level of firing costs. Hence these were the years of the single–contract, high EPR economy. The second sub-period goes from the mid-90s' until 2002, a transition period during which policymakers made a first step towards the liberalization of fixed-term contracts, although their use was still limited.[17] The third sub-period starts in 2003, when the so-called Biagi Law further liberalized the use of temporary contracts, and ends in 2012, when the Fornero reform reduced the protection of permanent jobs.[18] In the third sub-period the Italian economy was thus characterized by a dual labor market structure, with temporary contracts co-existing with highly protected permanent jobs.[19]

The first question we want to investigate is whether the single–contract/high EPR setting of the first sub-period was indeed inefficient and by how much. In the next Section we will further analyse the effects of the widespread adoption of temporary contracts, hence the dual labor market structure characterizing the third sub-period.

To answer the first question, we leverage on the analytical results presented before: having the first order conditions of the Ramsey planner, we can calibrate and simulate both the actual Italian economy as well as the counterfactual second best allocation implied by the constrained optimal level of firing costs that the Ramsey planner would choose. Furthermore, we can study how such optimal level vary with unemployment subsidies and trade union density. We now turn to the quantitative analysis.

4.2.1 Calibration

We discipline the model to match relevant targets for the Italian economy over the 1985-1995 decade. As previously explained, during these years the economy was characterized by strict employment protection and temporary contracts were almost non-existent, hence we avoid confounding effects due to their subsequent introduction. The calibration strategy is summarized in Table 1. We set the quarterly discount rate β to 0.97 to match an annual interest rate of 11.9% (OECD). Our second target is the average unemployment rate over the selected sub-period, equal to 9.4%. We target a job finding rate of 0.4, as in recent estimates by D'Amuri et al. (2021) for prime-age males, the group more attached to the labor market and closer to our definition of representative worker. Absent any firing costs, quits are assumed to account for 60% of total separations, as it emerges from the data of recent years (see Ministero del Lavoro e delle Politiche Sociali 2020), when restrictions

[17]The Treu Law (L. 196/97) was the first attempt to make the Italian labor market more flexible by introducing temporary contracts (or interim contracts) and changing regulations on fixed-term contracts.

[18]Here we refer to the Law n. 30/2003 (Biagi law) and Law n. 92/2012 (Fornero's labor market reform).

[19]For an overview of the last Italian labor market reforms see Pinelli et al. (2017).

have been largely lifted. Hiring costs are assumed to absorb 1% of output in steady state, as in Gertler and Trigari (2009) and Blanchard and Galí (2010).[20] By matching these targets we recover the matching efficiency, the vacancy posting costs, the exogenous separation rate and the bounds of the distribution of idiosyncratic productivity shocks, which are assumed to be drawn from a uniform distribution with mean zero, like in Mortensen and Pissarides (1994). To replicate a fully coherent Italian economy, these targets are matched together with the institutional parameters, to which we now turn. Unemployment benefits are set to match the out-of-work benefits as a share of labor income estimated by Luksic (2020) (0.04%), while Θ_w, the wage stickiness parameter, is set to 40%, the Italian trade union density back in time. Finally, we follow Garibaldi and Violante (2005) who estimated the tax component of the firing costs in Italy to be equal to 3.5 monthly wages and set γ accordingly to 1.2 times the average quarterly wage. Other parameters are taken from the literature. We assume equal bargaining power between workers and firms ($\eta = 0.5$) and impose that the Hosios condition holds ($\varepsilon = 1 - \eta = 0.5$) to focus on inefficiencies stemming from labor market institutions.

4.2.2 Simulations

In this Section we quantitatively assess how big are the inefficiencies induced by LMIs in the long-run. To do so, we compare the empirically relevant Italian case with the social optimum (first best allocation) and with a counterfactual second best allocation, which is achieved by setting firing costs at their constrained optimal level.[21] To explore how the decentralized economy deviates from the optimal allocation, in Figure 1 we plot how the steady states of the model vary as a function of the firing costs, keeping constant the other LMIs at their calibrated values for Italy.

As expected from the analytical results of Section 3, in the absence of firing restrictions the combination of unemployment benefits and trade union density which used to characterize the Italian labor market between the mid-'80s and the mid-'90s would trigger a high amount of inefficient separations and determine an unemployment rate above 30%. At the same time, consumption would be significantly lower than the efficient allocation. Therefore, a moderate amount of firing costs is Pareto-improving, as it mitigates the negative consequences of unemployment benefits and

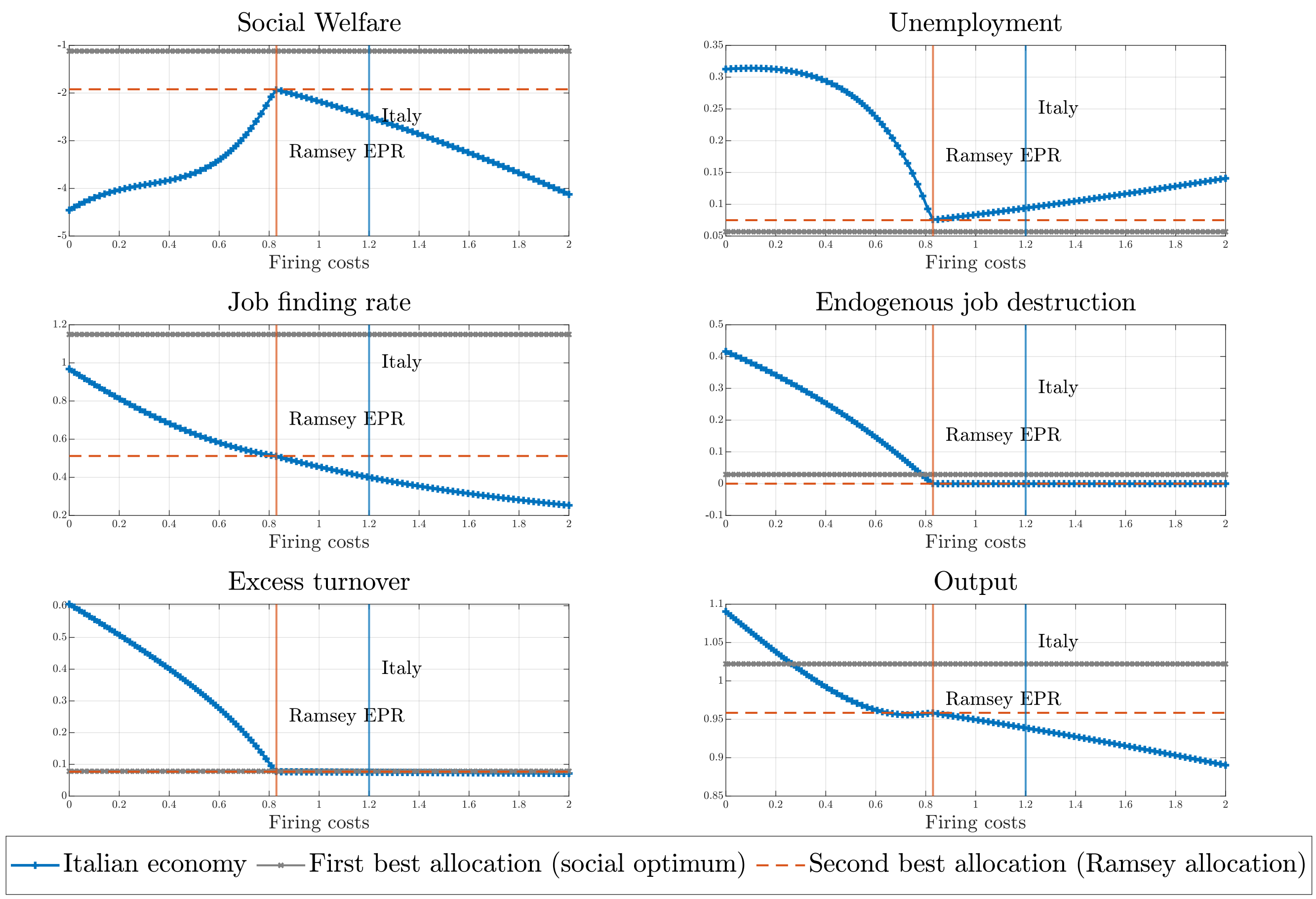
[20] We do not have evidence on the Italian labor market that could help us to pin down the hiring cost. Our results, however, are robust to a different calibration strategy where the vacancy posting cost is equal to 4.3% of the wage of the newly hired, as in Silva and Toledo (2009).

[21] The constrained optimal level of firing costs satisfies the first order conditions of the problem outlined in Section 4.1 if the optimal level of $\tilde{z}$ falls inside the boundaries of the productivity distribution. Instead, if the optimal job destruction threshold falls below the lower bound of the productivity distribution, our analytical results allow us to derive the optimal level of firing cost as the one which makes $\tilde{z} = \underline{z}$, thus minimizing inefficient job destruction.

Table 1: Calibration

	Parameter	Value	Source
Targeted moments			
Interest rate	-	11.9%	avg. annual interest rate (1985-1995)
Unemployment rate	u	9.4%	avg. unemployment rate (1985-1995)
Job finding rate	$f(\theta)$	0.4	D'Amuri et al. (2021)
Quits out of total separations	$\bar{s} = \phi/\delta$	60%	Comunicazioni Obbligatorie
Hiring costs as % of GDP	$\bar{h} = cn_0/Y$	1%	Blanchard and Galí (2010)
Parameters implied by targets			
Discount rate	β	0.97	
Matching efficiency	Φ	0.58	
Bound of the prod. distr.	$\bar{z}$	0.87	
Exogenous separation rate	ϕ	0.04	
Vacancy posting cost	c	0.25	
Institutional parameters			
Benefits over labor income	$\frac{bu}{w(1-u)}$	0.04	Luksic (2020)
Trade union density	Θ_w	40%	OECD
Firing cost as fraction of avg. perm wage	γ/w	1.2	Garibaldi and Violante (2005)
Calibrated parameters			
Elasticity of matching function	ε	0.5	
Workers' bargaining power	η	0.5	Petrongolo and Pissarides (2001)

Figure 1: Long-run effects of firing costs

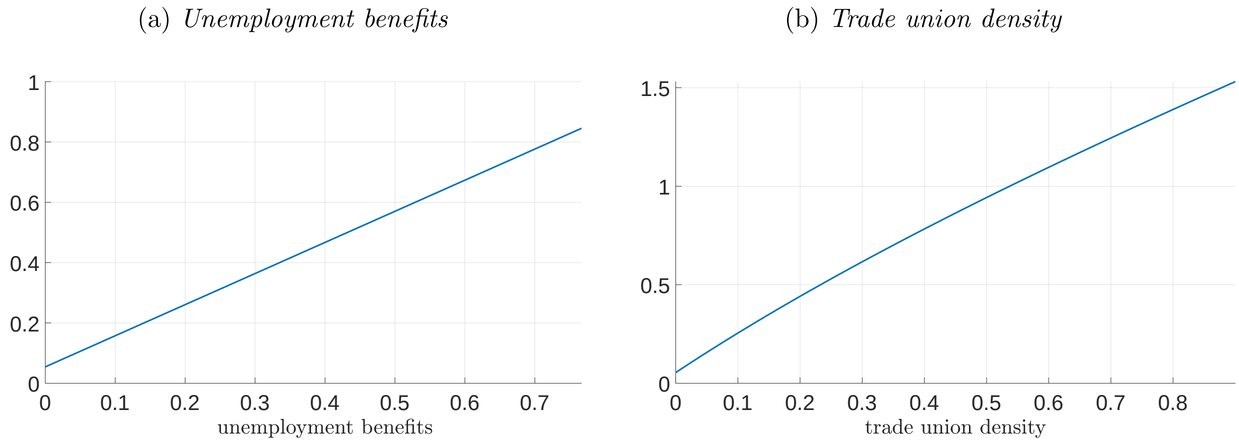


wage stickiness by reducing inefficient job destruction and unemployment. We find that the Ramsey planner would optimally choose a level of firing costs roughly equal to 2.5 monthly wages (0.83 at quarterly frequency). The stricter firing restrictions estimated by Garibaldi and Violante (2005) and faced by the decentralized economy (3.5 monthly wages) generate a sizeable consumption loss (1.7%) compared with the Ramsey allocation (30% loss in terms of social welfare). The consumption loss is even larger when the decentralized allocation is confronted to the first best (about 4%; more than 100% in terms of social welfare). Indeed the Ramsey planner is not able to fully restore efficiency: he sets the only available instrument (firing costs) to the level minimizing endogenous (inefficient) job destruction; excess turnover and unemployment are also minimized, the latter at 7.5%. Beyond the optimal level, firing costs become inefficient because they exhaust their beneficial impact on job destruction whereas they still have a negative effect on job creation, as we can infer from the reduction in the job finding rate. We can also notice that, as layoff taxes increase, output decreases. In the region where firing costs lie below the optimal level, the drop in output occurs notwithstanding the increase in employment because firms fire less workers, keeping also the less productive ones. For firing costs above the level chosen by the Ramsey planner, overall production is instead curtailed by the worse labor market performance.

Figure 2 shows graphically the intuition already provided in Sections 3 and 4.1: the constrained optimal level of EPR, i.e. the one chosen by a Ramsey planner endowed only with this instrument, is increasing in unemployment benefits (panel a) and in wage stickiness (panel b), as it reduces the inefficient separations generated by these two institutions.

Our results have relevant policy implications. First, they lend support to the view that labor market reforms should be designed as broad packages, taking into account the multiple interactions among LMIs. Indeed our findings always regard a *constrained* optimal level of EPR, highlighting its dependence on the presence of other institutions affecting firms' decisions. Crucially, the optimal level of EPR is increasing in the number of inefficient separations, which are determined by the downward real wage rigidity induced by some features of the labor market and the related legislation. Second, economies characterized by a high level of firing restrictions can achieve significant gains in efficiency through a reduction in EPR.

Figure 2: Optimal firing costs



In panel a) wages the wage rigidity parameter is set at its benchmark value ($\Theta_w = 0.4$); in panel b) unemployment benefits are at their benchmark level ($b = 0.37$).

5 Can temporary contracts restore efficiency when EPR is too high?

In the previous Section we showed that a too high level of EPR may cause significant welfare losses. In the late '90s southern European countries like Italy and Spain were characterized by restrictive regulations on regular contracts (RCs henceforth) which were deemed responsible of the relatively high unemployment rate. However, reducing EPR was politically unfeasible because of the opposition of the majority of workers holding a RC and enjoying high levels of protection. To overcome this issue, policy makers implemented labor market reforms that liberalized the use of temporary contracts (TCs henceforth) - originally limited to categories like seasonal workers and replacement of absentees - with the aim of introducing flexibility at the margin. As a consequence the labor markets of these countries assumed a “dual”structure, with part of the workers holding a RC and others a TC.

In light of the previous results on the efficiency of EPR some questions arise: “Can the introduction of temporary contracts restore efficiency when EPR is too high?”And if so, “what is the constrained optimal level of duality?”. In this Section we answer these questions by introducing TCs in the previous setting. In this extended model employment protection is twofold: on the one hand, as before, EPR denotes the firing restrictions on RCs which are instead absent on temporary ones; on the other hand employment protection on temporary contracts (EPT onward) represents restrictions in the creation and in the use of this type of jobs. Analysing the Ramsey problem in such a dual setting is beyond the scope if this paper. However we will answer the question about the constrained optimal level of duality be means of simulations.

5.1 The extended model

We model this dual economy by assuming a segmentation along the entry of firms in the labor market, with a novel setup that we label *one-sided directed search.* On the firms' side search is directed because they choose whether to post a temporary or a regular vacancy; on the other side search is instead undirected, as unemployed workers look for jobs in both markets. Within each market, meetings occur randomly. Since time is discrete, we take into account the possibility that workers receive both a regular and a temporary job offer in the same period. In this case, the job seeker always prefers the RC, which offers a higher wage and more protection. Therefore, in our model RCs and TCs co-exist both in the stock of incumbent matches and among new hires. This is a distinctive feature of our setup, since lot of papers (Cahuc and Postel-Vinay 2002, Sala, Silva, and Toledo 2012 among others) just assume that firms always prefer TCs, so that all new hires are stipulated as temporary if the policy maker does not impose any limit. A notable exception is represented by Garibaldi and Violante (2005), who assume that both firms and workers self-select in the two markets, thus significantly raising the model complexity and making strong assumptions to guarantee the existence of a unique equilibrium. We instead endogenize the share of temporary new matches in a simple way, as the firms' choice only depends on the different costs of posting a vacancy and on the relative tightness of the two markets. Moreover, our framework is consistent with the fact that, on the one side, jobs advertised by firms are characterized by a description including the type of contract and, on the other hand, job seekers usually apply to different kind of jobs (Belot, Kircher, and Muller 2018).

By denoting with a superscript 'T' ('P') all the variables related to TCs (RCs), we notice that there are spillovers from the market of regular jobs to the one of TCs, because the matching rate for RCs affects the meeting rate of the other type of vacancies:

$$\chi_t^T = f_t^T(1 - f_t^P) \tag{40}$$

$$\xi_t^T = q_t^T(1 - f_t^P) \tag{41}$$

where the job finding rate and the job filling rate for TCs (f^T and q^T, respectively) are multiplied by $(1 - f^P)$, which is the probability that a workers does not find a regular job in the same period.

Hence, the job creating condition for a permanent job is like that we derived in the single market model whereas the job creating condition for temporary jobs is:

$$\frac{c^T}{\xi_t^T\left(\theta_t^T\right)} = J_t^T(\bar{z}) \tag{42}$$

Like in the standard setup firms equate the real cost of posting a vacancy to the expected value of the new job. Notice that, despite preferring TCs which are not subject to firing restrictions, for firms it is optimal to post at least some jobs as regular to avoid congestion in the temporary market. As more jobs are posted as temporary, the probability of filling this type of vacancy decreases, hence raising the real cost represented by the left hand side of equation (42). Hence, the endogenous segmentation of firms in the two markets is driven by the trade-off between the ex-ante benefits of a quick search and the ex-post cost of firing. From the workers' point of view the value of unemployment is modified as follows:

$$U_t = b + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left[\chi_{t+1}^T W_{0t+1}^T + f_{t+1}^P W_{0t+1}^P - (1-\chi_{t+1}^T - f_{t+1}^P)U_{t+1}\right] \tag{43}$$

Once the match is formed, the value function of RCs remain unaffected, whereas the new value function for temporary jobs is:

$$J_t^T(z_{it}) = y_t(A_t, z_{it}) - w_t^T(A_t, z_{it}) + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left\{(1-\phi)\begin{bmatrix} \iota\int_{\tilde{z}_{t+1}^C}^{\bar{z}} J_{t+1}^P(z')dG(z') \\ +(1-\iota)\left[\int_{\tilde{z}_{t+1}^T}^{\bar{z}} J_{t+1}^T(z')dG(z') - G(\tilde{z}_{t+1}^T)\gamma^T\right]\end{bmatrix}\right\} \tag{44}$$

Let us examine the continuation value of equation (44). The match which does not break for exogenous reasons (which happens with probability ϕ), is subject to an exogenous expiration probability ι. If the contract expires the firms chooses whether to convert it into a permanent one or to let the worker go. With probability $1-\iota$ the contract does not expire and the firm chooses whether to renew it as an incumbent TC or to fire the worker at no cost (our benchmark setup postulates $\gamma^T = 0$). Conversions and renewals depend on the realization of idiosyncratic productivities with respect to their relative thresholds. The cut-off for conversion ($\tilde{z}^C$) and the one applying to renewals

$(\tilde{z}^T)$ satisfy the following conditions:

$$S_t^F(\tilde{z}_t^C) = J_{0t}^P(z_{it}) - V_t = 0 \tag{45}$$
$$S_t^F(\tilde{z}_t^T) = J_t^T(z_{it}) - V_t + \gamma^T = 0 \tag{46}$$

Notice that firing costs γ^P do not show up in the derivation of the job conversion threshold in equation (45), as the choice of not converting the temporary contract does not imply any penalty. The value function for temporary workers is defined in the same vein as for firms:

$$W_t^T(z_{it}) = w_t^T(A_t, z_{it}) + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left\{(1-\phi)\begin{bmatrix} \iota\int_{\tilde{z}_{t+1}^C}^{\bar{z}} W_{t+1}^P(z')dG(z') \\ +(1-\iota)\left[\int_{\tilde{z}_{t+1}^T}^{\bar{z}} W_{t+1}^T(z')dG(z')\right] \\ +\left[\iota G(\tilde{z}_{t+1}^C) + (1-\iota)G(\tilde{z}_{t+1}^T)\right]U_{t+1}\end{bmatrix} + \phi U_{t+1}\right\} \tag{47}$$

Like for permanent jobs, newly hired temporary workers are characterized by the maximum idiosyncratic productivity $\bar{z}$. The Nash bargained wage for temporary workers is:

$$w_t^{nT}(z_{it}) = (1-\eta)b + \eta\begin{bmatrix} y_t(z_{it}) + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left(c^P\theta_{t+1}^P + c^T\theta_{t+1}^T\right) - \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\zeta_{t+1}\gamma^P + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}f_{t+1}^P\gamma^P \\ +\left[1 - \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left[(1-\phi)(1-\iota) - \chi_{t+1}^T\right]\right]\gamma^T\end{bmatrix} \tag{48}$$

Since the worker's outside option is now determined by equation (43) we obtain a new definition of bargained wages for both newly hired workers and incumbent RCs:

$$w_t^{nP}(z_{it}) = (1-\eta)b + \eta\begin{bmatrix} y_t(z_{it}) + \left(1 - \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}(1-\phi-f_{t+1}^P)\right)\gamma^P + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\chi_{t+1}^T\gamma^T \\ +\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left(c^P\theta_{t+1}^P + c^T\theta_{t+1}^T\right)\end{bmatrix} \tag{49}$$

The bargained wage for newly hired workers is evaluated at $\bar{z}$. Finally, effective wages, which depend on the degree of centralized bargaining, are:

$$w_t^P(z_{it}) = (1-\Theta_w^P)w_t^{nP}(z_{it}) + \Theta_w^P w_t^{P*}$$
$$w_t^T(z_{it}) = (1-\Theta_w^T)w_t^{nT}(z_{it}) + \Theta_w^T w_t^{T*}$$
$$w_{0t}^P(\bar{z}) = (1-\Theta_w^P)w_{0t}^{nP}(\bar{z}) + \Theta_w^P w_t^{P*}$$
$$w_{0t}^T(\bar{z}) = (1-\Theta_w^T)w_{0t}^{nT}(\bar{z}) + \Theta_w^T w_t^{T*}$$

As explained before, in our basic scenario we assume no firing costs for temporary workers ($\gamma^T = 0$) and that wage rigidity only applies to RCs ($0 \leq \Theta_w^P \leq 1$), as temporary workers are often less unionized than permanent ones ($\Theta_w^T = 0$). Firing restriction on regular jobs continue to apply ($\gamma^P \geq 0$).

By following the same steps as in the single-contract economy, we can compute the new job destruction thresholds for permanent and temporary workers, respectively:

$$
\begin{aligned}
&\left[1-\eta\left(1-\Theta_w^P\right)\right]\left(A_t+\tilde{z}_t^P\right)+\left[1-\eta\left(1-\Theta_w^P\right)\right]\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left(1-\delta_{t+1}^P\right)\left[H(\tilde{z}_{t+1}^P)-\tilde{z}_{t+1}^P\right] \\
&-\Theta_w^P w_t^{P*}-(1-\eta)(1-\Theta_w^P)b-\eta(1-\Theta_w^P)\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left(c^P\theta_{t+1}^P+c^T\theta_{t+1}^T\right) \\
&+\left[1-\eta(1-\Theta_w^P)\right]\left[1-\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}(1-\phi)\right]\gamma^P-\eta(1-\Theta_w^P)\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}f_{t+1}^P\gamma^P-\eta(1-\Theta_w^P)\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\chi_{t+1}^T\gamma^T=0
\end{aligned}
$$

$$
\begin{aligned}
&\left[1-\eta\left(1-\Theta_w^T\right)\right]\left(A_t+\tilde{z}_t^T\right)+\left[1-\eta\left(1-\Theta_w^T\right)\right]\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left(1-\delta_{t+1}^T-\zeta_{t+1}\right)\left[H(\tilde{z}_{t+1}^T)-\tilde{z}_{t+1}^T\right] \\
&+\left[1-\eta\left(1-\Theta_w^P\right)\right]\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\zeta_{t+1}\left[H(\tilde{z}_{t+1}^C)-\tilde{z}_{t+1}^C\right]+\eta\left(1-\Theta_w^T\right)\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\zeta_{t+1}\gamma^P-\eta(1-\Theta_w^T)\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}f_{t+1}^P\gamma^P \\
&-\Theta_w^T w_t^*-(1-\eta)(1-\Theta_w^T)b-\eta(1-\Theta_w^T)\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\left(c^P\theta_{t+1}^P+c^T\theta_{t+1}^T\right) \\
&+\left[1-\eta(1-\Theta_w^T)\right]\left[1-\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}(1-\phi)(1-\iota)\right]\gamma^T-\eta(1-\Theta_w^T)\mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\chi_{t+1}^T\gamma^T=0
\end{aligned}
$$

It is useful to notice that by combining equations (29) and (45) we can find the relationship between the conversion and permanents cut-offs:

$$\tilde{z}_t^C = \tilde{z}_t^P + \frac{\gamma^P}{\left[1-\eta\left(1-\Theta_w^P\right)\right]}$$

Then, we can rewrite the job creating condition for a temporary worker as:

$$\frac{c^T}{\xi_t^T} = \left[1-\eta\left(1-\Theta_w^T\right)\right]\left(\bar{z}-\tilde{z}_t^T\right)-\gamma^T$$

Finally, we need to modify the law of motions for the different categories of workers:

$$1 = n_{0t}^T + n_t^T + n_{0t}^P + n_t^P + u_t$$
$$n_{0t}^T = \chi_t^T u_{t-1}$$
$$n_{0t}^P = f_t^P u_{t-1} + \zeta_t \left(n_{0t-1}^T + n_{t-1}^T \right)$$
$$n_t^T = (1 - \delta_t^T - \zeta_t)(n_{0t-1}^T + n_{t-1}^T)$$
$$n_t^P = (1 - \delta_t^P)(n_{0t-1}^P + n_{t-1}^P)$$

where $\zeta_t = (1-\phi)\iota \left[1 - G(\tilde{z}_t^C)\right]$ is the conversion rate and δ^T and δ^P represent the overall separation rates for TCs and RCs respectively, defined as follows: $\delta_t^T = \phi + (1-\phi)\left[\iota G(\tilde{z}_t^C) + (1-\iota)G(\tilde{z}_t^T)\right]$ and $\delta_t^P = \phi + (1-\phi)G(\tilde{z}_t^P)$. Notice that if TCs have limited length ($\iota > 0$) their separation rate is higher than the one for RCs even if the exogenous quit rate ϕ does not depend on the contract type.

5.2 Quantitative analysis

In this Section we simulate the introduction of temporary contracts in an economy where firing costs are inefficiently high, as the Italian one studied in Section 4.2. Our starting point is thus represented by the blue vertical line in Figure 1. The extended model requires to calibrate two additional parameters: c^T, the cost of creating a vacancy for a temporary job, and ι, the expiration rate. The latter is the inverse of the maximum duration of a temporary job. We set c^T and ι to match an average share of TCs equal to 12.6% and the transition rate from a temporary job to unemployment equal to 0.29. These are the average values in Italy over the third sub-period identified in Section 4.2, hence over the years 2003-2012, characterized by a dual labor market.[22]. The implied c^T turns out to be 1.6 times larger than the cost of posting a vacancy for a permanent job[23] and ι is set to 0.083, corresponding to a maximum duration of 12 quarters.[24] In our benchmark extended model, TCs are characterized by the absence of firing costs ($\gamma^T = 0$) and fully flexible wages ($\Theta_w^T = 0$); in our last analysis we investigate the relative importance of these two features. By simulating our extended model we can thus ask two questions: i) Should policymakers foster

[22] We do not consider the second sub-period (1996-2002) because fixed-term contracts were partially liberalized but their use was still subject to many restrictions. Regarding our calibration targets, the share of TCs over total employment is taken from the OECD and the transition rate from a temporary job to unemployment from the Italian Labor Force Survey.

[23] The implied value of c^T is 0.4.

[24] In this extended model we can always reproduce the single-contract economy by setting the cost of a temporary vacancy so high that (almost) all jobs are permanent.

the reliance on temporary contracts when firing costs are inefficiently high and difficult to reduce? ii) What is the optimal level of EPT?

To answer these questions, we investigate how the performance of the economy evolves as the employment protection on temporary contracts gets stricter, in the same spirit of the exercise conducted in Section 4.2.2. In this case, however, EPT has two dimensions. On the one side c^T/c^P – the relative cost of creating a temporary versus a permanent job – captures limitations in the use of TCs, such as the justification that firms should provide for using such contracts. On the other hand, ι – the expiration rate – is tightly linked to the maximum number of renewals, which is usually limited to avoid abuses in the use of TCs.[25] Therefore, we should assess the economic performance by considering the joint distribution of social welfare along both dimensions. To ease interpretation, however, we start by examining each aspect separately, by fixing the other parameter to the benchmark Italian calibration.

Figures 3-4 represent the evolution of the variables of interests as the cost of creating a TC increases and ι is fixed at its benchmark value; Figures 5-6 reproduce the same plot for increasing values of the expiration rate, holding constant c^T. Hence in all figures higher values of either c^T/c^P or ι correspond to a stricter EPT, which affects the outcomes of the Italian economy with a dual labor market (black line). We compare these outcomes with the single-contract Italian economy with high firing costs (blue line) – our starting point – and with a counterfactual single-contract economy where firing costs are set at the optimal level derived in Section 4.2.2 (orange line); the blue and the orange lines do not vary with EPT because TCs are not used. The scenario represented by the orange line corresponds to the alternative measure that policymakers could have adopted instead of introducing flexibility at the margin through TCs.

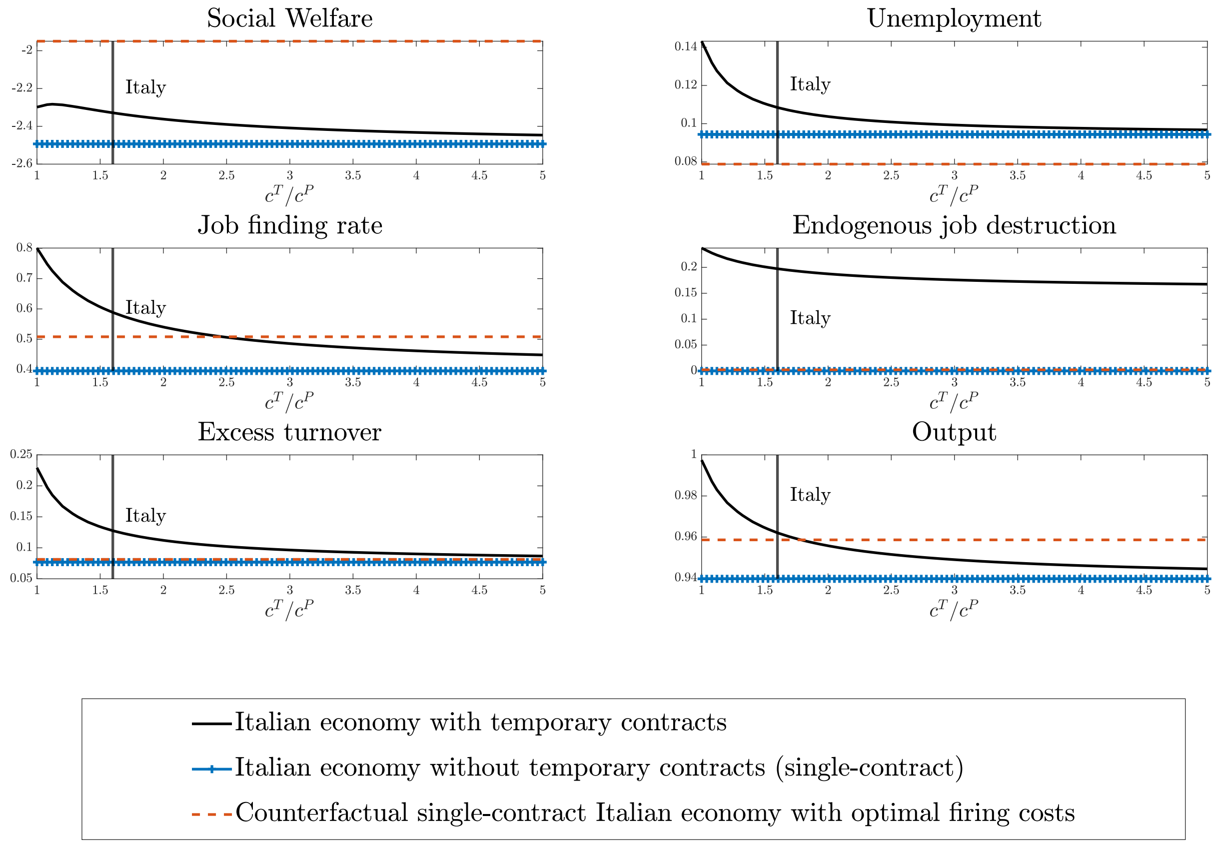
To answer the first question – whether the introduction of TCs is welfare improving – we compare the blue line with the black one. We find that introducing TCs increases social welfare and closes around one fourth of the gap between the decentralized single-contract economy (blue line) and the optimal EPR policy (orange line).[26]

To answer the second question – what is the optimal level of regulation – we should look at how the black line varies with EPT. We find that social welfare is maximized when TCs are almost fully

[25] Although we do not explicitly model a restriction on the maximum number of renewals, these are endogenously limited by the structure of the model: since the productivity of the match changes every quarter, temporary contracts cannot be extended more than four times a year. Moreover, the higher is ι the higher is the probability that temporary contracts expire and firms cannot renew them (because they are forced either to convert them to permanent or to severe the match).

[26] Tejada (2017) shows that temporary contracts increase labor market flexibility and generate welfare gains as labor protection becomes more tight.

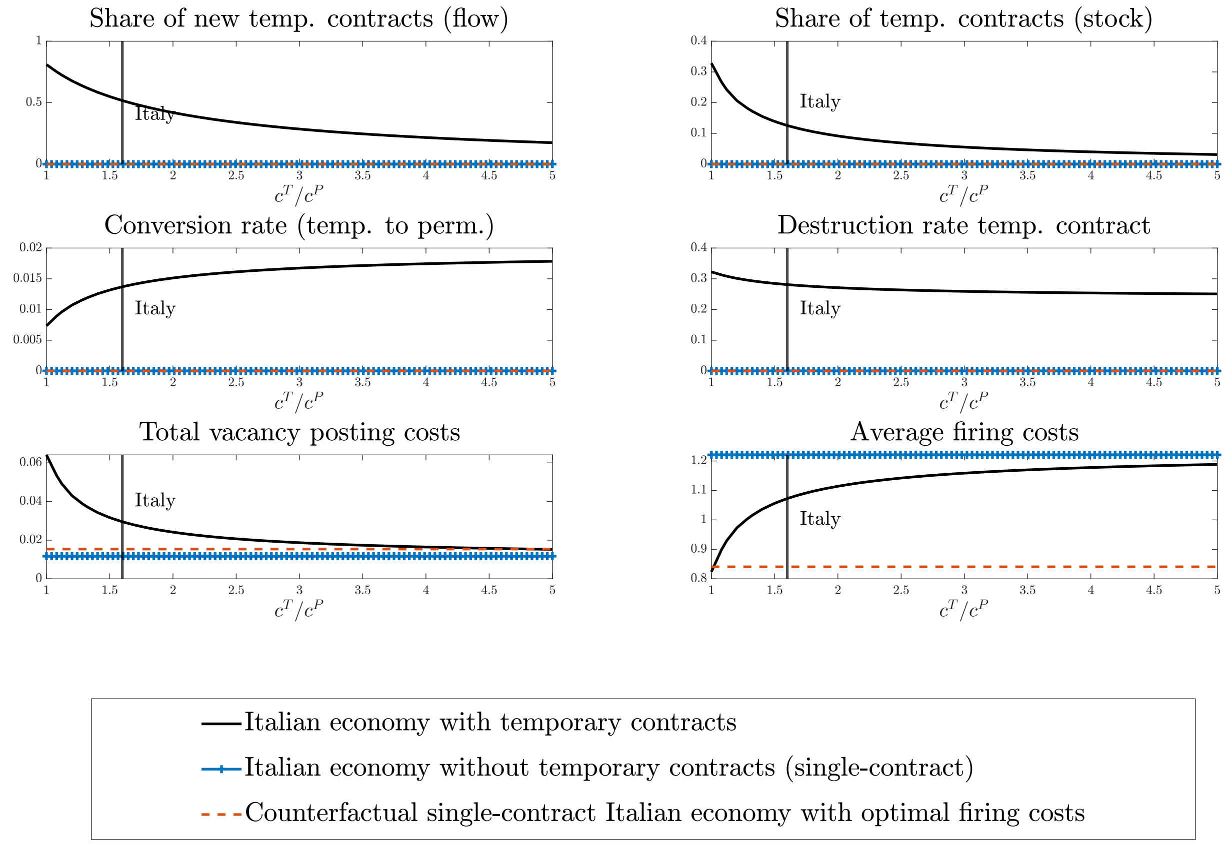
Figure 3: Long-run effects of the cost of creating a temporary job (1)



liberalized, hence when there are no limits to their duration ($\iota = 0$; Figure 5) and when the cost of posting a vacancy for a temporary job is only slightly higher than the cost of creating a regular job ($c^T/c^P = 1.1$; Figure 3). Notice that social welfare is a function of consumption and the latter is given by output minus vacancy costs. Hence the small increase in social welfare as c^T/c^P goes from 1 to 1.1 is due to a faster reduction in vacancy costs (Figure 4) compared to output (Figure 3); beyond that level, however, the drop in output more than offsets that in vacancy costs. As EPT gets stricter, with higher values of either c^T/c^P or ι, TCs become less convenient and their share in the flow of new matches declines. For this reason and because of the increased rate of conversion, also the share of TCs in the stock of existing jobs reduces.

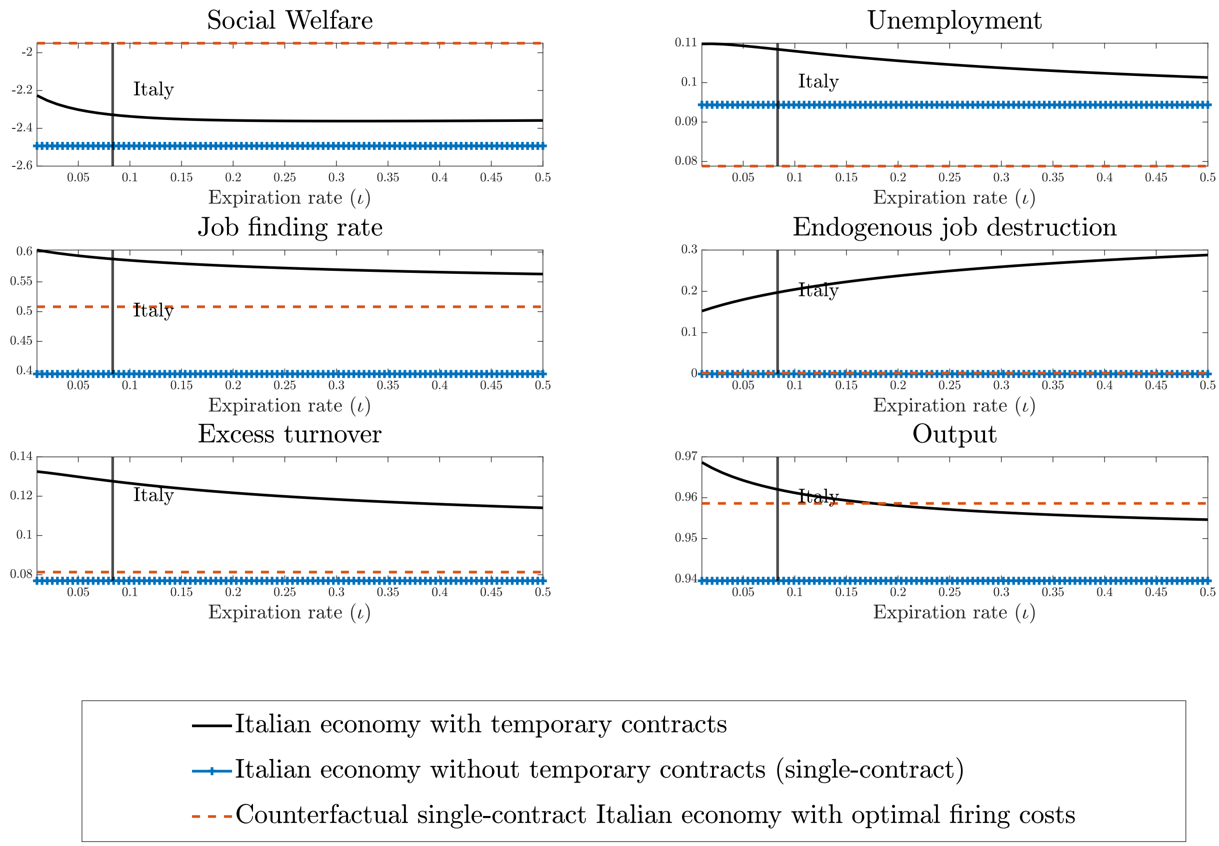
Notice that the Italian economy with a dual labor market is very different compared to both the decentralized and the second best single-contract allocations, despite being characterized by

Figure 4: Long-run effects of the cost of creating a temporary job (2)



an intermediate level of social welfare. The introduction of TCs induces high levels of turnover, as the majority of them is used to substitute for RCs rather than as an intermediate step towards permanent employment. In principle, the remarkable increase in turnover induced by the introduction of TCs could be mitigated by lower expiration rates, which allow firms to keep temporary workers for a longer period of time. However our simulations show that, at the aggregate level, this mitigating effect on the intensive margin (i.e. at the contract level) is dominated by the impact on the extensive margin, as reducing ι induces firms to stipulate more TCs (Figure 6). Hence, low levels of both c^T and ι generate high unemployment, which is however compensated by higher job finding rates. Moreover, low expiration rates are almost mechanically associated to lower destruction probabilities, as firms could renew TCs many times, whereas low levels of c^T/c^P determine slightly higher destruction rates because firms takes advantage of the low cost of posting vacancies

Figure 5: Long-run effects of the temporary contract's expiration rate (1)

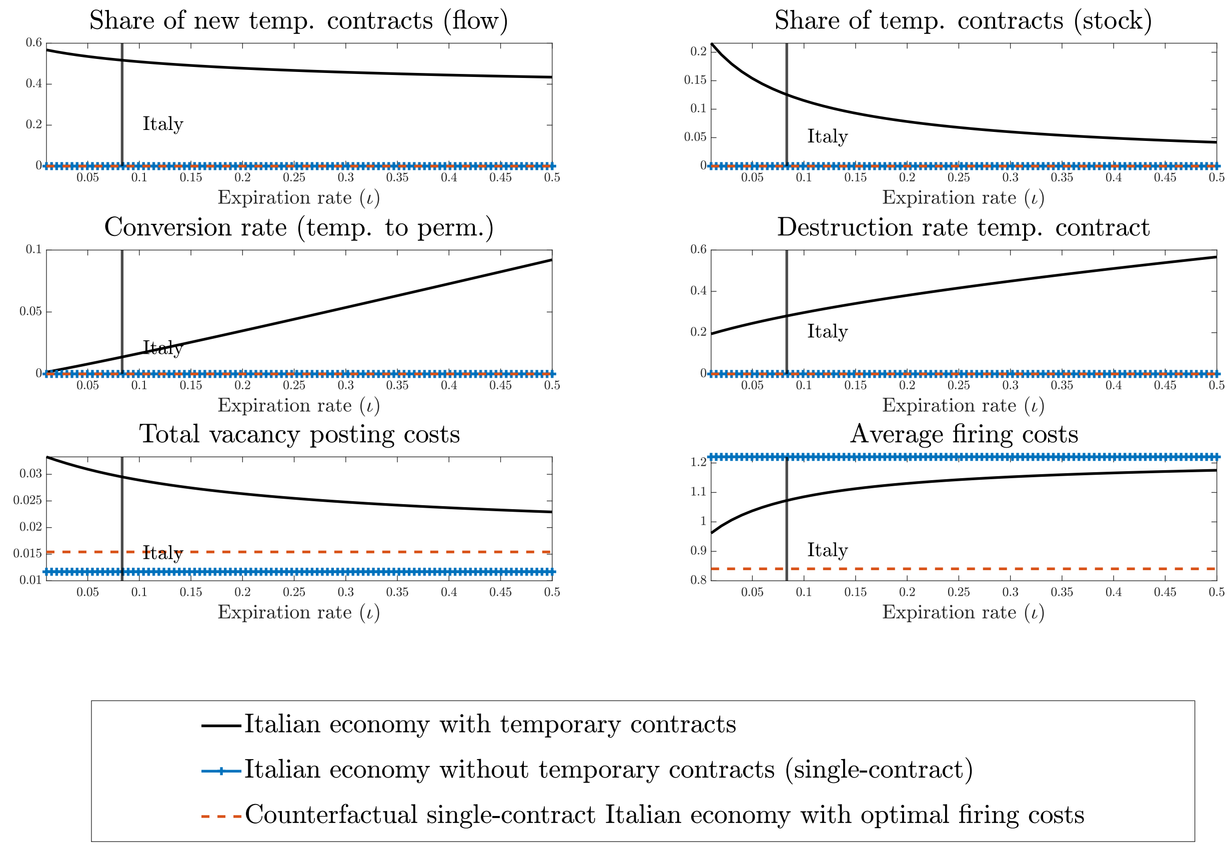


and rise the productivity threshold for renewals.

Overall, the dual labor market structure implied by the introduction of TCs presents pros and cons. On the positive side, higher turnover enhances productivity, because in our setting newly hired workers are more productive than incumbent ones; for this reason output and social welfare increase. On the negative side, excess turnover translates into higher unemployment and higher vacancy costs, subtracting resources to consumption.[27] All results hold when considering the joint distribution of c^T/c^P and ι (Figure A.1 in the Appendix). To sum up, our results show that: i) in

[27]Tealdi (2019) finds that high rates of turnover associated with temporary contracts offset the benefits (for incumbents) due to the increase of the labor market flexibility. Moreover, as shown by Cappellari, Dell'Aringa, and Leonardi (2012), not all reforms of temporary employment have been successful in Italy: the reform of apprenticeship contracts increased job turnover with an overall productivity-enhancing effect whereas that fixed-term contracts generated productivity losses.

Figure 6: Long-run effects of the temporary contract's expiration rate (2)



terms of efficiency, the reliance on temporary contracts is only a partial substitute of an alternative reform reducing inefficiently high firing costs; for the Italian economy our results show that the introduction of TCs allowed to close only one fourth of the gap between the decentralized single-contract economy and the optimal EPR policy; ii) the degree of EPT has relevant implications for economic outcomes; while our results call for low levels of EPT, the high level of unemployment determined by unregulated recourse to TCs could have adverse consequences not modelled in the present framework, like hysteresis effects and loss of human capital.

Lastly, we investigate what features of TCs are responsible for the improved economic performance. In particular, TCs differ from RCs along two dimensions: they do not have firing costs and wages are fully flexible. Therefore, to assess their importance for our findings, we let them vary between zero (our benchmark) and the value taken by the corresponding parameters for RCs.

Figure 7 describes how the variables of interest evolve as TCs' firing costs (γ^T) and trade union density (Θ_w^T) approach the corresponding values for RCs, with darker colors standing for higher values; our benchmark case is thus represented by the lower left corner, where both parameters are set to zero.[28] Social welfare reaches its maximum when wages are fully flexible and firing costs are slightly positive. This finding reminds of our analytical results on the link between optimal firing costs and other LMIs: indeed, also for TCs the welfare-maximizing level of γ^T is positive due to the presence of unemployment benefits and it increases with the degree of wage stickiness. Compared to our benchmark setup, increasing γ^T to γ^P while keeping wages fully flexible (i.e. moving from the lower left corner to the upper left corner of Figure 7) would decrease welfare by 6.3%; on the other hand, by increasing wage rigidity without raising firing costs (i.e moving towards the lower right corner) social welfare would drop even below its level in the inefficient single-contract economy. However, with rigid wages and γ^T roughly half of γ^P, the drop in social welfare compared to the benchmark dual labor market reduces to 3.3%. Overall, these results reinforce our main point that the impact and the optimality of firing costs depend on the other LMIs; in particular, both wage flexibility and firing costs are important features of TCs and they should be considered jointly in order to foresee their economic impact.[29]

6 Conclusions

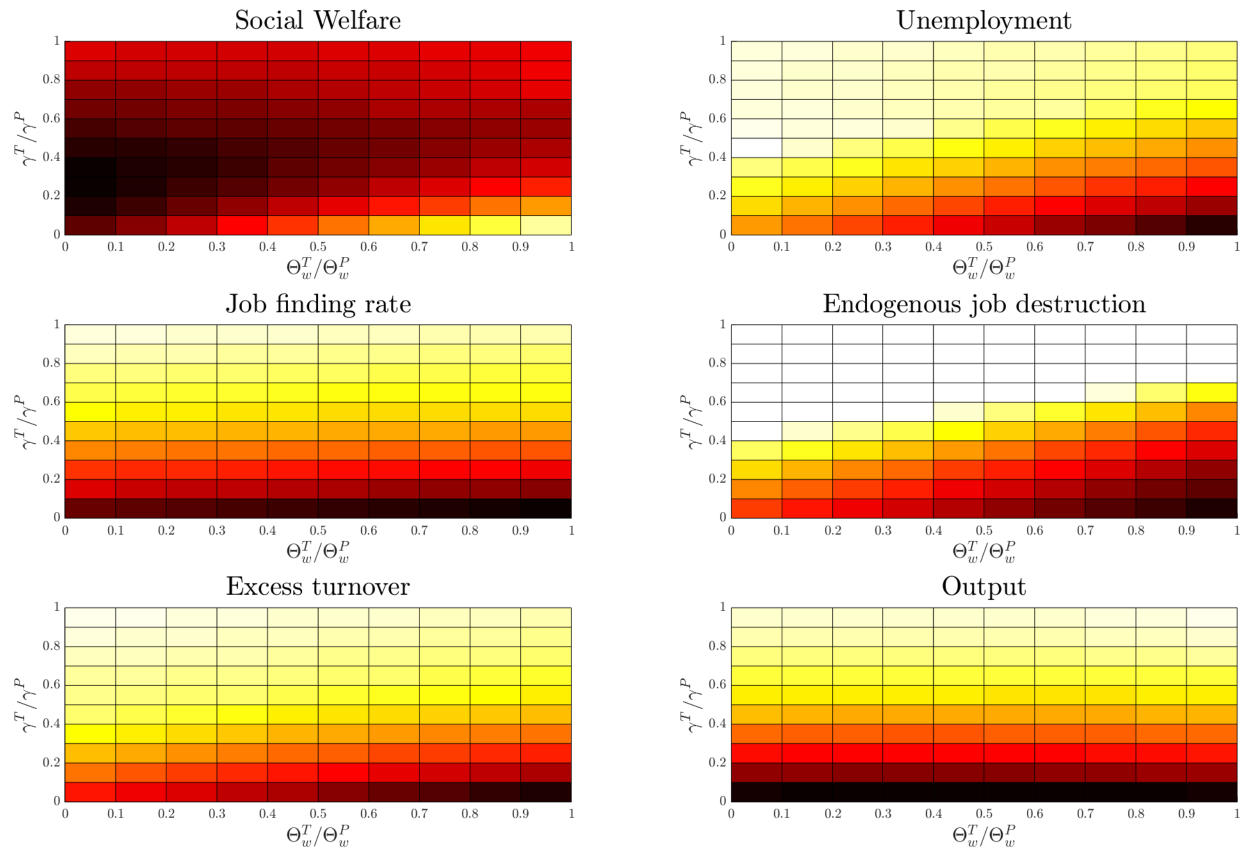
We revisit the macroeconomic effects of employment protection in a general equilibrium framework that allows for non-trivial interactions with others labor market institutions. In particular, we focus on trade union bargaining and unemployment subsidies as they are the most related to the job destruction margin, the one which is also directly affected by firing costs. Inefficient separations determined by such institutions provide a rationale for the use of firing costs as a way to restore efficiency. When firing costs are too high, however, they end up generating sizable welfare losses. Because of political difficulties in reducing job security on regular contracts, Italy, France and Spain have allowed a widespread adoption of temporary contracts. In our model such a policy is welfare improving but the gains are about four times smaller than one would obtain by reducing layoff taxes to their optimal level.

From a positive perspective our model, by highlighting the non-monotonic effects of firing costs, explains why some policies may be effective in some countries and not in others, depending

[28]See Figure A.2 in the Appendix for the 3D representation.

[29]Analogous considerations apply when considering an economy where c^T/c^P and ι are set to their optimal values. Results are available upon request.

Figure 7: Long-run effects the temporary contract's firing costs and wage stickiness



on the starting point and on the overall institutional context. On a normative side, we view our contribution as a useful tool for policymakers to assess the impact of labor market reforms taking into account the general equilibrium effects and the interaction between labor market institutions.

Our approach focuses only on the allocative efficiency of labor market reforms. Taking into account the insurance motive of employment protection would provide an additional reason to rise firing costs; at the same time, the dual labor market structure could have negative side-effects in connection to high turnover and job insecurity. Future research should advance on these issues by relaxing the assumption of full insurance of workers within the representative household.

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A Appendix: additional figures

Figure A.1: Long-run effects of EPT

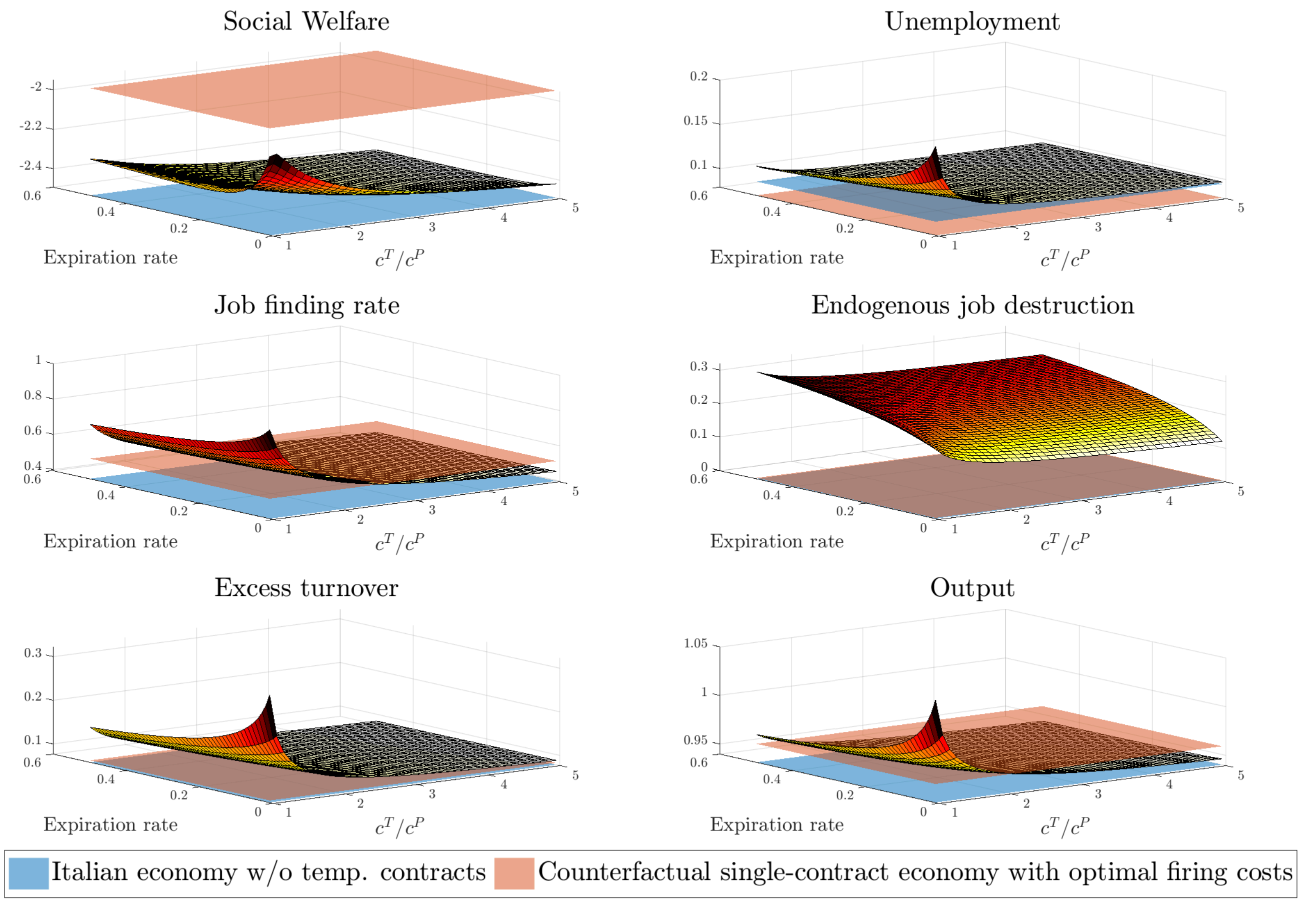

Figure A.2: Long-run effects of the temporary contract's expiration rate (2)