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THE ADVERSE EFFECTS OF SHORT-TERM CONTRACTS ON YOUNG WORKERS: EVIDENCE FROM ITALY*

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Short-term employment contracts have been deployed rapidly across European countries in the past decades. In this paper we suitably modify a known search and matching theoretical framework to quantify the effects of temporary contracts reforms on the present discounted value of the utility of junior and senior workers. We calibrate the model using data from Italy and find that while senior workers may benefit or not from the diffusion of temporary contracts depending on the productivity of the match, the utility of junior workers is always lower in the presence of temporary employment. This result is ascribable to the high rates of turnover associated with temporary contracts which offset the benefits of the increased labour market flexibility.

1 Introduction

High and persistent unemployment rates in Europe have often been associated with strong labour market rigidities and strict employment protection legislations (EPL). Particularly in Southern Europe, permanent contracts characterized by high hiring and firing costs, have represented for many decades the traditional way to hire workers. However, starting in the mid eighties, milder EPL short-term contracts were introduced and coexisted with the unchanged stricter EPL permanent contract, in an attempt to inject flexibility into the market, leading to the surge of dual labour economies (Saint-Paul, 1996). While the effects of this policy intervention have been studied theoretically for several macroeconomic variables, such as employment, unemployment, productivity, turnover (Aguirregabiria and Alonso-Borrego, 2014; Bentolila and Bertola, 1990; Bentolila and Saint-Paul, 1992;

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Bertola, 1990; Bruegemann, 2007; Cabrales and Hopenhayn, 1997; Cahuc *et al*., 2012; Hopenhayn and Rogerson, 1993; Wasmer, 1999), the microeconomic effects of such reform, specifically in terms of welfare, which are crucial to properly assess optimal policies toward short-term contracts regulations, remain largely unexplored. To address this important gap, this paper performs an income analysis to understand which categories of workers benefited from the introduction of short-term contracts side by side with permanent contracts.

By imposing implicit and explicit costs on the ability of firms to adjust their workforce to optimal levels, rigid employment protection legislation may limit efficient job separations and, indirectly, reduce efficient job creation (Mortensen and Pissarides, 1994). Even though, inefficiencies implied by job security provisions could be offset by wage adjustments, private payments or the design of efficient contracts (Lazear, 1990) wage rigidities and market imperfections may prevent these channels from working. By analysing firms' dynamics in the presence of firing costs, Bentolila and Bertola (1990) and Bertola (1990) show that the optimal strategy for firms is to reduce both hiring and firing, with an ambiguous effect on average employment over the business cycle. Regardless, stricter employment protection implies a slower speed of adjustment of employment towards its equilibrium level (Blanchard and Wolfers, 2001). Labour market equilibrium models such as Garibaldi (1998) and Mortensen (1999) come to similar conclusions about job mobility being negatively affected by EPL. Hence, theoretically the increased flexibility should improve market efficiency and workers should benefit from a dynamic labour market, brought about by flexibility-enhancing reforms. This occurs because in the process workers have greater opportunities to find jobs that better match their skills and needs and can more easily progress in their career and pay (OECD, 2013). However if the job turnover associated with temporary contracts becomes so high to offset the benefits of the increased tightness, workers who are predominantly hired on temporary contracts may be worse off. This is the issue that we want to investigate in this paper. To achieve this objective, we use Italy as a case-study since it is one of the European countries where the share and the variety of short-term contracts have increased significantly since the mid 1990s. The analysis of the changes registered in the labour market is the basis for developing a search model, with different types of contracts and heterogeneous agents. Calibrating the model, we are able to recreate working careers of different groups of workers and compute the present discounted value of their utility. One of our major findings is that for the case of Italy, on average, workers who randomly get a high productivity draw when turning senior face a substantial increase in income after the reforms. In contrast, junior workers as well as workers who experience a low productivity draw when turning senior are worse off.

The theoretical basis of this study is a micro-founded search model in the spirit of Mortensen and Pissarides (1994), where workers are heterogeneous with respect to productivity. We use a similar mechanism as in Blanchard and Landier (2002)(BL hereafter), however we characterize the model by including a number of additional features to study the impact of the reforms which lead to the surge of dual labour markets (Saint-Paul, 1996) on the income of different categories of workers. We consider two labour markets, one for junior workers, at the early stage of their working career and whose productivity is at the entry level, and one for senior workers, who have already accumulated work experience and differ according to their productivity level. The presence of match-specific productivity allows workers in bad matches to experience better matches along their career path. To analyse the way the income of workers has changed after the introduction of short-term contracts, we compare a benchmark pre-reforms model with a post-reforms model. The benchmark model describes an economy, characterized solely by permanent contracts, associated with firing costs to be paid by the employer in case of layoffs. This setting represents the case of Italy before the reforms, when temporary contracts were present but were so strictly regulated that their utilisation was very limited. In the model with short-term contracts, after the reforms, firms can choose to hire their workers on the existent and more rigid permanent contract or on the new more flexible short-term contract, which is characterized by zero firing costs at termination, and limited duration.[1] Following the strategy of Cahuc *et al.* (2016) in modelling the trade-off between permanent and temporary contracts, we do not allow firms to dismiss temporary workers before the termination date.[2] This is justified by the fact that while in the 'Spanish regulation' which covers Spain and Portugal, the rule for dismissals before the expiration date of temporary contracts is the same as for permanent contracts, in the 'French type' regulation, that prevails in Belgium, France, Greece, Italy and Germany, temporary contracts can not be terminated before their expiration date. Therefore, it is generally at least as costly to

[1]These two factors propose a trade off which is known in the empirical literature (Guell and Petrongolo, 2007) and analysed in the theoretical work of Cahuc et al. (2016) and Varejão and Portugal (2009). The importance of this trade-off is justified by its antithetical related implications. If firms use short-term contracts as a screening device, higher productivity is expected in the long-term since the objective is to find a better match (Nagypál, 2007). If they are used as a churning mechanism, they may instead cause a decrease in job stability, on the job training, and productivity growth (Blanchard and Landier, 2002). These features lead all types of workers to experience several sequences of short-term employment and unemployment during their working careers, as observed in the data.

[2]While in Cahuc *et al.* (2016) the length of the temporary contract is bargained over and fixed, in this paper we assume that temporary contracts terminate as a result of an idiosyncratic shock, as in Faccini (2014).

terminate a temporary contract before its date of termination as to terminate a regular contract. The assumption which is present in most of the literature which assumes that it is costly to terminate permanent contracts, whereas temporary contracts can be terminated at no cost at any time, is not in line with the current regulations and it introduces a distortion in the explanation of how firms choose between permanent and temporary jobs.

By solving our model, in equilibrium we have that all junior workers are hired with the same contract type as they are homogeneous with respect to productivity, however there is scope for the utilisation of both contract types when hiring senior workers. We calibrate the model using data from Italy and we find that junior workers are worse off after the reforms as by getting hired on temporary contracts they experience higher turnover rates. Workers, whose random level of productivity is sufficiently high when they turn senior, enjoy higher wages and the benefits associated with permanent contracts. Workers whose random draw of productivity is lower when turning senior, instead, fall into cycles of unemployment and short-term employment, facing lower salaries and reduced benefits. These results crucially depend on the short-term contracts duration: as the average length gets longer the utility of junior workers increases in the scenario with short-term contracts and the benefits of more flexibility overcome the costs. This is very relevant in a time in which there is evidence of short-term contracts getting on average significantly shorter (Cahuc *et al*., 2016; Charlot *et al*., 2016).

This paper is related to the limited literature that studies theoretically the effects of short-term contracts on individual income. Cahuc *et al*. (2016) adopt a political economy approach to study the impact of the simultaneous utilization of high EPL and short-term contracts. After identifying the political support for these two instruments, they compute their effects on the economy's total output and aggregate welfare. Using a similar framework, we depart from their setup by allowing for the ageing of individuals and therefore by focusing on the impact of high EPL and short-term contracts on different types of workers. By modelling short-term contracts as a mechanism to screen workers for permanent positions, Faccini (2014) shows that aggregate welfare gains derived from using temporary contracts as a screening device might be large. Even though both papers study the role of short-term contracts within a search model, their objective is to study the effect on aggregate welfare and not on individual income by worker's type which is the scope of this paper. The theoretical framework described by Casquel and Cunyat (2011) is conceptually very similar to the model presented in this paper, however they limit their study to the analysis of the different conversion patterns of temporary contracts into permanent contracts. A recent empirical paper by Garcia-Perez *et al*. (2018) provides evidence that in Spain even though short-term contracts allow young workers to find employment

more rapidly, the long-run consequences are negative, as long-run employment and earnings prospects are worse.

The BL paper is the closest to this work. They use a search and matching model to show that dual track reforms might have perverse effects on the labour market and specifically on the income of workers in France. Since young workers are the ones who are predominantly hired on temporary contracts, the authors present evidence consistent with the model predictions for this category of workers. They show that the excess turnover generated by the reduction of firing costs associated with entry-level jobs in the case of France is high enough to offset the efficiency gains which derive from the higher flexibility. The mechanism that we adopt is similar, however, by extending their model in a number of dimensions we are able to quantify the effects of the reforms on the income of junior and senior workers in an environment in which permanent and short-term contracts coexist and are optimally chosen. First, the BL model is extended to include ageing of the workers, that is when the productivity of the junior worker is revealed the worker becomes senior. This allows us to compute the impact of the reforms on the lifetime income of both junior and senior workers. This mechanism is not present in the BL model as in their simple framework when the productivity of the workers is revealed and they are not upgraded to a regular contract, they start again from an entry-level job with fixed productivity. Second, we model the reform as the availability of an additional contract type, the short-term contract, which coexists with the existing permanent contract and we allow firms to optimally choose between permanent and temporary contracts. In the BL setup, the modelling of the reform as a reduction of firing costs associated with entry-level jobs does not allow for any investigation of the trade-off between the two contract types and it limits the effect of the reform by assumption only to the transition from entry-level to regular jobs. Third, we also introduce endogenous separations for permanent jobs to allow the firing costs to play a role not only in the bargaining but also in the separation decision. Nevertheless, with the parametrisation used, regarding the specific effect of short-term contracts on the present discounted value of utility of junior workers, we are able to reach similar conclusions for the case of Italy. Moreover, the more general approach we adopt allows us to perform not only positive, but also normative analysis for policy recommendations.

This paper is organized as follows: in Section 2 we provide empirical evidence to assist us in designing the proper model specification. Section 3 describes the search model, and Section 4 presents the calibration approach to test the model. Section 5 illustrates our findings regarding the change in income for different categories of workers and explores the outcome of some counterfactual exercises. Section 6 concludes with a discussion of future research.

2 Motivation

2.1 Changes in the Italian Labour Market Regulatory Framework

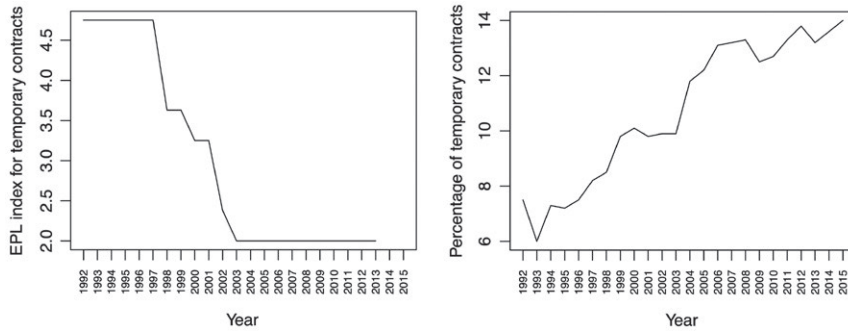
In Italy, since 1942 open ended contracts associated with quite rigid EPL and high firing costs represented the traditional legal instrument to hire workers. Short-term contracts were regulated in the early 60s. They share the same characteristics as the open-ended contracts, but for the limited duration established at stipulation (up to two years, with only one possibility of renewal). Due to strict rules for adoption, which limited significantly the scope for utilization, their percentage was small until the nineties. Only two other types of quasi substitute fixed-term contracts were available since the 70s: apprenticeship and *Contratto di Formazione Lavoro* (vocational training contract), which were specifically designed for young people.[3]

On the wave of liberalization of the European labour markets, in the past two decades many reforms have been approved in Italy to relax the rules for the utilization of fixed-term contracts and several new types of employment contracts (with fixed duration) have been legislated.[4] Specifically, three were the major reforms implemented with the objectives of improving labour market flexibility. The first reform known as *Legge Treu* was approved in 1997. It represents a milestone in the history of the recent Italian labour market. Some of the major innovations brought by Law-196/1997 are the regulation of agency contracts and collaboration contracts and the relaxation of the rules for the utilization of fixed-term contracts and apprenticeships. Few years later, with Law-368/2001, the Italian legal system by implementing a 1999 EU Directive removed the strict rules for adoption of short-term contracts and allowed firms to use short-term contracts under many different circumstances.[5] Prior to 2001, the law regulating short-term contracts provided a very specific list of circumstances under which firms could use those contracts, for example seasonal jobs or replacement of workers on sick leave. The new law liberalized the contract by abolishing the detailed list of specific occasions and allowing their utilization for reasons of a technical, organizational, production or replacement nature. In 2003, Law-30/2003, known as *Legge Biagi*, introduced new additional forms of atypical contracts (such as job on call and job sharing) and several modifications to the vocational training contract. However, the

[3]Together they represented less than 10% of the total number of contracts.

[4]See Tealdi (2011) for an extensive description of these reforms.

[5]According to some scholars (Aimo, 2006; Cappellari *et al*., 2012), the relaxation of these rules and the liberalization of short-term contracts created a sort of confusion among employers regarding the actual requirements for adoption. Specifically, it was not clear whether employers could use short-term contract also for activities which are not of temporary nature. Moreover, in case of court disputes, the applicability relied too much on the interpretations of the judges, causing delays and disincentives for the adoption of the contracts and therefore distorting the objective of the law.



(a) EPL associated with temporary contracts. (b) Share of temporary contracts.

FIG. 1. EPL and Temporary Contracts in Italy *Source*: OECD.

main novelty was the relaxation of the rules for the utilisation of apprenticeship contracts. Specifically, the age eligibility was extended and the possibility to perform on the job training within the firm (instead of outsourcing it) was introduced. These changes were made in order to make the apprenticeship contract more flexible and therefore more appealing for firms.

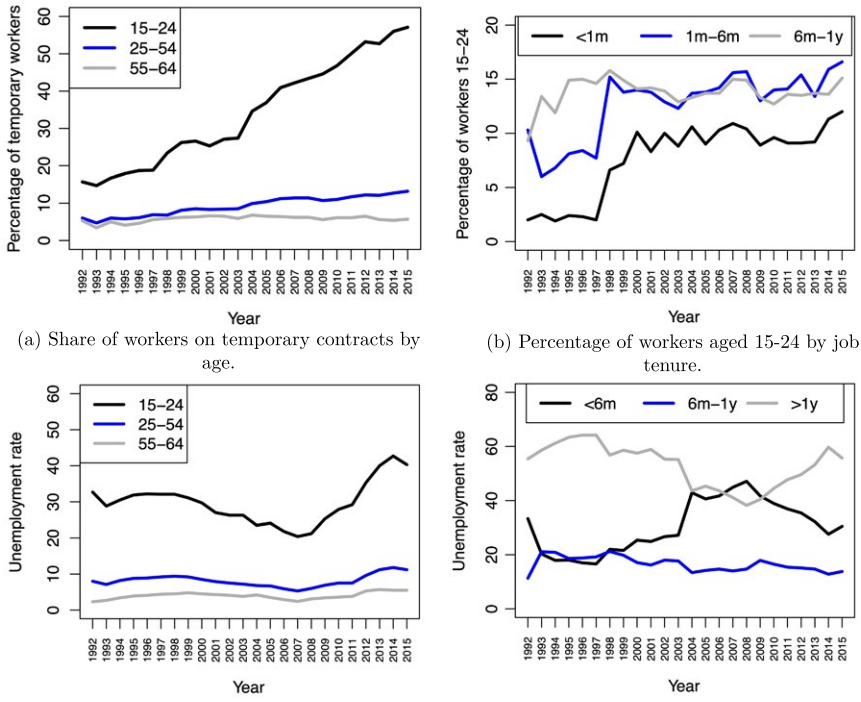
As a result of the implementation of these reforms, the employment protection index associated with temporary contracts decreased significantly (Figure 1a) and the share of short-term employment increased considerably (Figure 1b), with strong effects on labour market outcomes and dynamics.

Hence, while fixed-term contracts were already present before the reforms, they were strictly regulated and their utilisation was rather limited. The implementation of the reforms and the liberalisation of these contracts provided firms with an additional instrument to hire workers.

2.2 Stylized Facts

We present a set of stylized empirical facts emerging from the analysis of OECD data on the Italian labour market in the period 1992–2015. Figure 2a shows that among individuals in the 15 to 24 age group the share of temporary employees is much higher compared to older age groups. Moreover, this share has been constantly increasing since the mid 90s and in 2015 it was approximately four times higher than twenty years earlier (Figure 2a).[6] The share of workers in temporary contracts among older age groups has increased as well, but of few percentage points. When we look at job tenure among young workers (15–24) we observe that the percentage of workers with tenure below one year has increased significantly (Figure 2b). Specifically, the share of workers with tenure below one month went from

[6]Even before the 2009 crisis, the share was already three times higher than in the early 90s.



(a) Share of workers on temporary contracts by age.

(b) Percentage of workers aged 15-24 by job tenure.

(c) Unemployment rate by age.

(d) Youth unemployment rate by duration.

FIG. 2. Italian labour market statistics
SOURCE: OECD.

approximately 2% in early 90s to more than 10% in the early 00s. In the same way, job tenure between one and six months increased by approximately eight percentage points. Overall, approximately 40% of the workers in the age group 15–24 have a job tenure below one year.

When looking at the unemployment rate by age groups (Figure 2c), we observe that since the early 90s, the unemployment rate among individuals aged 15 to 24 declined significantly up to 2009, when the economic crisis severely hit the Italian economy. Similar declining trends are observable for older cohorts, but the magnitude of the change is much more contained. If we focus on the duration of unemployment for the age group 15–24, we notice that long-term unemployment (longer than one year) has significantly declined (Figure 2d), and has been replaced by short-term unemployment (below six months).

This evidence is in line with findings in the literature, which show that in Italy young workers have higher chances to be hired on a temporary basis, compared to workers in older age cohorts (Barbieri and Sestito,

Table 1
Transition Rates Across Labour Market States

	Transition to				
	Permanent	Temporary	Self-Employed	Unemployed	Inactive
Transition from					
	Age 16-30				
Permanent	85.6	6.5	2.5	2.6	2.7
Temporary	31.6	49.8	3.9	6.8	7.9
Unemployed	10.2	18.0	8.5	31.1	32.2
	Age 16–64				
Permanent	90.8	2.1	1.5	1.5	4.0
Temporary	26.5	49.9	4.7	7.3	11.5
Unemployed	11.7	12.6	6.3	32.6	36.7

Source: Cappellari *et al.* (2012) using Labour Force Survey 2007–8.

2008). Specifically, it has been found that when individuals step for the first time into the labour market, they are very likely to start their career with a temporary contract (Barbieri and Scherer, 2009; Naticchioni *et al*., 2010; Schizzerotto, 2002). This phenomenon is particularly common among recent college graduates. Similar trends are also observed in other Mediterranean countries characterized by dual labour markets, such as Spain, France and Portugal (ILO and OECD, 2011).

Regarding the impact of temporary jobs on future career opportunities, studies have found that the probability of moving from a temporary to a permanent position increases with the duration of the contract (Guell and Petrongolo, 2007), but decreases with repeated temporary jobs and career interruptions. In Italy the intermittent nature of temporary employment has been found to severely damage the career prospects of workers (Gagliarducci, 2005). This issue is particularly severe for certain categories of workers, such as school leavers, as they face an higher probability to be trapped in cycles of temporary contracts (Bruno *et al*., 2012). Similar results are found by Centeno and Novo (2012) for Portugal and by Bentolila, Cahuc *et al.* (2012) for Spain and France, who show that fixed-term contracts are positively associated with excess worker turnover. Nevertheless, evidence shows that the probability to transit to a permanent contract is higher for workers hired on temporary contract than for unemployed workers (Berton *et al*., 2007; Picchio, 2008).

Table 1 reports transition rates across different labour market states for the period 2007–8. It is interesting to notice that the transition rate from temporary to temporary employment is approximately 50% points across both age categories (16–30 and 16–64), while it is only 32% points from temporary to permanent employment for young individuals and 26.5 across the entire population. When considering the transition from permanent

to temporary or from permanent to unemployed the transition rates are rather small across both age categories. These results point to the fact that the turnover associated with temporary contracts is much higher than the turnover associated with permanent contracts, in line with the evidence for France (Abowd *et al.,* 1999).

Another important finding in the literature of temporary contracts, which has prompted research in the field, is the existence of wage differentials between temporary and permanent workers. Using data from the European Structure of Earnings Survey and controlling for individual and job characteristics, Dias da Silva and Turrini (2015) find that workers on permanent contracts earn on average about 15% more than workers on fixed-term contracts with similar observable characteristics. Similar results are reported by Boeri (2011), Faccini (2014), Stancanelli (2002). Findings on the wage penalties for temporary workers have been reported also by Booth *et al*. (2002) for Britain and by Blanchard and Landier (2002) for France.

In summary, stylized facts and empirical evidence point at the fact that young workers are the ones who are more exposed to the diffusion of temporary contracts. As a consequence, on one hand, they face higher turnover and earn lower wages, on the other hand they are more likely to find a job, so the duration of their unemployment spells is shorter. Depending on which of the two effects prevail, they might be better or worse off in the presence of temporary contracts.

In order to provide an answer to this open question, we use these stylized facts to develop a theoretical framework, described in the next section, to reconstruct the labour market dynamics before and after the reforms.

3 The Search Model

In this section we design a Mortensen and Pissarides (1994) search and matching model, based on the empirical evidence described above. To analyse the firms' behaviour in response to the introduction of short-term contracts, we enrich the Blanchard and Landier (2002) model with a number of features and compare an environment pre-reforms when only permanent contracts were accessible with an economy post-reforms, with the availability of both permanent and short-term contracts, and we allow firms to optimally choose the contract. The option for firms to offer short-term contracts, defined by a shorter duration and no firing costs at expiration, creates a meaningful trade-off (Varejão and Portugal, 2009). Moreover, to better model the choice between the two types of contracts and in line with the regulation and the literature (Cahuc *et al*., 2016), we do not allow for the dismissal of short-term employees before the contract expiration, but only for the upgrading to a permanent position.

3.1 The Setup

The set-up is described by a set of equations, which defines the model dynamics. The economy is composed by a population of measure 1. Every instant a measure of individuals are born (k) and each instant the same measure of individuals pass away (at rate d). When the individuals are born, they are *junior* (j) and they are out of the labour force. At rate m, which is the parameter of a Poisson arrival process, they join the labour force as unemployed and look for jobs. When they find a job, at rate μ, their productivity is the entry-level productivity y_0. However, a new productivity is drawn at rate λ, when a shock hits the worker-firm match and the workers' productivity is revealed. They are now *senior* (s). The new productivity level y is specific to the worker-firm match and is drawn randomly from a distribution with cumulative distribution function $H(y)$. Whenever the match is destroyed, and a new match is formed, a new productivity level is drawn. When senior, workers may decide to leave the labour force by retiring (at rate σ). We define b as the value of home production, e.g., unemployment benefits.

Firms hire both *junior* and *senior* workers.[7] Firms without workers post vacancies at cost c^p and they fill them with probability α, which is the parameter of a Poisson arrival process. In equilibrium, job creation is governed by profit maximization by taking into account expected revenues and costs of a new match. Firms and workers come together via a standard matching function $M(u, v)$, where u is the measure of unemployment and v is the measure of vacancies. This function is twice differentiable, increasing in its arguments, and exhibits constant returns to scale. The flow of matches for a vacancy may be defined as $M(u, v)/v = \alpha(\theta)$, which is a decreasing function, where θ is the tightness of the labour market defined by v/u. The flow of matches for an unemployed worker may be defined as $M(u, v)/u = \mu(\theta) \equiv \theta\alpha(\theta)$, which is an increasing function.[8] Existing junior matches may terminate at Poisson rate δ as a consequence of an exogenous shock. When this happens, each party goes through a costly search process in order to meet its next partner. Existing senior matches may terminate endogenously as a consequence of an idiosyncratic match-specific productivity shock η. In this economy the two labour markets, one for the juniors and one for the seniors, are segmented with two different matching functions.

We assume that wages are set through an asymmetric Nash Bargaining process, where the bargaining parties are workers and employers. In this setup, β represents the bargaining power of the workers.

[7]This is socially desirable since we assume that the value of work production is always higher than home production, i.e., $y_0 > b$.

[8]Standard Inada conditions apply.

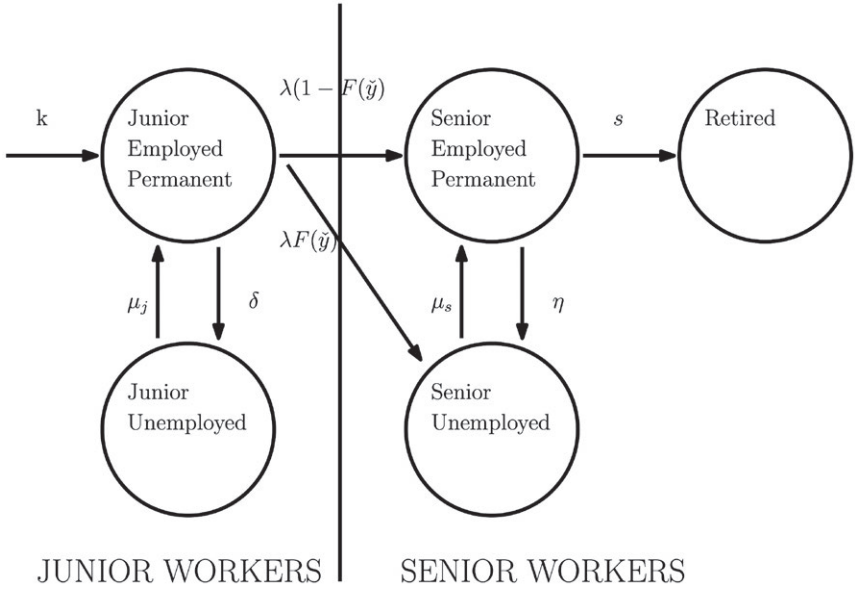


FIG. 3. Model Pre-Reforms

3.2 The Benchmark Model

In the basic set up, we assume that only permanent contracts are available and firing costs are to be paid by the firm in case of dismissal.[9] Specifically, if the dismissal involves a junior worker the firing cost is F_0, while if it involves a senior workers the firing cost is F.

A sketch of the workers flows across status as implied by the benchmark model is reported in Figure 3.

3.2.1 The Firm's Problem. When deciding whether to offer a permanent contract, the firm does not incur firing costs if the match is not formed, since firing costs are paid only when an ongoing relationship is severed. Therefore, the outside option is different whether the contract is new (N) or ongoing (O). Moreover, as the firing costs differ between junior and senior workers, the outside option is also different during the transition from junior to senior (R). When the firm posts a vacancy, the Bellman's equations read:

[9]Following standard practice in the literature it is assumed that dismissal costs are a pure resource waste, which occurs whenever a job is destroyed. As such, they can be considered as equivalent to a separation tax. Nevertheless, there is a growing literature on severance payments that avoids this assumption, see Alvarez and Veracierto (2001) among others.

$$rJ_j^V = -c^p + \alpha_j[J_j^E - J_j^V], \tag{1}$$

$$rJ_s^V = -c^p + \alpha_s \int_{\underline{y}}^{\overline{y}} \max\left[(J_s^N(y), J_s^V) - J_s^V\right] \, dH, \tag{2}$$

where c^p is the vacancy cost and α is the rate at which a vacancy in each market (junior and senior) is filled. In the market for senior workers, if the productivity level of the worker is not sufficiently high, it is not profitable for the firm to hire the worker and the firm prefers to keep the vacancy open. The threshold productivity level y^* (reservation productivity) defines the minimum productivity level required by the firm to hire the worker from the market.

The firm's Bellman's equations for a filled position for junior and senior workers are respectively:

$$rJ_j^E = y_0 - w_j + \delta[J_j^V - F_0 - J_j^E] + \lambda \int_{\underline{y}}^{\overline{y}} \left[\max\left(J_s^R(y), J_s^V - F_0\right) - J_j^E\right] \, dH, \tag{3}$$

$$rJ_s^N(y) = y - w_s^N(y) + \eta \int_{\underline{y}}^{\overline{y}} \left[\max\left(J_s^O(y'), J_s^V - F\right) - J_s^N(y)\right] \, dH + \sigma[J_s^V - J_s^N(y)], \tag{4}$$

$$rJ_s^R(y) = y - w_s^R(y) + \eta \int_{\underline{y}}^{\overline{y}} \left[\max\left(J_s^O(y'), J_s^V - F\right) - J_s^R(y)\right] \, dH + \sigma[J_s^V - J_s^R(y)], \tag{5}$$

$$rJ_s^O(y) = y - w_s^O(y) + \eta \int_{\underline{y}}^{\overline{y}} \left[\max\left(J_s^O(y'), J_s^V - F\right) - J_s^O(y)\right] \, dH + \sigma[J_s^V - J_s^O(y)]. \tag{6}$$

Equation (3) is the expected present value of utility for a firm hiring a junior worker on a permanent position. The entry level productivity of the worker is y_0 and the firm pays the junior worker wage w_j. When the match is exogenously destroyed at rate δ, the firm is required to pay firing costs F_0 and it is left with a new vacancy. At rate λ the firm learns the worker's productivity level specific for the match. The productivity threshold $\check{y}$ defines the productivity level by which the firm is indifferent between keeping the worker within the workforce and laying the worker off during the transition from junior to senior. If the drawn productivity level of the worker is above the threshold ($y \geq \check{y}$), the worker is upgraded to a permanent senior position

(J_s^R). Otherwise ($y < \check{y}$), the firm pays firing costs F_0 and opens a new vacancy. Equations (4)–(6) are the expected present value of profits from a new (N), transition (R), or ongoing (O) permanent position filled by a senior worker with productivity y. Each match may terminate endogenously as a consequence of an idiosyncratic match-specific productivity shock, if the new productivity level being drawn at rate η is too low, i.e., below the threshold $\hat{y}$, or if the worker retires at rate σ. In the former case the firm pays firing costs F. Hence, the productivity threshold $\hat{y}$ defines the productivity level by which the firm is indifferent between keeping the senior worker within the workforce and laying the worker off. In both situations, the firm is left with a new vacancy. The three Bellman's equations differ only for the associated wages paid to the worker, as in each of the three scenario the outside option is different.

3.2.2 The Worker's Value Functions. Let W_j^E and W_j^U denote the expected present value of utility of a junior worker currently employed or unemployed, respectively. The present discounted values of the utility of unemployed junior and senior workers satisfy the following equations:

$$rW_j^U = b + \mu_j[W_j^E - W_j^U], \tag{7}$$

$$rW_s^U = b + \mu_s \int_{\underline{y}}^{\bar{y}} \left[\max\left(W_s^N(y), W_s^U\right) - W_s^U\right] \, dH. \tag{8}$$

The first term on the right-hand side of both equation is the unemployment benefit, while the second term represents the probability to form a match with an employer times the change in the utility from unemployment to employment. In the market for senior workers (equation (8)), the worker gets the position whenever the productivity is above the equilibrium threshold ($y \geq y^*$). If the productivity is below the threshold ($y < y^*$), the worker remains unemployed.

The present discounted values of the utility of employed junior and senior workers read as:

$$rW_j^E = w_j + \delta[W_j^U - W_j^E] + \lambda \int_{\underline{y}}^{\bar{y}} \left[\max\left(W_s^R(y), W_s^U\right) - W_j^E\right] \, dH, \tag{9}$$

$$rW_s^N(y) = w_s^N(y) + \eta \int_{\underline{y}}^{\bar{y}} \left[\max\left(W_s^O(y'), W_s^U\right) - W_s^N(y)\right] \, dH + \sigma[W_s^{OLF} - W_s^N(y)], \tag{10}$$

$$rW_s^R(y) = w_s^R(y) + \eta \int_{\underline{y}}^{\overline{y}} \left[\max\left(W_s^O(y'), W_s^U\right) - W_s^R(y)\right] \, dH + \sigma[W_s^{OLF} - W_s^R(y)], \tag{11}$$

$$rW_s^O(y) = w_s^O(y) + \eta \int_{\underline{y}}^{\overline{y}} \left[\max\left(W_s^O(y'), W_s^U\right) - W_s^O(y)\right] \, dH + \sigma[W_s^{OLF} - W_s^O(y)], \tag{12}$$

where

$$rW_j^{OLF} = \pi_j^{OLF} + m(W_j^U - W_j^{OLF}),$$
$$(r+d)W_s^{OLF} = \pi_s^{OLF}.$$

The junior worker receives wage w_j. The worker-firm match may be destroyed at rate δ as the worker becomes unemployed (equation (9)). In addition at rate λ the worker turns senior as a new productivity level is drawn: the worker can either move to a senior position (W_s^R) or join the unemployment pool (W_s^U), according to the productivity level of the match. The utility of senior workers on a permanent position varies according to whether the worker has been hired from the market (W_s^N) or she has been upgraded from a junior position (W_s^R) or she is on an ongoing permanent position (W_s^O), because of the different wages received. Nevertheless, in all these scenarios the match may be destroyed in two cases: if an idiosyncratic match-specific productivity shock hits the match (at rate η) and the new productivity level is below the threshold $\hat{y}$ or if the worker retires, at rate σ. In the former case the worker joins the unemployment pool, in the latter case the worker exits the labour force (equations (10)–(12)).

3.2.3 Wage Determination and Equilibrium Conditions. We assume that wages are bargained using a Nash Bilateral Bargaining mechanism, where β represents the bargaining power of the workers. Wages are contingent on the productivity level of the worker. Therefore, w_j is the wage of junior workers, while there is a distribution of wages $w_s^i(y)$ for senior workers, where $i \in \{N, R, O\}$.

The sharing rules for the determination of the wages are described by the following equations:

$$\beta[J_j^E - J_j^V] = (1-\beta)[W_j^E - W_j^U], \tag{13}$$

$$\beta[J_s^N(y) - J_s^V] = (1-\beta)[W_s^N(y) - W_s^U]. \tag{14}$$

$$\beta[J_s^R(y)+F_0-J_s^V]=(1-\beta)[W_s^R(y)-W_s^U]. \tag{15}$$

$$\beta[J_s^O(y)+F-J_s^V]=(1-\beta)[W_s^O(y)-W_s^U]. \tag{16}$$

The termination of a match involving senior workers in ongoing relationships implies the payment of firing costs F by the employer (equation 16). Indeed, if the firm fails to agree to a continuation wage, its loss will be $J_s^O(y)+F$. This is not the case for senior workers in a new relationship (equation (14)) as the firm is not liable of paying firing costs if the match is not formed (Pissarides, 2000). However, for matches involving workers transiting from the status of junior to the status of senior (equation 15), the firm is required to pay firing costs F_0 in case of no agreement and termination of the contract.

The free entry conditions imply that on both markets (for junior and senior workers) the values of the vacancies are equal to zero ($J_j^V = 0$ and $J_s^V = 0$).

In case of senior workers, we compute the job creation and job destruction productivity threshold levels for the optimal allocation of workers. y^* is the job creation productivity level at which, when the firm meets the worker, the firm is indifferent whether to hire the worker or to keep the vacancy open. $\check{y}$ is the job productivity level at which during the transition from junior to senior, the firm is indifferent whether to keep the worker within the workforce or to fire the worker. Finally, $\hat{y}$ is the job destruction productivity level at which the firm is indifferent whether to keep the senior worker on an ongoing relationship within the workforce or to fire the worker.

$$J_s^N(y^*)=0, \tag{17}$$

$$J_s^R(\check{y})+F_0=0, \tag{18}$$

$$J_s^O(\hat{y})+F=0. \tag{19}$$

We compute y^* as the value of y for which the utility of a new filled position with a senior worker is equal to the utility of a vacancy (equation (17)). We compute $\check{y}$ by calculating the value of y for which the value of a transition filled position with a senior worker plus the firing cost F_0 the firm needs to pay to fire the worker is equal to the value of a vacancy (equation (18)). Similarly, we compute $\hat{y}$ by calculating the value of y for which the value of an ongoing filled position with a senior worker plus the firing cost the firm needs to pay to fire the worker is equal to the value of a vacancy (equation (19)). The job creation and job destruction equilibrium productivity thresholds read:

$$y^*=(r+\sigma)W_s^U-\sigma W_s^{OLF}+\eta F-\frac{\eta}{(r+\eta+\sigma)}\int_{\hat{y}}^{\overline{y}}(y-\hat{y}),dH, \tag{20}$$

$$\check{y} = (r+\sigma)W_s^U - \sigma W_s^{OLF} + \eta F - (r+\eta+\sigma)F_0 - \frac{\eta}{(r+\eta+\sigma)}\int_{\hat{y}}^{\overline{y}} (y-\hat{y}), dH, \quad (21)$$

$$\hat{y} = (r+\sigma)W_s^U - \sigma W_s^{OLF} - (r+\eta+\sigma)F - \frac{\eta}{(r+\eta+\sigma)}\int_{\hat{y}}^{\overline{y}} (y-\hat{y}), dH. \quad (22)$$

In addition, the equilibrium Nash wage equations for junior and senior workers read:

$$w_j = \beta y_0 - \left(\beta\delta + \lambda\int_{\underline{y}}^{\tilde{y}} h(y), dy\right)F_0 + (1-\beta)(r+\lambda)W_j^U - (1-\beta)\lambda W_s^U, \quad (23)$$

$$w_s^N(y) = \beta y - \beta\eta F + (1-\beta)(r+\sigma)W_s^U - (1-\beta)\sigma W_s^{OLF}, \quad (24)$$

$$w_s^R(y) = \beta y + \beta(r+\eta+\sigma)F_0 - \beta\eta F + (1-\beta)(r+\sigma)W_s^U - (1-\beta)\sigma W_s^{OLF}, \quad (25)$$

$$w_s^O(y) = \beta y + \beta(r+\sigma)F + (1-\beta)(r+\sigma)W_s^U - (1-\beta)\sigma W_s^{OLF}. \quad (26)$$

As in Pissarides (2000), the firing costs enter with a negative sign ($-\beta\delta F$) in the wage equation for new matches (equation (24)) and with a positive sign ($+\beta(r+\sigma)F$) in the wage equation for ongoing matches (equation (26)). The negative sign associated with firing costs in the equation for new matches is explained by the fact that the firm is liable to the firing cost only if the worker hired from the market agrees to sign the contract. Hence, the firing cost F reduces the expected match surplus at the creation date and so reduces the initial wage for that reason. In the equation for ongoing matches the positive sign associated with firing costs is due to the fact that the firm now has to pay the firing cost if the worker does not agree to continue the match. Once the job is formed, the firing tax is an employer liability if the job is destroyed. This fact strengthens the worker's hand in the wage bargain and so pushes the negotiated wage up for continuing workers (Mortensen and Pissarides, 2001).

3.3 The Model with Short-term Contracts

While in the BL theoretical framework the reform is simulated by analysing the outcome of a reduction in the firing cost F_0, we model the reform in a more complex way by letting firms optimally choose between permanent

and short-term contracts. This new framework allows us to study the impact of the reforms which liberalised the utilisation of short-term contracts on the income of both junior and senior workers, in an economy in which both contract types coexist. The main features of the short-term contract are the ones that are standard in the literature (Cahuc *et al*., 2016): the exposure to a termination shock, which limits the duration of the contract, and the absence of firing costs at termination. Moreover, short-term employees can not be dismissed before the expiration of the contract, even though firms are allowed to upgrade the worker to a permanent position before the expiration date.[10]

3.3.1 The Firm's Problem. Let the superscripts P and T denote permanent and temporary contracts, respectively. Keeping the same notation as described in Section 3, the Bellman's equations for the firm hiring a junior worker read:

$$rJ_j^V = \max\{-c^T + \alpha_j[J_j^T - J_j^V], -c^P + \alpha_j[J_j^P - J_j^V]\}, \tag{27}$$

$$rJ_j^T = y_0 - w_j^T + \lambda \int_{\underline{y}}^{\bar{y}} \left[\max\left(J_s^{NP}(y), J_s^T(y)\right) - J_j^T\right] dH + \tau[J_j^V - J_j^T], \tag{28}$$

$$rJ_j^P = y_0 - w_j^P + \lambda \int_{\underline{y}}^{\bar{y}} \left[\max\left(J_s^{NP}(y), J_s^V - F\right) - J_j^P\right] dH + \delta[J_j^V - F - J_j^P]. \tag{29}$$

The firm has the option to hire a junior unemployed worker on a permanent or short-term contract (equation (27)). The temporary contract (equation (28)) terminates naturally at rate τ without any firing costs to be paid by the firm. In case of a permanent contract (equation (29)), the worker-firm match can be exogenously terminated at rate δ, in which case the firm has to pay firing costs F. The trade-off is driven by the fact that on one side short-term contracts are limited in time and the search for a new worker is costly, however there are no firing costs to be paid by employers. On the other side, permanent contracts are open ended, but firing is costly. Moreover, by choosing to offer a permanent contract, whenever the productivity of the worker is revealed (at rate λ) and the worker turns senior, the firm is able to fire the worker by paying firing costs F. Let $\hat{y}$ be the productivity level by which a firm, which is currently hiring a junior worker on a

[10]This is justified by the fact that in Belgium, France, Greece, Germany and Italy, temporary contracts can not be terminated before the expiration date ('French regulation').

permanent position is indifferent whether to keep the worker on a permanent contract or to fire her by paying firing costs F, after the productivity level of the junior worker has been revealed (at rate λ). If the worker's productivity level turns out to be low, i.e., $y < \hat{y}$, the firm will pay firing costs F and will fire the worker; alternatively, if the worker's productivity level turns out to be high, i.e., $y \geq \hat{y}$, the firm will keep the worker on a permanent basis. With the temporary contract choice (equation (28)), when the productivity of the worker is revealed (at rate λ) and the worker turns senior, the firm can not dismiss the worker. Specifically, let $\tilde{y}$ be the productivity level by which a firm which is currently hiring a junior worker on a temporary position is indifferent whether to upgrade the worker on a permanent contract or to keep the worker now senior on a temporary contract. If $y \geq \tilde{y}$ the firm will upgrade the worker to a permanent position, while if $y < \tilde{y}$ the firm will keep the now senior worker on a short-term position. Hence, even in case of a very low productivity worker, the firm is forced to keep the worker within the workforce until the termination of the contract.[11]

The Bellman's equations for the firm hiring a senior worker read:

$$rJ_s^V = -c^P + \alpha_s \int_{\underline{y}}^{\bar{y}} \left[\max\left(J_s^{NP}(y), J_s^T(y), J_s^V\right) - J_s^V\right] \, dH, \tag{30}$$

$$\begin{aligned} rJ_s^{NP}(y) = y - w_s^{NP}(y) + \eta \int_{\underline{y}}^{\bar{y}} \left[\max\left(J_s^{OP}(y'), J_s^V - F\right) - J_s^{NP}(y)\right] \, dH \\ + \sigma[J_s^V - J_s^{NP}(y)], \end{aligned} \tag{31}$$

$$\begin{aligned} rJ_s^{OP}(y) = y - w_s^{OP}(y) + \eta \int_{\underline{y}}^{\bar{y}} \left[\max\left(J_s^{OP}(y'), J_s^V - F\right) - J_s^{OP}(y)\right] \, dH \\ + \sigma[J_s^V - J_s^{OP}(y)], \end{aligned} \tag{32}$$

$$rJ_s^T(y) = y - w_s^T(y) + (\tau + \sigma)[J_s^V - J_s^T(y)]. \tag{33}$$

In the market for senior workers, when the productivity level is drawn, the firm decides whether to hire the worker and what type of contract to offer, according to the productivity level. Specifically, if $y = \tilde{y}$ the firm is indifferent whether to offer a permanent or a short-term contract, while if $y = \ddot{y}$ the firm is indifferent whether to offer a short-term contract or to keep the vacancy open. Moreover, the permanent match is destroyed endogenously by paying firing costs F after an idiosyncratic match-specific

[11]For the equilibrium with short-term contracts to exist, it is assumed that that the profit loss from a bad productivity draw cannot exceed the firing cost on permanent positions, *F*.

productivity shock hits the match at rate η and a low productivity level is drawn ($y < \hat{y}$) or in case the worker retires at rate σ (equations (31) and (32)). A temporary contract (equation (33)) may only be terminated at expiration (at rate τ) at zero costs or due to the retirement of the worker (at rate σ).

3.3.2 The Worker's Value Functions. From the workers' point of view, we can define the value of being unemployed for *junior* and *senior* workers as:

$$rW_j^U = b + \mu_j \left[\max \left(W_j^P, W_j^T \right) - W_j^U \right], \tag{34}$$

$$rW_s^U = b + \mu_s \int_{\underline{y}}^{\bar{y}} \left[\max \left(W_s^{NP}(y), W_s^T(y), W_s^U \right) - W_s^U \right] dH. \tag{35}$$

Equation (34) shows that junior unemployed individuals can be offered either a permanent or a temporary contract when they meet a firm, depending on which of the two options is more profitable. When senior workers meet the firm and their productivity is drawn, they get a job offer with a permanent or short-term contract or no offer at all, according to the productivity level.

The Bellman's equations for employed *junior* and *senior* workers are:

$$rW_j^P = w_j^P + \lambda \int_{\underline{y}}^{\bar{y}} \left(\max \left[W_s^{NP}(y), W_s^U(y) \right] - W_j^P \right) dH + \delta [W_j^U - W_j^P], \tag{36}$$

$$rW_j^T = w_j^T + \lambda \int_{\underline{y}}^{\bar{y}} \left(\max \left[W_s^{NP}(y), W_s^T(y) \right] - W_j^T \right) dH + \tau [W_j^U - W_j^T], \tag{37}$$

$$\begin{aligned} rW_s^{NP}(y) = {} & w_s^{NP}(y) + \eta \int_{\underline{y}}^{\bar{y}} \left(\max \left[W_s^{OP}(y'), W_s^U \right] - W_s^{NP}(y) \right) dH \\ & + \sigma [W_s^{OLF} - W_s^{NP}(y)], \end{aligned} \tag{38}$$

$$\begin{aligned} rW_s^{OP}(y) = {} & w_s^{OP}(y) + \eta \int_{\underline{y}}^{\bar{y}} \left(\max \left[W_s^{OP}(y'), W_s^U \right] - W_s^{OP}(y) \right) dH \\ & + \sigma [W_s^{OLF} - W_s^{OP}(y)], \end{aligned} \tag{39}$$

$$rW_s^T(y) = w_s^T(y) + \tau [W_s^U - W_s^T(y)] + \sigma [W_s^{OLF} - W_s^T(y)]. \tag{40}$$

where

$$rW_j^{OLF} = \pi_j^{OLF} + m(W_j^U - W_j^{OLF}), \tag{41}$$

$$(r+d)W_s^{OLF} = \pi_s^{OLF}. \tag{42}$$

Equations (36) and (37) describe the present discount value of income for the two options available to the worker when in the junior phase of her working career. If the worker is offered a permanent contract, when her productivity is revealed (at rate λ) the worker might keep the permanent job or get fired. In addition, the worker might lose her job in case of an exogenous shock hitting the match (at rate δ). Alternatively, if offered a short-term contract, when the productivity level is revealed (at rate λ), the worker could be employed as a senior temporary worker or get upgraded to a permanent contract. Nevertheless, her contract will naturally terminate at rate τ. The value functions of permanent senior workers hired on permanent contracts (equations (38) and (39)) present no major differences compared to the benchmark model.

3.3.3 Equilibrium Conditions and Wage Determination. In order to derive the equilibrium values, first we compute the equilibrium wage levels for junior and senior workers, by maximizing the surplus of the employer-employee matches:

$$w_j^T = \beta y_0 + (1-\beta)(r+\lambda)W_j^U - (1-\beta)\lambda W_s^U, \tag{43}$$

$$w_j^P = \beta y_0 + (1-\beta)(r+\lambda)W_j^U - (1-\beta)\lambda W_s^U - \beta F\left(\delta + \lambda\int_{\underline{y}}^{\tilde{y}} h(y),dy\right), \tag{44}$$

$$w_s^T(y) = \beta y + (1-\beta)(r+\sigma)W_s^U - (1-\beta)\sigma W_s^{OLF}, \tag{45}$$

$$w_s^{NP}(y) = \beta y - \beta\eta F + (1-\beta)(r+\sigma)W_s^U - (1-\beta)\sigma W_s^{OLF}, \tag{46}$$

$$w_s^{OP}(y) = \beta y + \beta(r+\sigma)F + (1-\beta)(r+\sigma)W_s^U - (1-\beta)\sigma W_s^{OLF}. \tag{47}$$

Equations (43) and (45) describe the wage of junior and senior workers, respectively, on temporary contracts, equation (44) refers to the wage of junior workers on permanent contracts, while equations (46) and (47)

describe the wage of senior workers on new or ongoing permanent contracts, respectively.

3.3.4 The Choice Between Permanent and Temporary Contracts. It is crucial when computing the equilibrium to understand the decision of firms when offering a contract to junior workers. Since junior workers are homogeneous, i.e., they all have the same productivity y_0, they will all be offered the same type of contract. Specifically, the firm will optimally choose to offer a short-term contract to junior workers whenever the value of offering a short-term contract to junior workers is higher than the value of offering them a permanent contract, that is whenever $J_j^T > J_j^P$.[12] This optimal condition implies that

$$(r+\lambda+\delta)\left[y_0-w_j^T+\lambda\int_{\underline{y}}^{\bar{y}}\max\left(J_s^{NP}(y),J_s^T(y)\right)\,dH\right]$$
$$>(r+\lambda+\tau)\left[y_0-w_j^T+\beta F\left(\delta+\lambda\int_{\underline{y}}^{\hat{y}}h(y),dy\right)+\lambda\int_{\underline{y}}^{\bar{y}}\max\left(J_s^{NP}(y),-F\right)dH-\delta F\right]. \tag{48}$$

Rearranging, we get that short-term contracts for junior workers are more profitable for firms than permanent contracts whenever:

$$\lambda\left\{(r+\lambda+\delta)\left[\int_{\underline{y}}^{\tilde{y}}J_s^T(y),dH(y)+\int_{\tilde{y}}^{\bar{y}}J_s^{NP}(y),dH(y)\right]-(r+\lambda+\tau)\left[\int_{\tilde{y}}^{\bar{y}}J_s^{NP}(y),dH(y)\right]\right\}$$
$$-(\tau-\delta)(y_0-w_j^T)>-(r+\lambda+\tau)\left[(1-\beta)\left(\delta+\lambda\int_{\underline{y}}^{\hat{y}}h(y),dy\right)\right]F. \tag{49}$$

The trade off between permanent and temporary contracts is ascribable to three main factors: (i) the different endogenous destruction rates when the worker becomes senior (at rate λ), (ii) the different exogenous destruction rates (the temporary match is terminated at rate τ versus a permanent match is destroyed at rate δ), and (iii) the firing costs to be paid when a permanent match is destroyed (either endogenously or exogenously). Equation (49) clearly points to the fact that all three elements play an important role in the initial decision of the firm. The first term on the LHS of equation (49) includes the different endogenous destruction rates when junior workers become senior, while the second term describes the different exogenous destruction rates. The term on the RHS of equation (49) includes

[12]If it is optimal for the firm to offer a permanent contract to junior workers, the opportunity to offer a short-term contract will arise again only when the worker is senior. Therefore in equilibrium the share of short-term contracts would be minimal and would involve only senior workers. This hypothesis would rule out the screening device argument for the utilization of short-term contracts. Moreover, this is not observed in the data, which instead show a significant share of young individuals hired on a temporary basis.

the firing cost, which enters with a negative sign. While the first LHS term could be both positive or negative depending on a number of parameters of the model, the second term depends on the termination rates τ and δ. Even though it is not possible to infer a priori whether the condition is satisfied, it is crucial to notice the important role played by the firing cost: for F that grows big the right hand side becomes more negative, that is, for sufficiently large F, equation (49) is always satisfied and the firm always hire junior workers on short-term contracts.

In order for equation (49) to be satisfied, the firing cost F needs to be sufficiently large (please see Appendix for further details), that is:

$$F > \frac{(\tau-\delta)(y_0-w_j^T)-\lambda(r+\lambda+\delta)\left[\int_{\underline{y}}^{\tilde{y}} J_s^T(y), dH(y)+\int_{\tilde{y}}^{\overline{y}} J_s^{NP}(y), dH(y)\right]}{(1-\beta)(r+\lambda+\tau)\left(\delta+\lambda\int_{\underline{y}}^{\hat{y}} h(y), dy\right)} + \frac{\lambda(r+\lambda+\tau)\left[\int_{\hat{y}}^{\overline{y}} J_s^{NP}(y), dH(y)\right]}{(1-\beta)(r+\lambda+\tau)\left(\delta+\lambda\int_{\underline{y}}^{\hat{y}} h(y), dy\right)}. \tag{50}$$

It is interesting to notice that, for the case of equal exogenous destruction rates across contracts, i.e., $\tau = \delta$, substituting in equations (31) and (33), equation (51) simplifies to:

$$F > \frac{\lambda\left\{(r+\tau+\sigma)\int_{\tilde{y}}^{\hat{y}}(y+\epsilon), dH(y)-(r+\eta+\sigma)\int_{\underline{y}}^{\hat{y}}(y+\epsilon), dH(y)\right\}}{(r+\tau+\sigma)(r+\eta+\sigma)\left[(1-\beta)(\delta+\lambda\int_{\underline{y}}^{\tilde{y}} h(y), dy)-\beta\lambda\eta\int_{\tilde{y}}^{\hat{y}} h(y), dy\right]}. \tag{51}$$

where $\epsilon = -(r+\sigma)W_s^U + \sigma W_s^{OLF}$.

As analytically it is rather complicated, in what follows, we assume that this condition is satisfied, that is firms maximise their utility by choosing optimally to offer short-term contracts to junior workers. In the calibration exercise we will numerically verify that equation (50) is satisfied.

We then compute the two job creation optimal threshold levels for which the firm is indifferent between offering a permanent or a temporary contract ($\tilde{y}$), and between offering a temporary or no contract ($\ddot{y}$) when hiring a senior worker.

$$J_s^{NP}(\tilde{y}) = J_s^T(\tilde{y}), \tag{52}$$

$$J_s^T(\ddot{y}) = 0 \tag{53}$$

We also compute the job destruction productivity threshold for which the firm is indifferent whether to keep the worker on a permanent contract or to fire the worker ($\hat{y}$), whenever an idiosyncratic match-specific job destruction shock hits the permanent match, at rate η.

$$J_s^{OP}(\hat{y}) + F = 0 \tag{54}$$

Hence in equilibrium, the productivity thresholds read:

$$\tilde{y} = (r+\sigma) W_s^U - \sigma W_s^{OLF} - \frac{\eta(r+\tau+\sigma)}{(\tau-\eta)} \left(\frac{1}{(r+\eta+\sigma)} \int_{\hat{y}}^{\overline{y}} (y-\hat{y})\, dH - F \right), \tag{55}$$

$$\ddot{y} = (r+\sigma) W_s^U - \sigma W_s^{OLF}, \tag{56}$$

$$\hat{y} = (r+\sigma) W_s^U - \sigma W_s^{OLF} - (r+\eta+\sigma) F - \frac{\eta}{(r+\eta+\sigma)} \int_{\hat{y}}^{\overline{y}} (y-\hat{y})\, dH. \tag{57}$$

3.4 *The Economy Before and After the Reforms*

The workers' flows implied by the models before and after the reforms are reported in Figures 3 and 4. For junior workers, in equilibrium the main change between the two scenarios has to do with the type of contract they are hired on, which is chosen optimally in the post-reforms economy by the firm. In the pre-reforms economy, the junior worker is hired on a permanent basis. Her contract may be hit by an exogenous job destruction shock

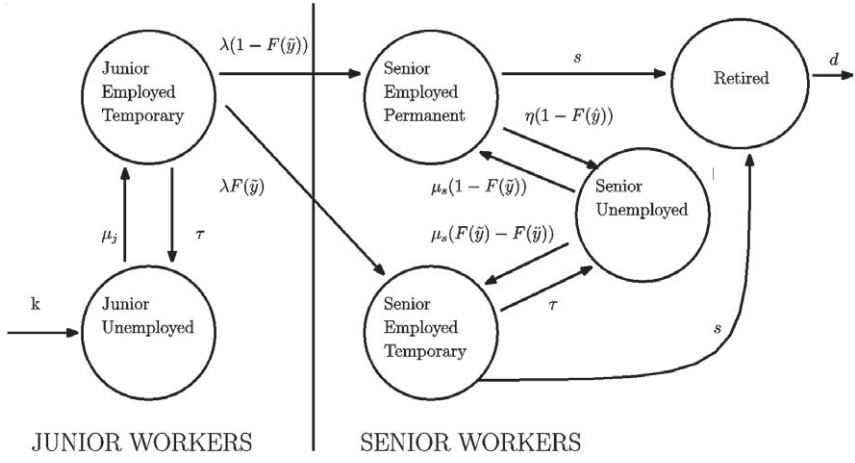


FIG. 4. Model Post-Reforms

at rate δ and she becomes unemployed or she may become senior at rate λ. In the post-reforms economy, the junior worker is hired on a temporary basis. Her contract may therefore terminate at rate τ (because of its limited duration) and she becomes unemployed or she may become senior at rate λ. The transition rate from junior to senior is unchanged before and after the reforms and happens at rate λ. Also the junior job seeker in the pre-reforms economy finds a job at rate μ_j and then at rate λ she transits to the senior market. This is the same after the reforms.

Senior workers are hired on permanent contracts before the reforms. They can get a job if the productivity levels drawn are high enough, either after the productivity shock λ hits the match when they are still junior ($y > \check{y}$), or when hired from the unemployment pool ($y > y^*$). They can lose their job after the productivity shock η hits the match if $y > \hat{y}$ and they can also retire at rate s. In the post-reforms economy, we observe for senior workers the coexistence of both short-term and permanent contracts. Specifically, they can get a permanent job if the productivity levels drawn are high enough ($y > \tilde{y}$), either after the productivity shock λ hits the match, or when hired from the unemployment pool. Alternatively, they can get a short-term job if the productivity level drawn after the productivity shock λ hits the match when they are still junior is low ($y \leq \tilde{y}$) or if the productivity level drawn when hired from the unemployment pool is in a medium range ($\ddot{y} < y < \tilde{y}$). They can lose their permanent job after the productivity shock η hits the match if $y > \hat{y}$ and they can also retire at rate s. If hired on a short-term job, they can loose their job at termination (at rate τ) and they can also retire at rate s.

3.5 The economy compared to Blanchard and Landier (2002)

The model pre-reforms is not very different from the BL model. Indeed, in our model, junior workers have fixed productivity, while the productivity level of senior workers is drawn by a distribution, in their model workers in entry-level jobs have fixed productivity, while the productivity level of workers in regular jobs is drawn by a distribution. In addition, entry-level jobs can be upgraded to regular jobs and are associated with lower firing costs, while regular jobs are open-ended and associated with higher firing costs. However, in our model workers age over time, so we distinguish between junior and senior workers (Figure 5). Moreover, in their model they do not allow for endogenous separations for workers hired on regular jobs, so the firing costs enter only in the bargaining and not in the separation decisions. Finally, they model the reform as a reduction in the firing cost associated with entry-level jobs. We depart from this modelling strategy and we model the reforms as the availability of an additional type of contract, i.e., the short-term contract. This setup is more general as, while in their model firms do not choose which contract to offer, but always hire workers

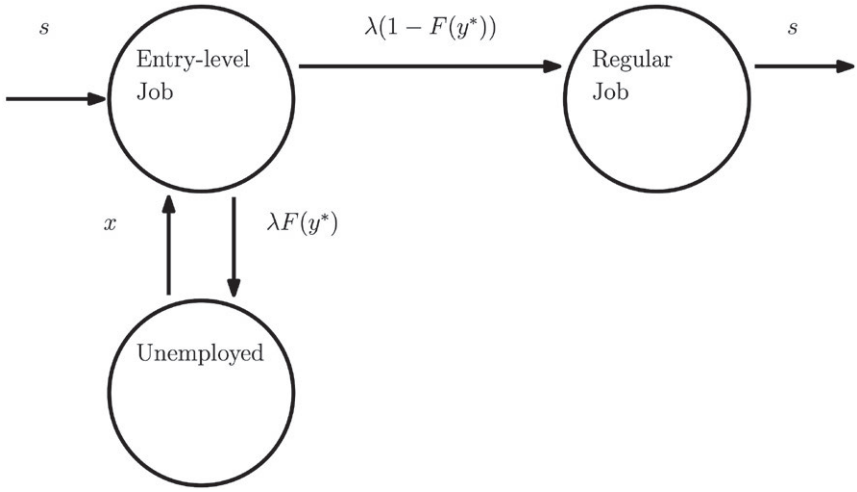


Fig. 5. Model of Blanchard and Landier (2002)

on entry-level jobs first, in our model firms optimally decide whether to hire workers (both junior and senior) on short-term or permanent contracts. This allows us to perform policy experiments to capture the effect of specific policy interventions related to the use of short-term versus permanent contracts. Hence, while their model is useful to perform a positive analysis, our model also allows for a normative investigation.

4 Calibration

Parameter values are selected so that the steady-state equilibrium of our model matches key labour market statistics of the Italian economy before the reforms (1990–5) and after the reforms (2004–8), assuming that one period of time equals one month.

A summary of the parameter values and their source can be found in Table 2.

The discount factor r is set to match an annual interest rate of 5%, as reported by OECD. Following a common practice in the literature, we assume a Cobb-Douglas matching technology of the form $m(u, v) = hu^{\kappa}v^{(1-\kappa)}$, where h is the parameter which captures the overall efficiency of the matching process and κ is the elasticity of the matching function with respect to unemployment. We calibrate the parameters of the matching technology according to the estimates of Peracchi and Viviano (2004). Specifically, we set the elasticity of the matching function with respect to unemployment for junior workers to 0.17, which is the estimated value for the population aged 16–24. Then, we set the same parameter for senior workers to 0.31, as

Table 2
Calibration Parameter Values

Parameter	Pre-reforms	Source	Post-reforms
r	0.004	OECD	0.004
h_j	0.273	Peracchi and Viviano (2004)	0.273
h_s	0.17	Peracchi and Viviano (2004)	0.17
κ_j	0.17	Peracchi and Viviano (2004)	0.17
κ_s	0.31	Peracchi and Viviano (2004)	0.31
β	0.5	Pissarides and Petrongolo (2001)	0.5
δ	0.0085	Bertola and Rogerson (1997), Faccini (2014)	0.0085
F	5	Boeri and Burda (2009), Faccini (2008)	5
F_0	5	Boeri and Burda (2009), Faccini (2008) Garibaldi and Violante (2006)	—
λ	0.05	Blanchard and Landier (2002), Dolado *et al.* (2007)	0.05
τ	—	Lilla and Staffolani (2012)	0.1
c^P	0.15	Boeri and Burda (2009), Djankov *et al.* (2002)	0.15
c^T	—	Abowd and Kramarz (2003)	0
b	0.5	Dolado *et al.* (2007); OECD (2013)	0.5
π_j^{OLF}	0	Normalized	0
π_s^{OLF}	0	Normalized	0
$\underline{y}$	0	Normalized	0
k	0.201	To match the % of junior workers in unemployment	0.201
m	0.024	To match the % of junior workers in employment	0.019
η	0.013	To match the % of senior workers in employment	0.013
σ	0.0036	To match the % of senior workers in unemployment	0.0028
y_0	1.6	To match the wage of junior workers	1.6
y	2.6	To match the wage ratio of junior and senior workers	2.6

the weighted average of the estimated values for the population aged 35–44 and above 45. The mismatch parameter h is also calibrated as the average by population groups and is set equal to 0.273 and 0.17 for junior and senior workers, respectively.

We set the parameter which defines the bargaining power of the workers equal to 0.5, which is standard in the literature (Pissarides and Petrongolo, 2001). The exogenous job destruction rate δ is set to 0.0085 as in Faccini (2014) to match a yearly job destruction rate of 10%, which is consistent with the values reported by Bertola and Rogerson (1997) for Italy as well as for other European countries. We will explore the robustness of this value in the sensitivity analysis reported in Section 5.2.

Although there are no direct estimates, in the literature firing costs in Mediterranean countries vary from six weeks of average revenue (Nagypál, 2002) to 50% of annual income (Alonso-Borrego *et al.*, 2005) to one year and a half of average output (Blanchard and Landier, 2002). We follow Faccini

(2008) and set the firing costs equal to 5, which correspond to a value between three and four months of the average salary observed in equilibrium, which is consistent with the value reported by the World Bank for Italy. We assume the cost is the same for junior and senior workers. This is in line also with the calibration of Boeri and Burda (2009) and corresponds to the levels of the pure tax component of employment protection legislation estimated by Garibaldi and Violante (2006) for Italy.

The monthly probability of a productivity change on an entry level job is set by Blanchard and Landier (2002) and Faccini (2008) to 10%. Dolado *et al*. (2007) set the quarterly probability of a productivity change to 2% and 5% for more and less productive workers, respectively. We set the value of the parameter to a conservative level of 5%. The parameter τ, which represents the rate at which the contract exogenously terminates, is set equal to 0.1. This value sets the average length of a contract between six and seven months, which lays in between the estimated average length of temporary contracts in Italy of eight months and the estimated average length of short-term contracts only[13] of four months (Lilla and Staffolani, 2012).

The vacancy cost, represented by the parameter c, is set equal to 0.15, which reflects typical estimates of total start-up costs as a percentage of income per capita by Djankov *et al*. (2002), converted to a fraction of labour productivity using the average 1990s employment rate, as in Boeri and Burda (2009). We set the vacancy cost associated with short-term contracts to be zero, in line with the estimation by Abowd and Kramarz (2003) for France.

Next, we calibrate the parameter b of unemployment benefits. Selecting an appropriate value is quite controversial since b includes not only unemployment benefits, but also other non measurable entities, such as the dis-utility of work, the home production, etc. Moreover, in Italy benefits are less generous compared to most European countries (Schindler, 2009).[14] Dolado *et al*. (2007) estimated the replacement ratio in Italy to be equal to 0.2, OECD (2013) reports a replacement ratio of 0.2 for the years 1990–97 and 0.34 for the years 1999–2003. We choose a value for b equal to 0.5 to match an average value of 0.35 and explore the robustness of this value in the sensitivity analysis reported in Section 5.2.

[13]Short-term contracts represent approximately 65% of all temporary contracts (Lilla and Staffolani, 2012).

[14]The Italian unemployment insurance (UI) system is complex and uneven. While ordinary UI benefits are initially relatively high, with a net replacement rate of 60 per cent, they drop to zero after 8 months (12 months for workers aged over 50), and complex eligibility rules imply that only few unemployed individuals actually receive such UI benefits (Demekas, 1995). In 2005, 2.3% of the labour force received UI benefits, about a third the rate in other EU countries.

Table 3
Labor Market Statistics: Data Versus Model

	Data		Model	
	Pre-reforms	Post-reforms	Pre-reforms	Post-reforms
Junior workers (Age 15–24)[a]				
Employment	28.7%	26.2%	28.1%	24.9%
Unemployment	12.7%	8.2%	13.3%	9.7%
Out of labourforce	58.6%	65.6%	58.6%	65.4%
Senior workers (Age 25–64)[a]				
Employment	58.2%	65.0%	58.8%	64.8%
Unemployment	4.8%	4.0%	4.7%	3.8%
Out of labourforce	37.0%	31.0%	36.5%	31.3%
Wages[b]				
Junior Perm.	934	–	951	–
Junior Temp.	–	856	–	876
Senior Perm.	1335	1453	1394	1449
Senior Temp.	–	1091	–	1012
Junior Perm./ Senior Perm.[c]	0.700	–	0.682	–
Junior Temp./ Senior Perm.[d]	–	0.589	–	0.610
Senior Temp./ Senior Perm.[e]	–	0.751	–	0.705

[a]Source: OECD. [b]Monthly wages in euros deflated using the CPI index as provided by the Italian Institute of Statistics (ISTAT). Source: WHIP (2005). [c]Calculated as the ratio of the average wage of junior and senior workers hired on permanent contracts. [d]Calculated as the ratio of the average wage of junior workers hired on temporary contracts and senior workers hired on permanent contracts. [e]Calculated as the ratio of the average wage of senior workers hired on temporary contracts and senior workers hired on permanent contracts.

We select a uniform distribution for the function $H(y)$ and set the lower bound of the distribution equal to 0. Finally, we normalize the flow of home production for junior and senior workers to zero ($\pi_j^{OLF} = \pi_s^{OLF} = 0$).

The next six rows in Table 2 show the parameters set within the model to match the following moment conditions for the pre-reforms economy, which are obtained from the OECD statistics and social security data (Table 3)[15]: (1) an average share of junior workers (age 15–24) in employment in the period 1990–94 equal to 28.7%; (2) an average share of junior workers (age 15–24) in unemployment in the period 1990–94 equal to 12.7%; (3) an average share of senior workers (age 25–64) in employment in the period 1990-1994 equal to 58.2%; (4) an average share of senior workers (age 25–64) in unemployment in the period 1990–94 equal to 4.8%; (5) the average wage of junior workers (age 15–24) hired on permanent contracts equal to 934 euro (6) a ratio of the average wage of junior (age 15–24) and senior workers (age 25–64) hired on permanent contracts equal to 0.70.

[15]We use the Work Histories Italian Panel (WHIP) dataset as provided by Collegio Carlo Alberto (WHIP, 2005) for the years 1990–2004.

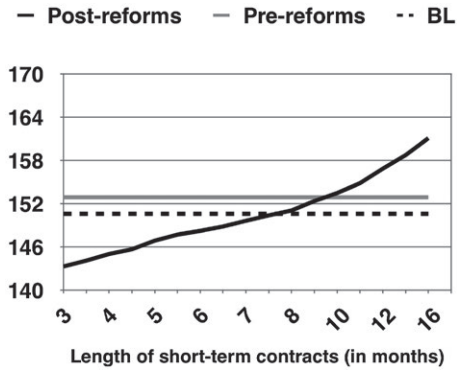


FIG. 6. Length of Temporary Contracts

In the post-reforms economy, we used the same parameters as in the pre-reforms economy.[16]

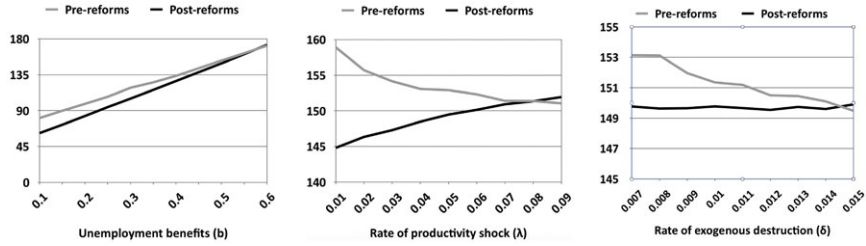
The sensitivity analysis performed in Figure 7 explores the robustness of the results to changes in the most sensitive parameters (b, λ and δ).

5 FINDINGS

Using the parameter values described in Section 4, we compute the present discounted value of income for all workers before and after the reforms, represented by the workers' value functions.

Let's start with junior workers. We compare the present discounted value of the utility of a junior worker when employed before and after the reforms. Before the reforms an employed junior worker is employed permanently and the worker-firm match she is part of is subject to an exogenous destruction rate δ. In the post-reforms economy the worker is hired short-term and the match destruction is due to the contract termination, which happens at rate τ. According to our calibration, the match destruction rate is much higher in the second scenario ($\tau = 0.1$ while $\delta = 0.0085$) and therefore a junior worker after the reforms is significantly more exposed to cycles of employment and unemployment. When unemployed, the junior worker has more chances to find a job whenever short-term contracts are present: 38%

[16]We can notice that the retirement rate turns out to be higher after the reforms to capture the lower percentage of senior workers out of the labour force. This can be explained by the fact that important pension reforms have been implemented in order to increase the age of retirement. According to the OECD Statistics, while the effective retirement rate for women has slightly declined from 59.7 to 59.4 in the decade 1995–2004, the effective retirement rate for men has increased from 59.1 to 61.4. Numbers show the labour force participation has increased for the two oldest cohorts, 45–54 and 55–64 years old, between 2000 and 2008 proportionally to the increase of employment. Nevertheless, robustness exercises are provided in order to test for the relevance of this parameter.



(a) Unemployment benefits b· (b) Rate of productivity shock λ· (c) Rate of job destruction δ·

FIG. 7. Sensitivity Analysis

in the post reforms economy compared to 12% in the pre-reforms economy, according to our calibration. However, whenever a productivity shock hits the match and the worker becomes senior (at rate λ), junior workers face different perspectives before and after the reforms. In the pre-reforms economy, the worker can be offered a permanent position with 61% probability or become unemployed with 39% probability. In the post-reforms economy, the worker may be offered a permanent position, with 58% probability or might keep a contract of temporary nature with 42% probability.

We then compute the present discounted value of the utility of junior workers (W_j^E and W_j^T), and we find lower values in the scenario with short-term contracts. This is due to the fact that the (quite) short duration of temporary contracts causes junior workers to experience several cycles of temporary employment and unemployment before getting senior; and even though the probability to find a new job when unemployed is much higher post-reforms, this is probably not enough to compensate for the loss due to the higher turnover. Moreover, upon turning senior, junior workers face a lower chance to get a permanent position and have to go through some cycles of short-term employment before getting a productivity draw high enough to be offered a permanent job. Therefore, even though the wage level is only slightly lower post-reforms, we find that junior workers are worse off in the scenario with temporary contracts.

This result is heavily dependent on the length of the short-term contract. In order to understand how much our results depend on the the termination rate of the short-term contracts and therefore on their length, we compute the present discounted value of the utility for different values of the parameter τ. Specifically, we consider a range of values for the termination shock τ corresponding to a contract length varying from 3 months to 16 months (Figure 6). In the calibration exercise we use a value of τ equal to 0.1, which corresponds to the average duration of short-term contracts in Italy of approximately 6.5 months.

Table 4
Present Discounted Value of Income By Worker's Types

	Pre-reforms	Post-reforms	% change
Utility when employed			
Junior (J_j^E)	152.9	149.7	−2.1%
Senior More productive			
ongoing (J_s^O)	161.2	182.9	+12.3%
transiting (J_s^R)	155.7		
new (J_s^N)	149.9	180.2	+20.0%
Senior Less productive (J_s^T)		146.2	
Utility when unemployed			
Junior (J_j^U)	152.0	149.5	−1.6%
Senior (J_s^U)	148.5	176.3	+18.9%

Interestingly, we observe that the present discounted value of the utility of junior workers increases substantially for junior workers as the length of the contract gets longer. This result is not surprising: whenever a young worker incurs in a job loss because of contract expiration (at rate τ), the worker is still junior; hence, the worker's career will include a period of unemployment until another job offer arrives with the same characteristics: a new short-term contract with the same salary. Therefore, the loss in utility is ascribable to the period that the worker spends in unemployment with a lower income (unemployment benefits). The shorter the contract, the higher is the probability that the worker will experience this loss multiple times. However, as the contract gets longer, the gain from the increased labour market flexibility may overcome the loss due to the higher turnover, increasing the income of junior workers. In the scenario in which the length of short-term contracts is longer than 10 months, the present discounted value of utility is higher in the presence of short-term contracts. This result is particularly interesting as there is evidence of short-term contracts becoming shorter and shorter (Cahuc *et al*., 2016; Charlot *et al*., 2016) and according to our model this might further reduce the income of junior workers.

When considering high productivity senior workers, i.e., those workers whose randomly drawn productivity level when turning senior is high enough that they would have been hired permanently both before and after the reforms, we find that they are better off in the economy with short-term contracts (Table 4). This is partly due to the fact that they stay longer in the labour force as the parameter associated with retirement is lower and partly due to the higher salary they enjoy in the post-reforms economy. To disentangle the two effects, we perform a counter-factual exercise. We compute the present discounted value of the utility using the same value of the retirement parameter as in the pre-reforms economy, and we find that senior workers are still better off in the presence of short-term contracts, but the gap is smaller (Table 5). Next, we compute the present discounted

Table 5
Counterfactual Exercise: Same Retirement Rate (σ) Before and After the Reforms

	Pre-reforms	Post-reforms	% change
Utility when employed			
Junior (J_i^E)	152.9	148.5	−2.9%
Senior More productive			
ongoing (J_s^O)	162.8	178.6	+9.7%
transiting (J_s^R)	155.7		
new (J_s^N)	150.1	173.5	+15.6%
Senior Less productive (J_s^T)		146.6	
Utility when unemployed			
Junior (J_i^U)	152.0	148.2	−2.5%
Senior (J_s^U)	148.2	168.3	+13.6%

value of the utility considering the same salary as they would have earned in an economy without short-term contracts, and again we find that they are still better off in the post-reforms economy, even though the gap is smaller (Table 6).

When considering less productive workers, i.e., those workers whose drawn productivity level when turning senior is such that they would have been hired permanently before the reforms and short-term in the post-reforms economy, we find that they are worse off in the second scenario. Not only the destruction rate of their match is higher due to the short-term nature of their contract ($\tau > \eta H(\hat{y})$), but also their wage level is lower. Therefore, the present discounted value of their utility is lower. In order to disentangle the wage effect from the turnover component, we perform the same counter-factual exercise as for senior more productive workers. We replace the wages post-reforms with the same wages workers would have earned before the reforms. The aim of this exercise is to understand whether it is the lower wage associated with short-term contracts, which determines the results or the findings are due to the nature of the short-term contracts itself. The results of this exercise are shown in Table 6. We obtain interesting findings: workers hired short-term still face lower income after the reforms. We interpret this result as evidence that it is not only the lower wages associated with short-term contracts for senior workers which lead to lower income post-reforms, but the high turnover associated with this type of contracts significantly reduced their well-being.

In summary, we conclude that junior workers are worse off after the reforms. Workers who end up in a good match when they turn senior are better off after the reforms due to lower retirement rates and higher salaries, while workers who end up in a bad match at the time of the transition to seniority, face a reduction in the present discount value of income when short-term contracts are present. In addition, the length of short-term contracts is a rather important element affecting the workers' income: for short-term

Table 6
Counter-Factual Exercise: Same Wage Before and After the Reforms

	Pre-reforms	Post-reforms	% change
Utility when employed			
Junior (J_j^E)	152.9	147.5	−3.5%
Senior More productive			
ongoing (J_s^O)	162.8	168.1	+3.3%
transiting (J_s^R)	155.7		
new (J_s^N)	150.1	156.6	+4.3%
Senior Less productive (J_s^T)		147.7	
Utility when unemployed			
Junior (J_j^U)	152.0	149.3	−1.8%
Senior (J_s^U)	148.2	155.2	+4.7%

Table 7
Alternative Modelling of the Reforms: A Reduction in Firing Costs for Junior Workers

	Pre-reforms	Post-reforms	% change
Utility when employed			
Junior (J_j^E)	152.9	150.6	−1.5%
Senior More productive			
ongoing (J_s^O)	162.8	162.1	−0.4%
transiting (J_s^R)	155.7	149.6	−3.9%
new (J_s^N)	150.1	148.7	−0.9%
Senior Less productive (J_s^T)	147.7	147.5	−0.1%
Utility when unemployed			
Junior (J_j^U)	152.0	149.8	−1.4%
Senior (J_s^U)	148.2	147.4	−0.5%

contracts of very short duration junior workers are better off in the pre-reforms economy, while for contracts longer than 18 months, the opposite is true (see Table 7).

5.1 Alternative modelling of the reforms à la Blanchard and Landier (2002)

As in Blanchard and Landier (2002), we could have alternatively modelled the reforms by quantifying the impact of the reduction of firing costs F_0 for junior workers within the benchmark model setup. Even though this choice would not have allowed us to analyse the choice faced by firms between short-term contracts and permanent contracts, it is interesting to compare the results. Let's therefore assume that in the benchmark model the firing costs for junior workers F_0 are now reduced to zero, while firing costs F associated with permanent employees are kept at the same value. We compute the present discounted value of the income of both categories of workers in this scenario. We find a negative impact of the reforms on the present discounted value of income of junior workers, confirming the BL results. In

fact, due to lower firing costs, on one hand the probability to find a job is higher, on the other hand firms fire more junior workers when the productivity is revealed, increasing the turnover. As this second effects prevails, junior workers are worse off after the reforms, confirming the findings obtained using the model with short-term contracts. The magnitude of the change is similar in both approaches: in fact, according to this modelling approach, the income of junior workers is down by 1.5% after the reforms, compared to a decline of 2.1% as obtained using the model with short-term contracts. The slight smaller effect in the former may be due to the fact that with this modelling strategy firms do not have choices regarding the type of contracts to use when hiring junior workers. In the model with short-term contracts, instead, firms have a trade-off: they can use the traditional permanent contract which is open-ended and associated with firing costs or the short-term contract, which has limited duration, but no firing costs. As in equilibrium firms optimally choose to use short-term contracts, and as according to our calibration, turnover is higher with short-term contracts, the impact of the reforms is stronger. However, when we perturb other key policy parameters in dual labour economies such as Southern European countries, for instance the short-term contract termination rate (τ), we get interesting results with our model, while no insights from the BL model (Figure 6). In the BL model in fact, the length of the entry-level job is determined by the same shock that defines the transition to a regular job. In our model, we disentangle the two shocks in order to separately analyse the impact of each of them on the junior income. Hence, compared to the BL framework, our model has the potential of providing more normative insights in terms of policy recommendations related to specific features of the short-term contract and to crucial parameters affecting the choice between permanent and short-term contracts.

5.2 Sensitivity Analysis

We analyse in this section the robustness of the results to perturbations of key parameters. In the left panel of Figure 7 we report the utility of junior workers pre and post-reforms as a function of the unemployment benefit b. We observe that the present discounted value of the utility is always higher pre-reforms, and as expected both values increase as the unemployment benefit increases. In addition, we can notice that as b increases, the utility post-reforms tends to converge to the one pre-reforms.

Then, we consider the perturbation of the parameter reflecting the rate at which the productivity of a junior worker is revealed, λ. We allow the parameter to vary in a range from 0.01 to 0.09. The change in the parameter's value affects junior workers pre-reforms and post-reforms. In the middle panel of Figure 7, the graph shows that as λ increases, the utility of junior workers is higher in the pre-reforms economy, confirming the robustness of

our results to perturbation of the λ parameter. As λ increases the utilities in the two economies converge.

Finally, we perturb the parameters associated with the exogenous destruction rate, δ. The change in the parameter's value affects directly junior workers in the pre-reforms economy. The right panel in Figure 7 shows that the utility is higher pre-reforms, however as δ increases, the utility of junior workers before and after the reforms converge.

In summary, we can conclude that our results are robust to the perturbation of the model key parameters and the present discounted value of the utility of junior workers is higher in the pre-reforms economy when temporary contracts are not present.

6 Conclusions and Discussion

In this paper we quantify the effect of the introduction of short-term employment contracts in the labour market on the utility of different categories of workers. We suitably modify the search and matching framework developed by Blanchard and Landier (2002) in several directions to compute the present discounted value of the utility of junior and senior workers. Specifically, we allow for the ageing of the workers, for the endogenous separations of senior workers, and we model the reform as the availability of an additional contract type, i.e., the short-term contract, and we let the firms optimally choose the most profitable option. Then, we compare the working careers of both types of individuals before the reforms, when only permanent contracts are available, and after the reforms, when permanent and short-term contracts coexist.

We perform the calibration of the model using data from Italy in order to quantify the income change due to the implementation of the reforms. We find that junior workers are worse off in the economy with temporary contracts. Even though the probability to find a job when they are unemployed is higher after the reforms, due to the higher market tightness, the short-term length of the contract they are hired on leads to a much higher turnover rate and lower present discounted value of the utility. That is, the higher labour market flexibility does not compensate for the increased frequency of cycles of employment and unemployment. Senior workers who would have been hired on a permanent contract before and after the reforms, are better off in the second scenario as they have higher chances to find a new job when their match is hit by an endogenous destruction shock and they enjoy a higher salary. Finally, senior workers who would have been hired on a permanent basis before the reforms but on a temporary basis in the post-reforms economy, fare worse, as they experience high rates of turnover and a wage reduction.

Finally, we find that the length of the short-term contract is a crucial determinant of the utility of junior workers: the longer the temporary

contracts, the higher the present discounted value of their utility. This result has important policy implications in a time in which the length of temporary contracts is getting significantly shorter (Charlot *et al*., 2016).

Next step in our research agenda is to study the effect on the utility of junior workers of the new labour market reform, which has been recently implemented in Italy, which introduces a unique open-ended contract with increasing firing costs with tenure, as suggested by several economists in Europe (Bentolila, Jimeno *et al*., 2012; Boeri *et al*., 2012; Lepage-Saucier *et al*., 2013; Saint-Paul, 1996).

Appendix

A.1 Optimal Choice of Permanent Versus Temporary Contracts for Junior Workers

In order for firms to choose which contract to offer to junior workers, they need to compare the gain from offering a short-term contract versus a permanent contract, that is they compare the value function associated with the two contract types and offer a temporary contract whenever:

$$J_j^T > J_j^P, \tag{58}$$

that is whenever

$$rJ_j^T = y_0 - w_j^T + \lambda \int_{\underline{y}}^{\overline{y}} (\max\left[J_s^{NP}(y), J_s^T(y)\right] - J_j^T)\, dH - \tau J_j^T, \tag{59}$$

is greater than

$$rJ_j^P = y_0 - w_j^P + \lambda \int_{\underline{y}}^{\overline{y}} (\max\left[J_s^{NP}(y), -F\right] - J_j^P)\, dH - \delta(J_j^P + F). \tag{60}$$

Knowing the wage of junior workers under the two circumstances:

$$w_j^T = \beta y_0 + (1-\beta)(r+\lambda) W_j^U - (1-\beta)\lambda W_s^U, \tag{61}$$

$$\begin{aligned} w_j^P = {} & \beta y_0 + (1-\beta)(r+\lambda) W_j^U - (1-\beta)\lambda W_s^U \\ & - \beta F \left(\delta + \lambda \textstyle\int_{\underline{y}}^{\tilde{y}} h(y), dy\right), \end{aligned} \tag{62}$$

we get that

$$w_j^P = w_j^T - \beta F \left(\delta + \lambda \int_{\underline{y}}^{\tilde{y}} h(y), dy\right). \tag{63}$$

Hence, firms prefer to offer short-term contracts to junior workers whenever:

$$\begin{aligned}&(r+\lambda+\delta)\left[y_0-w_j^T+\lambda\int_{\underline{y}}^{\overline{y}}\max\left(J_s^{NP}(y),J_s^T(y)\right)\,dH\right]\\&>(r+\lambda+\tau)\left[y_0-w_j^T+\beta F\left(\delta+\lambda\int_{\underline{y}}^{\tilde{y}}h(y),dy\right)\right.\\&\left.+\lambda\int_{\underline{y}}^{\overline{y}}\max\left(J_s^{NP}(y),-F\right)dH-\delta F\right].\end{aligned}\tag{64}$$

where

$$J_s^{NP}(y)=\frac{(1-\beta)(y-(r+\sigma)W_s^U+\sigma W_s^{OLF})+\beta\eta F}{r+\eta+\sigma},\tag{65}$$

$$J_s^T(y)=\frac{(1-\beta)(y-(r+\sigma)W_s^U+\sigma W_s^{OLF})}{r+\tau+\sigma}.\tag{66}$$

Rearranging, we get that short-term contracts for junior workers are more profitable for firms than permanent contracts whenever:

$$\begin{aligned}&\lambda\left\{(r+\lambda+\delta)\left[\int_{\underline{y}}^{\hat{y}}J_s^T(y),dH(y)+\int_{\hat{y}}^{\overline{y}}J_s^{NP}(y),dH(y)\right]\right.\\&\left.-(r+\lambda+\tau)\left[\int_{\tilde{y}}^{\overline{y}}J_s^{NP}(y),dH(y)\right]\right\}-(\tau-\delta)(y_0-w_j^T)\\&>-(r+\lambda+\tau)\left[(1-\beta)\left(\delta+\lambda\int_{\underline{y}}^{\tilde{y}}h(y),dy\right)\right]F.\end{aligned}\tag{67}$$

The trade off between permanent and temporary contracts is given by three main factors: (i) the different options available when a junior worker becomes senior (first term on the LHS of equation (67)), (ii) the different exogenous destruction rate (second term on the LHS of equation (67)) and (iii) the firing costs to be paid when a permanent match is destroyed, either endogenously or exogenously (the RHS of equation (67)).

The above equation is satisfied whenever the firing cost is sufficiently large, that is:

$$\begin{aligned}F>&\frac{(\tau-\delta)(y_0-w_j^T)-\lambda(r+\lambda+\delta)\left[\int_{\underline{y}}^{\hat{y}}J_s^T(y),dH(y)+\int_{\hat{y}}^{\overline{y}}J_s^{NP}(y),dH(y)\right]}{(1-\beta)(r+\lambda+\tau)\left(\delta+\lambda\int_{\underline{y}}^{\tilde{y}}h(y),dy\right)}\\&+\frac{\lambda(r+\lambda+\tau)\left[\int_{\tilde{y}}^{\overline{y}}J_s^{NP}(y),dH(y)\right]}{(1-\beta)(r+\lambda+\tau)\left(\delta+\lambda\int_{\underline{y}}^{\tilde{y}}h(y),dy\right)}.\end{aligned}\tag{68}$$

It is interesting to notice that, for $\tau = \delta$, which is whenever the exogenous destruction rate is equal for both permanent and temporary contracts, equation (68) simplifies to:

$$F > \frac{\lambda \left\{ \int_{\tilde{y}}^{\hat{y}} J_s^{NP}(y), dH(y) - \int_{\underline{y}}^{\hat{y}} J_s^{T}(y), dH(y) \right\}}{(1-\beta)\left(\delta + \lambda \int_{\underline{y}}^{\tilde{y}} h(y), dy\right)}. \tag{69}$$

Equation (69) highlights the fact that whenever the firing cost is higher than the difference between the value of the future opportunities for junior workers turning senior under short-term versus permanent contracts, discounted by the rate at which the permanent contract terminates, the firm would optimally choose to offer short-term contracts to junior workers.

Substituting in for the value function of senior workers, we get:

$$F > \frac{\lambda \left\{ (r+\tau+\sigma) \int_{\tilde{y}}^{\hat{y}} (y+\epsilon), dH(y) - (r+\eta+\sigma) \int_{\underline{y}}^{\hat{y}} (y+\epsilon), dH(y) \right\}}{(r+\tau+\sigma)(r+\eta+\sigma)\left[(1-\beta)(\delta + \lambda \int_{\underline{y}}^{\tilde{y}} h(y), dy) - \beta\lambda\eta \int_{\tilde{y}}^{\hat{y}} h(y), dy\right]}. \tag{70}$$

where $\epsilon = -(r+\sigma)W_s^U + \sigma W_s^{OLF}$.

A.2 Model Extension: Upgrading of Senior Temporary Workers

The model with short-term contracts can be extended by allowing senior workers hired on temporary contracts the possibility to be upgraded to a permanent position. This implies that the value functions for firms and workers respectively read:

$$\begin{aligned} rJ_s^T(y) = y - w_s^T(y) + \eta \int_{\underline{y}}^{\bar{y}} \left[\max\left(J_s^{NP}(y'), J_s^T(y')\right) - J_s^T(y)\right] dH \\ + (\tau+\sigma)[J_s^V - J_s^{\bar{T}}(y)], \end{aligned} \tag{71}$$

$$\begin{aligned} rW_s^T(y) = w_s^T(y) + \eta \int_{\underline{y}}^{\bar{y}} \left(\max\left[W_s^{NP}(y'), W_s^T(y')\right] - W_s^T(y)\right) dH \\ + \tau[W_s^U - W_s^{\bar{T}}(y)] + \sigma[W_s^{OLF} - W_s^T(y)]. \end{aligned} \tag{72}$$

A match-specific productivity shock hits the match at rate η and if the new productivity draw is higher than the productivity threshold $\tilde{y}$, the worker will be upgraded to a permanent position, otherwise the worker will keep the temporary job.

Table 8
Present Discounted Value of Utility by Worker's Types

	Pre-reforms	Post-reforms	% change
Utility when employed			
Junior (J_j^E)	152.9	148.0	−3.2%
Senior More productive			
ongoing (J_s^O)	161.2	181.8	+12.7%
transiting (J_s^R)	155.7		
new (J_s^N)	149.9	182.9	+22.0%
Senior Less productive (J_s^T)		145.1	
Utility when unemployed			
Junior (J_j^U)	152.0	147.8	−2.8%
Senior (J_s^U)	148.5	163.5	+10.1%

By solving the model, we get the following productivity thresholds:

$$\begin{aligned}\tilde{y} = \frac{1}{(1-\beta)\tau}\Bigg[&(r+\eta+\sigma)\eta\left(\int_{\underline{y}}^{\tilde{y}}\frac{(1-\beta)(y-y^*)}{r+\tau+\sigma}\,dH(y)+\int_{\tilde{y}}^{\overline{y}}\frac{(1-\beta)(y-\tilde{y})}{r+\eta+\sigma}\,dH(y)\right)\\&+\tau\left((r+\sigma)W_s^U-\sigma W_s^{OLF}\right)+(r+\tau+\sigma+\eta)(1-\beta)\eta F\\&-\frac{\eta}{(r+\eta+\tau+\sigma)}\left(\int_{\hat{y}}^{\overline{y}}\frac{(1-\beta)(y-\hat{y})}{r+\eta+\sigma}\,dH(y)\right)\Bigg],\end{aligned} \tag{73}$$

$$\ddot{y} = (r+\sigma)W_s^U-\sigma W_s^{OLF}-\frac{\eta}{(r+\eta+\sigma)}\int_{\tilde{y}}^{\overline{y}}(y-\hat{y})\,dH, \tag{74}$$

$$\hat{y} = (r+\sigma)W_s^U-\sigma W_s^{OLF}-(r+\eta+\sigma)F-\frac{\eta}{(r+\eta+\sigma)}\int_{\hat{y}}^{\overline{y}}(y-\hat{y})\,dH. \tag{75}$$

We calibrate this version of the model using the same parameters described in Section 4. Even in this case we are able to match fairly well the statistics reported in Table 3 and we get similar results. Table 8 shows that the utility of junior workers is lower after the reforms by approximately 3 percentage points both when employed and unemployed. Senior workers are better off if the productivity of the match is high, while if the match productivity is low, they fare worse.

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