Tenure and Mismatch in a Dual Labor Market*

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Abstract

This paper investigates why firms offer contracts subject to firing restrictions. The coexistence of costly open-ended contracts with cheaper temporary employment is still a theoretical puzzle. We provide a new explanation that hinges on heterogeneous match productivity, interpreted as the fit of workers’ skills to tasks’ requirements. Our model delivers two predictions: i) mismatch increases the likelihood of stipulating temporary contracts; ii) reforms liberalizing fixed-term contracts increase their use, more so for higher degrees of skill mismatch. These policies have non-linear effects on aggregate unemployment, whose lowest rate is attained at moderate levels of contracts’ flexibility. We estimate the effect on new hires of a reform that lowered restrictions on temporary contracts, and increased their maximum length. Identification relies on a difference-in-difference approach using matched employer-employee data from a large Italian region. We find a negative, but delayed effect on the probability of stipulating new open-ended contracts, which confirms our theoretical predictions.

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1 Introduction

A persistent puzzle in the labor literature concerns the reasons why firms stipulate open-ended contracts. In this paper we argue that employers offer longer contracts to workers who are particularly fit to the task they are recruited for.

In a dual labor market, when hiring a new worker, a firm may offer her an open-ended contract (OEC, or permanent) or a fixed-term contract (FTC). OECs do not carry any expiration date, and entail deadweight losses (fines, legal expenses) in case of unjust layoff. These costs substantially act as a firing tax. FTCs, limited in length, are convertible to OECs at final expiration – comprehensive of possible extensions – or terminated at no cost. The use of FTCs is typically subject to qualitative or quantitative restrictions (reasons for use, quotas).

During the last 30 years, several European labor markets have experienced extensive liberalizations increasing employment flexibility. Although such reforms led to a rise in FTCs stipulations, permanent contracts still represent an important share of new hires. This phenomenon, however, is not only Euro-centric. In Anglo-Saxon countries, governed by an “employment-at-will” principle, we observe firms voluntarily committing to contracts carrying firing restrictions. Up-or-out policies, in which matches start as FCTs that, at expiration, are either upgraded to OECs or terminated, are standard in industries such as consulting, law, and academia.

The co-existence of costly permanent contracts with cheaper temporary employment remains a theoretical puzzle. The literature has mostly advocated the existence of exogenous factors determining sorting. Authors either assume that all matches start as temporary (see, Blanchard and Landier (2002)), or impose exogenous limits on FTCs stipulation, as in Cahuc and Postel-Vinay (2002). Other studies rely on structural differences between the two contracts: distinct matching technologies in Wasmer (1999); higher productivity levels in permanent jobs in Caggese and Cunat (2008); on-the-job search by temporary workers in Cao, Sao, and Silos (2010). Only a few contributions, however, have obtained full endogenous sorting of firms and workers. Berton and Garibaldi (2012) propose a model with directed search and exogenous wages, while in Cahuc, Charlot, and Malherbet (2012), firms face a distribution of production opportunities of different lengths.
Section 2 provides a few stylized facts to advance worker-to-occupation mismatch as a new explanation for firms’ sorting between OECs and FTCs. A widespread hypothesis is that skills, measured by educational attainment, are the main determinant of match productivity. If productivity depends on education, firms will want to retain high-skilled workers by offering them job stability. Indeed, if offered tenure, these employees may search less while employed, and invest more in the match (see Portugal and Varejao (2009) and Cairò and Cajner (2011)). Hence, we should observe higher shares of OECs offered to qualified workers. Yet, data on new hires across industries do not validate such intuition: education is not a good predictor for tenure. In line with recent findings (see Adalet MacGowan and Andrews (2015)), we argue that match productivity is determined by the fit of worker’s skills to task requirements, rather than by workers characteristics alone. Indeed, we observe high shares of new hires as OECs at low degrees of mismatch.

Section 3 rationalizes this evidence in a search model in which idiosyncratic match productivity corresponds to the fit between workers and vacancies. In this perspective, the distance between educational attainment and required job skills lowers productivity. Vacancies meet workers randomly. Both parties perfectly observe the worker-vacancy fit, hence the expected productivity of the match. Based on this assessment, the employer decides whether to hire the worker, and under which contract. The firm-worker pair continuously bargains over the wage. FTCs are subject to fixed stipulation costs; at expiration they can be either converted or terminated at no further loss. OECs do not carry a pre-set expiration date, but are subject to continuous shocks that may eventually make them unprofitable. In this case, the firm can lay off the worker but has to pay a firing tax. These ingredients lead to endogenous sorting: as long as OECs last longer than FTCs, firms offer tenure to workers who display a strong fit to the job. FTCs, free from any cost at termination, are preferred in case of strong mismatch.

The model delivers two predictions: i) mismatch increases the likelihood of stipulating a FTC; ii) reforms liberalizing FTCs increase their share among new hires, more so for higher degrees of mismatch. These policies have non-linear effects on aggregate unemployment: its lowest rate is attained at moderate levels of employment flexibility.

Section 4 tests these predictions on matched employer-employee administrative data from a large
Italian region. The probability of stipulating a new OEC controlling for education, occupational tasks, employment history and demographics increases in the worker-job fit. This validates our first theoretical result. The second prediction is verified through a rich difference-in-difference design exploiting a 2001 reform lowering FTCs’ stipulation costs, and increasing their maximum length. We find that the reform had a negative, but delayed effect on the probability of stipulating a new contract as open-ended.

Finally, the Theoretical Appendix explores two extensions of the benchmark model. The first one introduces investment in match-specific human capital. Investment results in higher OECs stipulations since, on average, they last longer than FTCs. Furthermore, if human capital is complementary to match productivity, firms are willing to hire workers under OECs at lower levels of occupational fit. The second extension introduces learning and probationary periods for permanent contracts. With a few supplementary conditions, the model predictions are robust to these extensions.

2 Stylized Facts

In several European countries, the steady introduction of flexicurity policies has widely reduced EPL restrictions. In turn, between 1990 and 2013, the share of temporary jobs on total dependent employment has risen from 4 to 13% in Italy, from 9 to 15% in France, while averaging 31% in Spain (see Figure 1). The youngest working cohort has absorbed most of this increase, but the trend is increasing across all age groups.

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1 In Italy, contractual freedom for each occupation is regulated by general agreements known as CCNL, negotiated at the national level between firms associations, unions, and government representatives. New regulation modifying any of the conclusions reached through the CCNL becomes effective only at their expiration. These agreements also regulate the limits imposed on the use of FTCs. Hence, the treated group will only include new hires belonging to occupations whose CCNL was either expired at the announcement of the reform, or renewed after the reform.

2 The OECD computes an aggregate measure of employment protection legislation (EPL), rated on a (0-6) scale. EPR represents the index for regular (open-ended) contracts, rating legislation on individual and collective dismissals. EPT is the corresponding index for standard fixed-term positions, and contracts stipulated by temporary work agencies. EPT measures valid cases for use, the maximum number of successive contracts and maximum cumulated duration.
Figure 1: Share of Temporary Employment: all age groups

Source: OECD calculations on Labor Force Surveys (LFS). Temporary job definition in the LFS: "A job may be considered temporary if employer and employee agree that its end is determined by objective conditions such as a specific date, the completion of a task or the return of another employee who has been temporarily replaced (usually stated in a work contract of limited duration). Typical cases are: (a) persons with seasonal employment; (b) persons engaged by an agency or employment exchange and hired to a third party to perform a specific task (unless there is a written work contract of unlimited duration); (c) persons with specific training contracts."

Italy, characterized by a high youth unemployment rate, marked labor duality, and a strongly informal matching process\(^3\), represents a suitable case study. Figure 2 reports the evolution of the share of new hires as FTCs or OECs over the last 30 years. A new hire is every new contract stipulated between a firm and a worker at a certain date. To avoid double counting, we exclude series of contracts between a same firm-worker pair, keeping only their first occurrence. In this way we exclude recalled workers but keep track of the first time they were hired.

Over the years, policy makers have enforced a series of liberalizations of the labor market. These interventions were strongly related to the business cycle, aiming at increasing job creation during recessions (gray areas) or unemployment peaks. The introduction of cheaper and more flexible

\(^3\)Various sources (see next note) show that more than 50\% of job seekers mainly rely on informal channels (family, friends) and spontaneous candidacies when applying for jobs. In this sense, firms mostly operate in a random search framework, rather than segmenting vacancies ex-ante.
temporary employment has reduced the share of new hires as OECs. Yet, even after the dramatic 2008 crisis, OECs continue to account for more than 30% of new hires. Understanding what drives firms’ sorting across contracts is a relevant, and not trivial task.

![Graph showing the share of new hires in a large Italian region.](image)

**Figure 2: Share of new hires in a large Italian region**

Data source: our elaborations on Planet data from Osservatorio Veneto Lavoro. Temporary workers are defined as those holding a standard short-term contract, excluding seasonal workers and apprentices.

The empirical labor literature often refers to education as the main determinant of match productivity. If applied to the study of contract duality, we intuitively expect that firms will want to offer job stability to skilled workers. At higher levels of aggregation, this implies that we should observe bigger shares of OECs in “knowledge intensive” industries. Knowledge intensity (KI) can be measured either by the share of skilled employees over the employed workforce, or by the share of
cognitive occupations over the total of number of jobs in that industry\textsuperscript{4}. In facts, while it is true that KI sectors make extensive use of OECs, this is also the case for industries predominantly employing low-skilled workers, in low-qualified occupations. Thus, neither education nor task sophistication seem to explain the stipulation of OECs.

These measures of knowledge intensity, however, do not refer to the same object. While education refers to labor supply factors, job tasks reflect labor demand. The two convey equivalent information only if workers are matched with occupations corresponding to their skills. In other words, firms should hire a college graduate in a cognitive job, a high-school dropout in a routine job, and a fifth-grader in a manual job. Perfect matching between workers’ skills and tasks’ requirements would imply a tight relationship between the share of college graduates and the share of cognitive occupations. So that, plotting one against the other, observations should line up along the 45-degree line. Figure 3 displays a strong positive relationship between the share of cognitive tasks and share of college graduates, but with substantial dispersion along the line. We interpret this fact as evidence of skill-occupation mismatch. Such misalignment suggest the need to analyze skills and occupation jointly.

\textsuperscript{4}Eurostat classifies as knowledge intensive firms employing at least 30\% of college graduates. Concerning occupations, following the literature on mismatch we classify jobs as manual, routine manual, routine cognitive of abstract (see Manning et al. (2011)).
We argue that a good fit between worker’s qualification and task requirements provides a better proxy for match productivity, hence of the probability of stipulating a permanent contract. We build a mismatch index, constructed as the difference between workers’ educational attainment and the education required by the jobs they are occupying. Figure 4 offers some support to our hypothesis, as we observe that the likelihood of stipulating an OEC decreases in the level of mismatch. In the next sections, we build on this intuition and provide a theory of endogenous sorting based on skill mismatch.
An important caveat here applies. Due to the nature of their products and services, some industries display structurally higher proportions of temporary contracts (e.g. arts and entertainments, lodging services, agriculture). In this paper, we do not attempt to address this issue. We only consider firms in which FTCs can be considered as substitutes to OECs, and not solutions to short-term needs for additional workforce.

3 The Model

In our model, firms post vacancies and randomly meet job seekers. Upon meeting, workers and firms observe the productivity of their potential job relationship. We assume that the productivity of the match is increasing in an idiosyncratic component denoted by $\alpha$. We interpret $\alpha$ as an inverse measure of mismatch between the worker’s skill and her fit to the proposed occupation. The higher is $\alpha$ the better the fit between the worker and the task associated to the vacancy, and the higher the productivity in the job. Ideally, one would have a model with double-sided
heterogeneity, where vacancies are associated to different occupations and workers are heterogeneous in education. Then, one would be able to distinguish three separate contributions to the productivity of the match: the worker’s skill, the characteristics of the occupation and the fit between the two components. However, the problem we are going to investigate is already complicated by the presence of heterogeneity in the type of contract. We thus adopt a simpler strategy which only considers one-sided heterogeneity in the match-specific productivity component. Hence, our heterogeneity mainly regards the fit between worker’s skill and task requirements. Our theoretical setup will have a direct empirical counterpart. In our empirical analysis we will investigate the role played by mismatch controlling for education and task characteristics.

If the worker does not meet the requirement of the task (low $\alpha$), the meeting does not follow up. When the fit is good enough, it is instead profitable to start a job relationship. In this case the parties can choose to stipulate either a fixed-term contract (FTC) or an open-ended contract (OEC). FTCs require the payment of a fixed cost upon stipulation and have limited length. At expiration, they can be either converted into an OEC contract or be terminated at no cost. OECs do not have a pre-determined duration. However, they are hit by random shocks that can negatively affect the productivity of the match. In this case the firm can fire the worker but has to pay a tax.

This setup thus allows us to study how mismatch affects job creation and endogenously leads to the emergence of a dual labor market. We can also perform policy simulations to study the effects of reforms which liberalize the use of FTCs.

In Appendixes A.2 and A.3 we further consider two extensions of the benchmark model. The former includes endogenous investment in human capital, whereas the second incorporates imperfect information and learning about the productivity of the match.

\footnote{To provide an intuition, imagine a game theorist applying for an applied econometrician job. Although she might excel in her field, she would poorly meet the requirements of that position.}
3.1 Environment

The economy is populated by a continuum of firms indexed by \(j\) and a continuum of workers, indexed by \(i\). In a symmetric equilibrium, all agents adopt the same strategy; we can thus simplify the notation by omitting the indexes \(j\) and \(i\). Workers inelastically supply labor: \(\int_0^1 L(i) \, di = L = 1\), where \(L\) stands for labor force. We abstract from population growth and we assume \(L\) constant.

\[
\int_0^1 N_t(i) \, di = N_t \text{ is aggregate employment at time } t \text{ and } u_t = 1 - N_t \text{ is aggregate unemployment.}
\]

In a stationary environment (as we assume in what follows), we can neglect the time index.

Firms produce using only labor, which is hired on a frictional labor market. We assume that the number of contacts between firms and workers per period of time is the outcome of a Cobb-Douglas technology, which depends on the number of vacancies \((V_t)\) and searchers \((u_t)\): \(M_t(V_t, u_t) = \chi V_t^n(u_t)^{-\eta}\). The probability that a firm meets a worker is \(q(\theta_t) = \frac{M_t(V_t, u_t)}{V_t}\), \(f(\theta_t) = \frac{M_t(V_t, u_t)}{u_t}\) expresses the job-seeker’s probability of meeting a potential employer. The labor market tightness is defined as \(\theta_t = \frac{V_t}{u_t}\). It is easy to show that \(q(\theta)\) is a decreasing function of \(\theta\), while \(f(\theta)\) is an increasing function of \(\theta\). Furthermore, \(f(\theta) = \theta q(\theta)\).

We can distinguish three stages in the firm-worker relationship. We denote the first stage as period -1 because it precedes the formation of the match. In this first stage, a firm meets a worker and the match-specific productivity \(\alpha_i\) is drawn from the continuous distribution \(g(\alpha)\), defined over the support \([\alpha_l, \alpha_u]\). As explained above, \(\alpha\) can be interpreted as an (inverse) measure of mismatch between workers’ skills and task requirements. The realization \(\alpha_i\) is perfectly observed both by the firm and by the worker. According to the realization \(\alpha_i\), the worker and the firm agree on one of these possibilities: i) not starting the job relationship; ii) hire with a FTC; iii) hire with an open-ended contract.

If the agents choose to stipulate any of the two contracts, a match is formed and enters stage 0. This is an intermediary period between the agreement on the formation of the match and the actual stipulation of the contract. In stage 0 any match produces a fixed amount \(y_0\), irrespective of the value of \(\alpha\). Firms that stipulate a FTC must pay a fixed costs \(c_F\), which proxies restrictions imposed by the law on the use of short-term contracts. We introduce this additional step as a convenient
device to distinguish the surplus of the initial relationship from the surplus of an ongoing match\textsuperscript{6}. At rate $\mu_0$ stage 0 ends. Then, the firm and the worker must decide whether to break the relationship at no cost or to actually stipulate the contract. If they opt for continuation, the contract enters stage 1. In stage 1, production deterministically depends on the idiosyncratic match specific component $\alpha_i$ and on a given firm specific component. All productive matches entering stage 1 start with the same firm’s productivity component, which coincides with the upper bound of the distribution $\varepsilon_u$.

The two contracts differ for their institutional setting. Fixed-term contracts end at rate $\mu^F$. A new productivity value is drawn and the firm and the worker jointly decide whether to continue the match under an open-ended contract or rather terminate the relationship at no cost. Open-ended contracts are hit by i.i.d. random shocks at Poisson rate $\mu$. When a shock occurs, a new independent value of $\varepsilon$ is drawn from the distribution $f(\varepsilon)$, defined over the interval $[\varepsilon_l, \varepsilon_u]$. If the new productivity of the match is too low, the firm may prefer to fire the worker and the law obliges it to pay a fixed cost $K$. $K$ represents the cost of legal procedures related to the firing of permanent workers; it can be interpreted as the model counterpart of the Employment Protection legislation on Regular contracts (EPR). As such, $K$ is not paid to the worker but it’s a pure waste. As shown by Lazear (1990), firing costs can be entirely internalized by the wage bargaining process if they take the form of severance payments\textsuperscript{7}.

Any decision about the continuation of the match and layoffs is taken with regard to the joint surplus of the job relationship. This ensures that, given the institutional environment, decisions are efficient. Furthermore, wages are Nash-bargained and are continuously renegotiated.

\textsuperscript{6}The distinction is particularly important for OECs. In fact, when deciding upon the stipulation of the match the firm’s outside option is represented only by the value of a vacancy. On the contrary, ongoing matches are also subject to firing costs, which thus enter the definition of the surplus.

\textsuperscript{7}In many countries, EPR also establishes a compensation to be paid to the fired worker. It seems unlikely that firms are able to transfer all these costs to the worker: evidence in this sense for the italian case is provided by Leonardi and Pica (2007).
3.2 Value Functions

In this section we formally introduce the value of a job relationship in the two stages and for the two types of contracts. Variables referring to FTCs are indexed by $F$; open-ended contracts, considered as the regular employment relationship, are not indicated by any index. To save space we only present here the value functions relative to the joint surplus of the matches. Firms’ and workers’ value functions are relegated in Appendix A.1.1. We proceed by backward induction. Hence, we start by characterizing the value functions in stage 1. We then use this result in the continuation value of stage 0.

Stage 1

We can define the joint surplus of an open-ended job in stage 1 as the sum of the firm’s and the worker’s surplus, namely: $S_1(\alpha, \varepsilon_u) = J_1(\alpha, \varepsilon_u, w_1) - J^V + K + W_1(\alpha, \varepsilon_u, w_1) - U$, where $J_1(\cdot)$ and $W_1(\cdot)$ are the value functions of an open-ended job in stage 1 to the firm and the worker, respectively; $J^V$ is the value of a vacancy and $U$ is the value of unemployment. Notice the presence of $K$ in the firm’s surplus. When it enters stage 1, the outside option of the firm is represented by $J^V - K$, that is opening another vacancy and paying the firing costs.

Combining equations (20) and (21) reported in Appendix A.1.1 and rearranging terms, we obtain:

$$(r + s + \mu)S_1(\alpha, \varepsilon_u) = y(\alpha) + \varepsilon_u - r(J^V + U) + (r + s)K + \mu \mathbb{E}_{\varepsilon'} \left[ \max \{S(\alpha, \varepsilon'); 0\} \right] \tag{1}$$

where $s$ is the exogenous quit rate, $S(\alpha, \varepsilon')$ denotes the value of the same open-ended contract (i.e. with the same $\alpha$) when it has been hit by a shock which has reset the firm productivity component to $\varepsilon'$. Notice that the surplus of a permanent job continuing beyond stage 1 is stochastic and it is not indexed by any number. We can define: $\tilde{S}(\alpha) \equiv S_1(\alpha, \varepsilon') - \varepsilon'$. Furthermore, define a function $G$ such that:

$$G(z) = \int_{\varepsilon_l}^{\varepsilon_u} \max (z + \varepsilon; 0) f(\varepsilon) \, d\varepsilon \quad \forall \, z \in \mathbb{R}$$
Hence, the function determining continuation can be written as:

$$G(\bar{S}(\alpha)) = \mathbb{E}_{\varepsilon'} \max \{ \bar{S}(\alpha) + \varepsilon'; 0 \}$$

Equation (1) can thus be rewritten as:

$$(r + s + \mu)S_1(\alpha, \varepsilon_\text{u}) = y(\alpha) + \varepsilon_\text{u} - r(J^V + U) + (r + s)K + \mu G(\bar{S}(\alpha))$$

(2)

Let’s now turn to the characterization of stage 1 of fixed-term contracts. Define the joint surplus of a temporary position in stage 1 as:

$$S_1^F(\alpha, \varepsilon_\text{u}) = J_1^F(\alpha, \varepsilon_\text{u}, w_1^F) - J^V + W_1^F(\alpha, \varepsilon_\text{u}, w_1^F) - U.$$

Combining eq. (22) and (23) reported in Appendix A.1.1, we obtain:

$$(r + s + \mu^F)S_1^F(\alpha, \varepsilon_\text{u}) = y(\alpha) + \varepsilon_\text{u} - r(J^V + U) + \mu^F \mathbb{E}_{\varepsilon'} \left[ \max \{ S(\alpha, \varepsilon') - K; 0 \} \right]$$

(3)

At rate $\mu^F$ a new $\varepsilon$ is drawn and the FTC expires. Then, the average length of a temporary job is $1/\mu^F$. In our setting, firms do not choose the length of the temporary contract. $\mu^F$ thus captures both the policy restrictions on the maximum cumulated length of a FTC and the actual duration chosen by the firm-worker pair. Upon expiration of the short-term contract, the firm observes the new productivity draw and then decides whether to let the worker leave at no cost or upgrade her to a permanent position subject to firing costs. Notice the continuation value of the FTC. When the contract expires, firms can separate from the worker without paying any cost. Then, the decision on the conversion is taken with regard to the surplus of a continuing permanent contract net of the firing costs.

**Stage 0**

Having computed the surplus in stage 1, we can now introduce the value functions relative to the previous stage. Stage 0 should be interpreted as an intermediary step between the meeting of the firm and the worker and the actual start of the productive relationship. The former occurs randomly at a rate which depends on the tightness of the market. Let’s denote the moment of
the first contact between the firm and the worker as stage -1. In this phase, the firm and the worker discover the realization of the match specific productivity component (\( \alpha \)). Then, the agents compare the surplus they would get from an OEC or from a FTC with the value of an unfilled vacancy and choose the best option. The surpluses they consider in these calculations are the ones corresponding to stage 0 in our setup. These differ from stage 1 because the outside option is simply the value of a vacancy. We do not introduce any randomness in switching from stage 0 to stage 1.

Once \( \alpha \) has been observed, the firm knows the value of the job in stage 1, because the firm specific component is fixed to \( \varepsilon_u \) by assumption. For this reason, \( S_0 (S_F^0) \) is deterministic and we highlight its dependence not only on \( y_0 \) but also on the arguments of \( S_1 (\alpha, \varepsilon_u) (S_F^1 (\alpha, \varepsilon_u)) \).

If we normalize \( y_0 \) so that \( y_0 = r (J^V + U) \) and define the joint surplus of a permanent contract in stage 0 as \( S_0 (\alpha, \varepsilon_u) = J_0 (\alpha, y_0, w_0, \varepsilon_u, w_1) - J^V + W_0 (\alpha, y_0, w_0, \varepsilon_u, w_1) - U \), we can write:\(^8\)

\[
(r + s + \mu_0) S_0 (\alpha, \varepsilon_u) = \mu_0 \left[ \max \{ S_1 (\alpha, \varepsilon_u) - K; 0 \} \right]
\]

(4)

From equation (4) it is evident that the value of a new permanent contract deterministically depends on its surplus in stage 1, when it will become fully productive. However, firing costs should not be taken into account when assessing the convenience of stipulating the contract.

Finally, we can define the joint surplus of a new temporary contract as \( S_F^0 (\alpha, \varepsilon_u) = J_F^0 (\alpha, y_0, w_F^0, \varepsilon_u, w_F^1) - J^V + W_F^0 (\alpha, w_F^0, w_F^1) - U \). Combining the value functions reported in the appendix, we get:

\[
(r + s + \mu_0) S_F^0 (\alpha, \varepsilon_u) = -c^F + \mu_0 \left[ \max \{ S_F^1 (\alpha, \varepsilon_u); 0 \} \right]
\]

(5)

where \( c^F \) is a fixed cost of stipulating temporary contracts which captures restrictions imposed by the law on their use.

Equation (5) indicates that the value of a new FTC depends on its productivity once reaching stage 1 net of the cost of stipulation.

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\(^8\)The firm’s and worker’s value functions are contained in Appendix A.1
3.3 Wage Setting

As it is customary in search models, we assume that wages are Nash bargained. Consider the wage in an open-ended contract at stage 1. The splitting of the surplus obeys the following rule:

\[(1 - \beta)(W_1(\alpha, \varepsilon_u, w_1) - U) = \beta(J_1(\alpha, \varepsilon_u, w_1) - K)\]  \hspace{1cm} (6)

where \(\beta\) is the workers’ bargaining power and free entry holds.

After some algebra we obtain:

\[w_1(\alpha) = (1 - \beta)rU + \beta[y(\alpha) + \varepsilon_u + (r + s)K]\]  \hspace{1cm} (7)

Notice that eq. (7) implies that the wage in continuing matches is a positive function of the firing costs. As emphasized by other authors (see Bentolilla et al. (2010)), the cost imposed by the law in case of layoff can be used by the worker as a threat on the employer in the bargaining game.

Similar calculations allow us to recover the wage in the other types of jobs:

\[w^F_1(\alpha) = (1 - \beta)rU + \beta[y(\alpha) + \varepsilon_u - \mu^F(1 - F(\varepsilon^F_{\alpha}(\alpha)))K]\]  \hspace{1cm} (8)

\[w_0 = rU - \beta\mu_0K\]  \hspace{1cm} (9)

\[w^F_0 = rU - \beta c^F\]  \hspace{1cm} (10)

where \(\varepsilon^F_{\alpha}(\alpha)\) is the job destruction threshold for a fixed-term contract with productivity \(\alpha^9\). Equation (8) shows that the wage of temporary workers is lower because of the absence of EPL provisions. \(w^F_1\) is further lowered by the subsequent presence of firing costs, as the firms are able to partly transfer this cost from permanent to temporary workers.

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9See next Section.
3.4 Job Destruction

A match is severed either because the worker quits at exogenous rate \( s \) or because a fixed-term contract is not converted at expiration or because a permanent worker is laid off. We only consider endogenous separations which are efficient. This means that a layoff or a missed conversion occurs only if the joint surplus of the match falls below zero.

First consider the firing problem in ongoing open-ended jobs. Call \( \varepsilon_d \) the firm productivity component such that the firm-worker pair is indifferent between continuing to produce and breaking the match. Then, \( \varepsilon_d \) is the solution to \( S(\alpha, \varepsilon_d) = 0 \). Doing the computation leads to an implicit formula for the firing threshold:

\[
\varepsilon_d + y(\alpha) + \mu \int_{\varepsilon_d}^{\varepsilon_u} S(\alpha, \varepsilon') dF(\varepsilon') - r(J^V + U) + (r + s) K = 0
\]  

(11)

It is apparent from eq. (11) that the firing threshold crucially depends on the intrinsic match quality and the firing costs. For what follows, it is convenient to highlight the dependence on \( \alpha \), thus writing \( \varepsilon_d(\alpha) \). We summarize these results in the following lemma:

**Lemma 1.** There exists \( \varepsilon_d(\alpha) \) such that \( S(\alpha, \varepsilon_d(\alpha)) = 0 \). Any open-ended job of quality \( \alpha \) hit by a shock \( \varepsilon' > \varepsilon_d(\alpha) \) is continued iff \( \varepsilon' > \varepsilon_d(\alpha) \) and severed otherwise. Moreover:

i) \( \frac{\partial \varepsilon_d}{\partial \alpha} < 0 \)

ii) \( \frac{\partial \varepsilon_d}{\partial K} < 0 \)

We can define the firing rate as \( \tilde{s}(\alpha) = \mu F(\varepsilon_d(\alpha)) \). This can be interpreted as the arrival rate of a shock sufficiently bad to destroy a permanent match. By combining Lemma 1 with the monotonicity of the c.d.f. we can state

**Lemma 2.** Define the firing rate as: \( \tilde{s}(\alpha) = \mu F(\varepsilon_d(\alpha)) \). Then, the firing rate is a decreasing function of \( \alpha \).

Lemmas 1 and 2 say that an open-ended job is less likely to be destroyed the higher its productivity and the higher the firing costs.
Having defined the job destruction threshold as in (11), we can rewrite the joint surplus of a productive match as:

\[ S(\alpha, \varepsilon) = \frac{\varepsilon - \varepsilon_d(\alpha)}{r + s + \mu} \]  

(12)

Consider now the decision of converting a FTC. Define the firm productivity component which makes the firm-worker pair indifferent between breaking the relationship and converting the match from temporary to permanent.

**Lemma 3.** Indicating with \( \varepsilon_d^F(\alpha) \) the job destruction threshold of a FTC of quality \( \alpha \), it satisfies \( S(\alpha, \varepsilon_d^F(\alpha))) - K = 0 \). From Lemma 1 it follows that

\[ \varepsilon_d^F(\alpha) = \varepsilon_d(\alpha) + (r + s + \mu)K \]

Then, we can define the destruction rate for FTCs as \( \tilde{s}_d^F(\alpha) = \mu^F F(\varepsilon_d^F(\alpha)) \). Lemma 3 implies that temporary contracts are generally destroyed more frequently, except if \( \mu^F \) is significantly lower than \( \mu \). The job destruction threshold for FTCs is raised by firing costs because firms anticipate that future matches will be subject to them. The conversion rate from temporary to permanent for a match of type \( \alpha \) is \( 1 - F(\varepsilon_d^F(\alpha)) \).

### 3.5 Match Formation and Job Creation

After the meeting between a firm and a worker and the realization of \( \alpha \), the agents are able compute the surplus they would get from an OEC and a FTC in stage 0. A new match is formed only if any of the two is positive. In this case, the type of contract which generates the highest value is chosen. We can thus define two profitability thresholds, one for OECs and one for FTCs. They are

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\(^{10}\)However, in this case it would be hard to justify the assumption that workers in FTCs are not hit by shocks to the firm’s productivity component while they are still in the match.

\(^{11}\)We define the aggregate conversion rate as \( \frac{\int_{\tilde{\alpha}}^{\alpha} (1 - F(\varepsilon_d^F(\alpha))))dG(\alpha)}{G(\tilde{\alpha}) - G(\alpha^F)} \), where \( \tilde{\alpha} \) and \( \alpha^F \) are defined in the next Section.
such that

\[
(r + s + \mu_0)S_0(\alpha, \varepsilon_u) = \begin{cases} 
\mu_0 [S_1(\alpha, \varepsilon_u) - K] & \text{if } \alpha > \alpha_0 \\
0 & \text{otherwise}
\end{cases}
\]

Equation (13) tells us that stipulating a permanent contract is convenient only for realizations of \( \alpha \) higher than \( \alpha_0 \). Equivalently, FTCs are profitable only if the idiosyncratic productivity component exceeds \( \alpha_F \). Equations (13) and (14) represent the match formation conditions (MFC) for permanent and fixed-term contracts, respectively.

We are now able to discuss the relative values of new permanent and temporary jobs for any value of \( \alpha \). This analysis allows us to understand which type of contract is stipulated after observing the quality of the match. Depending on the parameterization, different configurations may emerge. Suppose, for instance, that EPL on FTCs is set to a high value. Then, most likely FTCs would never be preferred to permanent ones. Instead of exploring all these different possibilities, we rather focus on the more interesting case of FTCs being more convenient for low-productivity matches and permanent contracts being more profitable for higher values of \( \alpha \). Appendix A.1 discusses the set of parameter configurations which allow the emergence of a pooling equilibrium in the flow of new hires\textsuperscript{12}. Let define \( \tilde{\alpha} \) as the match productivity value such that the parties are indifferent between stipulating a temporary or a permanent contract\textsuperscript{13}. If we indicate with \( \tilde{p} \) the fraction of newly hired workers who enter the firm with an open-ended job, the following Proposition clarifies when it takes interior values.

**Proposition 1.** Under Assumption H1 and \( \tilde{\alpha} \) as defined in Lemma 4, two equilibria in the flow of new hires may emerge:

\textsuperscript{12}With this term we denote the co-existence of new hires both under temporary and permanent contracts.

\textsuperscript{13}See Lemma 4 in Appendix A.1 for a formal definition.
1) \( \hat{p} = 0 \) iff \( \hat{\alpha} \geq \alpha_u \) (separating equilibrium with all temporary).

2) \( \hat{p} \in (0, 1) \) iff \( \hat{\alpha} < \alpha_u \) (pooling equilibrium: co-existence of temporary and permanent).

In this case, all matches with \( \alpha \in [\alpha^F, \hat{\alpha}] \) are formed with a temporary contract, whereas matches characterized by \( \alpha \in [\hat{\alpha}, \alpha_u] \) start directly with an open-ended contract. Hence,

\[
\hat{p} = \frac{1 - G(\hat{\alpha})}{1 - G(\alpha^F)}
\]

The possibility of a separating equilibrium with only permanent contracts is excluded by point 1 of Assumption 1. The two other cases are described by Proposition 1. The corner solution in which all new hires are temporary emerges when FTCs are always more profitable than open-ended contracts in the range of admissible productivity values. In the pooling equilibrium (the second case of Proposition 1) low-productivity matches are offered a FTC and high-productivity matches start directly as permanent. We have thus shown that, for some parameterizations, it is possible to obtain the endogenous emergence of duality in hiring activities. Notice that duality in the stock of employed workers can still be present in the corner solution with all FTCs in the initial stage, because some of them may be converted later on. From now on we focus on the third case as the most interesting one.

We are now able to study the value of a vacancy and the job creating condition. Firms post vacancies at unit cost \( \kappa \). The vacancy is filled at rate \( q(\theta) \), which negatively depends on the labor market tightness (\( \theta \)). Further recalling that the fraction of the surplus accruing to the firm is \( 1 - \beta \), the value of an unfilled vacancy is

\[
rJ^V = -\kappa + q(\theta)(1 - \beta)\mathbb{E}_\alpha \left[ \max \left\{ S_0(\alpha, y_0, \varepsilon_u); S^F_0(\alpha, y_0, \varepsilon_u); 0 \right\} - J^V \right]
\]

(15)

Competition among firms drive the value of a vacancy to zero. Imposing the standard free entry condition on eq. (15) yields

\[
\frac{\kappa}{q(\theta)} = (1 - \beta)\mathbb{E}_\alpha \left[ \max \left\{ S_0(\alpha, y_0, \varepsilon_u); S^F_0(\alpha, y_0, \varepsilon_u); 0 \right\} \right]
\]

(16)
Eq. (16) is the job creating condition (JCC). Firms post vacancies up to the point where the real cost (rhs) equals the expected return of the productive match (lhs).

Finally, the steady state assumption that inflows into unemployment equal outflows leads to a modified version of the Beveridge curve:

$$u = \bar{s} \left( \frac{\hat{s}}{\hat{f}(\theta) + \hat{s}} \right)$$ (17)

where $\hat{f}(\theta) = \theta q(\theta) (1 - G(\alpha^F))$ is the job finding rate which takes into account also the acceptance probability and $\bar{s}$ is the composite separation rate which takes into account quits, terminations and layoffs\textsuperscript{14}. As usual, the Beveridge curve defines an inverse relationship between vacancies and unemployment. The novelty is represented by the endogeneity of the job destruction rate. The latter depends on the EPL on open-ended contracts and the distribution of the match-specific productivity component in the population of the employed. Consequently, in our model policy provisions affect the equilibrium unemployment rate by shifting the Beveridge curve.

\textsuperscript{14}More details on the calculations are in Appendix A.1.4
Figure 6: Joint surplus of new permanent and FTCs

Figure 7: Two tier labor market: job creating condition and Beveridge curve
3.6 Calibration and Results

We calibrate the model on a monthly basis. The annual interest rate is set to 6%. The elasticity of the matching function and the workers’ bargaining power are both set to the standard values of 0.5, such that the Hosios-Pissarides condition holds. The matching efficiency ($\chi$) is calibrated to target an unemployment rate of 10% in the benchmark setting. The vacancy posting cost $\kappa$ corresponds to roughly 10% of the average wage in FTCs. The output of the match is simply given by the sum of the match-specific and the firm specific productivity components: $y = \alpha + \varepsilon$.

The quit rate is set to 0.01. The arrival rate of shocks hitting permanent matches is 0.03, thus implying that average tenure in an open-ended job is about three years. We calibrate $\mu^F$, the arrival rate of shocks ending FTCs, to target the maximum length allowed by legislation. Our benchmark calibration implies a length of approximately one year. This corresponds to the limit fixed by the Italian legislation before 2001. We then consider a reform extending the admissible length of temporary jobs to 20 months. For simplicity, we assume that both the match and the firm specific productivity components follow uniform distributions, the first ranging from 0.1 to 1 and $\varepsilon$ from -6 to 0.5. The EPL on the creation of FTCs ($c^F$) is normalized to 2, while firing costs are about 11 months of pay. When simulating a policy reducing EPL on FTCs we assume that the cost of stipulating a FTC is halved ($c^F = 1$). The calibration is summarized in Table 1.

The endogenous outcomes of the model are reported in Table 2, where we compare the results of the benchmark model (Column 2) with those obtained from an equivalent model where only OECs exist (Column 1). With respect to the benchmark setting, the impossibility of stipulating FTCs substantially heightens the unemployment rate (from 10% to 13.5%). For the benchmark two tier labor market, 75% of new hires are temporary positions, and 94% of the labor force holds a permanent job.

We further perform simulations of policies aiming at increasing the degree of flexibilization of the labor market. Such policies have been widely implemented in many European countries in the last

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15To obtain the results in Column 1 we keep the matching efficiency $\chi$ as in the benchmark two-tier model. Remember that $\chi$ is calibrated to target 10% of unemployment in Column 2.
20 years also with the indirect scope of fostering job creation and reducing unemployment. However, the net effect on aggregate employment is ambiguous, since a broader use of FTCs generates more job destruction. The results of our simulations are reported in Table 3. In the second column we postulate a reduction of the fixed stipulation costs on FTCs ($c^F = 1$). The third column shows the results for an alternative policy measure which extends the length of temporary contracts from 12 to 20 months. Finally, the fourth column considers the joint effect of the two previous policies. The last column is of interest because in Section 4 we will explore the consequences of a reform implemented in Italy in 2001 which both lifted restrictions on the use of FTCs and increased the maximum length.

Both reforms markedly enlarge the use of FTCs, which now account for 45% and 63% of new hires after the first and the second reform, respectively. However, FTCs mainly crowd out permanent jobs and job creation is increased only marginally. This is evident from the small increase in $\theta$ and the augmented conversion rate, which signals that relatively good workers who were previously hired in permanent jobs are instead offered a FTC after the implementation of the reform. As expected, job destruction ($\bar{s}$) substantially increases. Overall, the net effect on employment is negative: the unemployment rate goes from 10% to 10.9 and 10.6%. The last three rows conveniently summarize the effects of the reforms in terms of elasticities. For instance the figures in the last row imply that reducing EPT almost doubles conversions, whereas doubling the length of FTCs increases the conversion rate by more than 9 times. In general, the effects of the two reforms go in the same direction, but lengthening FTCs has a stronger impact on the flows in OECs and on conversions and a milder one on unemployment\footnote{These are local elasticities, computed for the specific policy changes taken into account given the benchmark calibration. The effects of any reform could be different as the institutional context changes.}.

To explore in more detail the impact of flexibilization policies on the overall economy we can jointly vary the length of FTCs and the stipulation costs. The results are reported in Figures 8 and 9. On the x-axis there is the arrival rate of expiration of FTCs ($\mu^F$): lower values correspond to longer durations. The vertical axis report different levels of the fixed stipulation cost $c^F$. As
we move from the south-western corner to the north-eastern area of the graph, FTCs become less and less convenient. The left panel of Figure 8 represents how \( \tilde{p} \) vary with different degrees of EPT, with darker colors corresponding to higher shares of new hires in OECs. The pictures makes it clear that any reform which facilitates the use of temporary employment effectively encourages the creation of fixed-term jobs. On the right panel we report how the conversion rate \( (\tilde{p}) \) varies with EPT. Broadly speaking, the higher the share of entry flows in OECs the lower the interest in converting FTCs. However, we can notice a non linear effect of \( c^F \) when temporary contracts are relatively long. When FTCs last 25 months \( (\mu^F = 0.04) \), conversions reach their maximum level when \( c^F \) is comprised between 1 and 3. This happens because when stipulation costs are close to zero firms have the incentive to create low productive matches which have little or no chance to be converted later on. For values of \( c^F \) close to 4, conversely, FTCs become more expensive, so that relatively highly productive matches (those which would have the highest probability to be converted) are stipulated directly as OECs.

In Figure 9 we show the results for the unemployment rate. The impact of labor market duality at the macro level crucially depends on the institutional design of FTCs. Different combinations of stipulation costs and length imply very different aggregate outcomes. The lower unemployment rate is attained when stipulation costs \( (c^F) \) are high and FTCs are long \( (low \ \mu^F) \)\(^{17} \). This is a situation in which the improper use of FTCs is discouraged and job destruction is limited. As one lowers the stipulation costs, FTCs become more attractive: to avoid their excessive use even for highly productive matches, the best policy is to reduce the length. This guarantees that FTCs are used for low productive matches that would never be formed with an OEC but not for high values of \( \alpha \). In general, flexibilization policies have non-linear effect on aggregate employment. When only costly open-ended contracts exist, the introduction of temporary contracts fosters job creation and allows the formation of matches that would have been unprofitable otherwise. However, simulations shows that excessive liberalization leads to increased substitution of permanent with temporary employment. This implies more job destruction, which eventually offsets the benefits

\(^{17}\)The minimum level of unemployment (7.4%) is attained with \( c^F = 4 \) and \( \mu^F = 0.04 \).
Table 1: Model calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r$</td>
<td>discount rate (annual)</td>
<td>0.06</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>vacancy posting cost</td>
<td>0.01</td>
</tr>
<tr>
<td>$\chi$</td>
<td>matching efficiency</td>
<td>0.03</td>
</tr>
<tr>
<td>$\eta$</td>
<td>elasticity of the matching function w.r.t $V$</td>
<td>0.5</td>
</tr>
<tr>
<td>$\beta$</td>
<td>workers bargaining power</td>
<td>0.5</td>
</tr>
<tr>
<td>$s$</td>
<td>quit rate</td>
<td>0.01</td>
</tr>
<tr>
<td>$1/\mu_0$</td>
<td>length of stage 0 (months)</td>
<td>1.00</td>
</tr>
<tr>
<td>$\mu$</td>
<td>arrival rate of shocks</td>
<td>0.03</td>
</tr>
<tr>
<td>$1/\mu^F$</td>
<td>length of FTCs</td>
<td>12.50</td>
</tr>
<tr>
<td>$\alpha_l$</td>
<td>skills distribution: lower bound</td>
<td>0.1</td>
</tr>
<tr>
<td>$\alpha_u$</td>
<td>skills distribution: upper bound</td>
<td>1.0</td>
</tr>
<tr>
<td>$\varepsilon_l$</td>
<td>shock distribution: lower bound</td>
<td>-6.0</td>
</tr>
<tr>
<td>$\varepsilon_u$</td>
<td>shock distribution: upper bound</td>
<td>0.5</td>
</tr>
<tr>
<td>$c^F$</td>
<td>EPL on FTCs</td>
<td>2</td>
</tr>
<tr>
<td>$K$</td>
<td>firing costs</td>
<td>10</td>
</tr>
</tbody>
</table>

from job creation and produces adverse consequences on employment.

4 Empirics

In this section, we set out to test the predictions derived from the theory. Our model attributes a crucial role to the fit of workers to the occupations in which they are employed. Empirically, we expect workers’ skills and occupations not to have any individual positive effect on the probability of stipulating new OECs. Rather, we expect their right combination, namely the absence or low levels of mismatch, to have a positive effect on the attribution of tenure.

We exploit a rich linked employer-employee database which records every contract stipulated in the large Italian region of Veneto. We have both detailed characteristics of the contract and the firm from administrative sources, and rich information on the worker’s side, including education\textsuperscript{18}. First,

\textsuperscript{18}A description of the database can be found in Appendix B.
Table 2: Endogenous outcomes of the model

<table>
<thead>
<tr>
<th></th>
<th>One-Tier</th>
<th>Two-Tiers</th>
<th>KI industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment ($u$)</td>
<td>0.135</td>
<td>0.100</td>
<td>0.076</td>
</tr>
<tr>
<td>Labor mkt tightness ($\theta$)</td>
<td>58.8</td>
<td>59.3</td>
<td>117.7</td>
</tr>
<tr>
<td>Flows (%) OECs ($\tilde{p}$)</td>
<td>n.a.</td>
<td>0.75</td>
<td>0.84</td>
</tr>
<tr>
<td>Stock (%) OECs ($p$)</td>
<td>n.a.</td>
<td>0.94</td>
<td>0.97</td>
</tr>
<tr>
<td>Conversions (%) FTCs ($\check{p}$)</td>
<td>n.a.</td>
<td>0.00300</td>
<td>0.00304</td>
</tr>
<tr>
<td>Job destruction ($\bar{s}$)</td>
<td>0.025</td>
<td>0.021</td>
<td>0.017</td>
</tr>
</tbody>
</table>

Column 1: benchmark model (see calibration in Table 1) with open-ended contracts only. Column 2: benchmark model (see calibration in Table 1) when both permanent and temporary contracts are available. Column 3: Production function with higher return on match-specific productivity: $y = A\alpha + \varepsilon$, with $A = 2$.

Table 3: Policy simulations

<table>
<thead>
<tr>
<th></th>
<th>Two-Tiers</th>
<th>Low EPT</th>
<th>Longer FTC</th>
<th>Low EPT + Longer FTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment ($u$)</td>
<td>0.100</td>
<td>0.109</td>
<td>0.106</td>
<td>0.150</td>
</tr>
<tr>
<td>Labor mkt tightness ($\theta$)</td>
<td>59.3</td>
<td>60.8</td>
<td>61.9</td>
<td>65.1</td>
</tr>
<tr>
<td>Flows (%) OECs ($\tilde{p}$)</td>
<td>0.75</td>
<td>0.55</td>
<td>0.37</td>
<td>0.15</td>
</tr>
<tr>
<td>Stock (%) OECs ($p$)</td>
<td>0.94</td>
<td>0.87</td>
<td>0.75</td>
<td>0.47</td>
</tr>
<tr>
<td>Conversions (%) FTCs ($\check{p}$)</td>
<td>0.00300</td>
<td>0.00592</td>
<td>0.01685</td>
<td>0.02390</td>
</tr>
<tr>
<td>Job destruction ($\bar{s}$)</td>
<td>0.021</td>
<td>0.026</td>
<td>0.024</td>
<td>0.038</td>
</tr>
<tr>
<td>Elasticity unemployment ($\mathcal{E}(u)$)</td>
<td>n.a.</td>
<td>0.177</td>
<td>0.120</td>
<td>n.a.</td>
</tr>
<tr>
<td>Elasticity flows OECs ($\mathcal{E}(\tilde{p})$)</td>
<td>n.a.</td>
<td>-0.515</td>
<td>-1.004</td>
<td>n.a.</td>
</tr>
<tr>
<td>Elasticity conversions FTCs ($\mathcal{E}(\check{p})$)</td>
<td>n.a.</td>
<td>1.943</td>
<td>9.233</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Column 1: benchmark model (see calibration Table 1) with Two-Tier labor market. $c^F = 1$; length of FTC = 12 months. Column 2: two-tier model with $c^F = 0$. Column 3: two-tier model with length of FTC = 20 months. Column 4: two-tier model with $c^F = 0$ and length of FTC = 20 months.
Figure 8: Fraction of new hires in OECs ($\hat{p}$) and conversion rate ($\tilde{p}$) as function of EPT

The horizontal axis refers to different lengths of FTCs, with higher values corresponding to shorter durations. On the vertical axis there is the fixed-cost of stipulating a temporary contract ($c^F$). Darker colors indicate higher values of $\tilde{p}$ (left panel) and conversion rate (right panel).

Figure 9: Unemployment rate as function of EPT

The horizontal axis refers to different lengths of FTCs, with higher values corresponding to shorter durations. On the vertical axis there is the fixed-cost of stipulating a temporary contract ($c^F$). Darker colors indicate higher values of the unemployment rate.
we run a linear probability model (probit and logit provide similar results) where the dependent variable in the probability of a new hire to be an OEC. Second, we evaluate, on this same probability, the impact of a reform liberalizing the use of FTCs.

4.0.1 Correlations

Before evaluating the effect of labor reforms, it is useful to analyze the role of worker and firms characteristics on the distribution of contracts. We have observed that mismatch plays a determinant role on the endogenous sorting of employers among contracts. Our data contain two types of information for the characterization of the worker-match dimensions. On the one side, we observe the educational attainment of each employee. This element mirrors the entry ability of the worker in the match. On the other side, we know the occupation covered within the firm, which can be classified according to the nature of the tasks performed on the job (manual, routinary, abstract).

We adopt the following specification:

$$I_{OEC} = \text{cons} + \beta_sS_i + \beta_tT_j + \beta_{s,t}S_iT_j + \gamma X + \psi Z + \alpha + \varepsilon_j$$ (18)

where $I_{OEC}$ is an indicator variable that takes value 1 if the contract is stipulated as open-ended, and zero otherwise. $S$ identifies the level of workers’ educational attainment at time of hiring: low-skilled (until high-school), middle-skilled (high school and some college), high-skilled (college graduate). $T$ identifies the nature of the task performed by the workers in the occupations in which they are hired: these can be manual, routine manual, routine cognitive, or abstract. $X$ is a vector of workers’ characteristics, including demographics (age, age$^2$, gender, nationality), and employment history. Finally, $Z$ is a vector of industries’ and firms’ characteristics, $\alpha$ includes various fixed effects, and $\varepsilon$ is the error term, clustered at the occupational level.

We run four incremental specifications of this regression over PLANET data from 1999 to 2003. The first one - 'Match' - only includes elements pertaining the singular match (skills, task, mismatch), and then we add industry characteristics, workers’ demographics and employment history. The results are summarized in Table 4.0.1. Let us focus on the last specification - 'Experience' -
which contains more information. As expected from our simple stylized facts and from the simulation results, education and task by themselves do not increase the likelihood of landing a permanent job. As these are categorical variables, the results must be read with respect to a reference category (dropped not to incur into the dummy trap). For education the reference category is "low-skilled" and for job task is "manual". Thus, the results say as education and cognitive content are increasing with respect to their base levels, the probability of a new hire as OEC decreases.

In this way must be read the interaction between skills and task, which provides a central results of this paper (see below for the margins analysis). Mismatch, as measured by this interaction, has a non-linear effect across educational attainment and occupation. This means that a high-skilled worker will have better chances at an abstract job than at a manual job, with this difference bigger than the middle-skilled counterpart. Note that also that high-skilled workers have, however, more difficulty to obtain a purely abstract job than a routine cognitive one. This facts suggests the presence of some form of queueing for cognitive jobs. This seems to be confirmed by our "Sector" variables. We compute the share of (abstract + r. cogn.) occupations over total occupations by industry and interpret it as a measure of sector knowledge intensity ('Industry Occupation KI'). Its coefficient tells us that as the quality of jobs increases, the probability of being hired with an OEC decreases. The interaction between skills and KI confirm this result and add the effect is worse for more skilled workers. Let us now focus on the mismatch regressor, appearing with a minus in the table. We build this index as a measure of mismatch alternative to the simple interaction between skill and task. In practice, we follow the ILO (International Labor Organization) guidelines and identify the quality of occupations that should be observed with a certain education level. Education and occupations are each classified over four categories and the index is computed as (education - occupation). Thus, it is included between -3 and 3. This means that as the index increases, over-qualification decreases until perfect match at 0, above which we observe under-qualification. The regression coefficient tells us that as the index becomes less negative, the likelihood of a permanent contract increases. Our demographics controls tell us that age as a positive but non-linear effect of the dependent variable, and that women are strongly penalized on the labor market. Finally, the coefficients the employment history regressors have the expected signs. The total time employed
in the past has a positive effect, while time between contracts (idle u.) and unemployment periods declared at an unemployment agency (agency u.) have negative signs.

Figure 10 provides the margins on the interactions between workers’ skills and occupations. We observe that the probability of being hired with an OEC is positively related with the worker-occupation fit. Indeed, a middle-skilled worker has a higher probability of being hired in a routine-cognitive occupation than in a manual one. Furthermore, the hiring probability increases in education. On average, high-skilled workers are more likely to be offered an OEC, but the probability is even higher for skilled workers performing abstract tasks.
Table 4: Probability of a New Hire as OEC

<table>
<thead>
<tr>
<th>Worker Skills:</th>
<th>Match</th>
<th>Sector</th>
<th>Demo</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle</td>
<td>-0.059***</td>
<td>-0.024***</td>
<td>-0.478***</td>
<td>-0.412***</td>
</tr>
<tr>
<td>High</td>
<td>0.106***</td>
<td>0.171***</td>
<td>-0.605***</td>
<td>-0.580***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Job Task:</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R. Man.</td>
<td>-0.163***</td>
<td>-0.318***</td>
<td>-0.263***</td>
<td>-0.320***</td>
</tr>
<tr>
<td>R. Cogn.</td>
<td>-0.019***</td>
<td>-0.098***</td>
<td>-0.099***</td>
<td>-0.159***</td>
</tr>
<tr>
<td>Abstract</td>
<td>-0.029***</td>
<td>-0.021**</td>
<td>-0.047***</td>
<td>-0.079***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skills*Task</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle*R. Man.</td>
<td>0.048***</td>
<td>0.026***</td>
<td>0.018***</td>
<td>0.030***</td>
</tr>
<tr>
<td>Middle*R. Cogn.</td>
<td>0.041***</td>
<td>0.051***</td>
<td>0.061***</td>
<td>0.079***</td>
</tr>
<tr>
<td>Middle*Abstract</td>
<td>0.067***</td>
<td>0.088***</td>
<td>0.051***</td>
<td>0.043***</td>
</tr>
<tr>
<td>High*R. Man.</td>
<td>-0.028***</td>
<td>-0.063***</td>
<td>-0.070***</td>
<td>-0.019</td>
</tr>
<tr>
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<td>0.093***</td>
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<tr>
<td>Middle*(Cogn. Tasks)</td>
<td>-0.001***</td>
<td>-0.001***</td>
<td>-0.001***</td>
<td></td>
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<tr>
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<td>-0.002***</td>
<td>-0.003***</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Idle Unempl.</td>
<td>-0.001***</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Agency Unempl.</td>
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<td></td>
<td>0.663***</td>
<td>0.686***</td>
<td>0.458***</td>
<td>0.538***</td>
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| Observations           | 575022 | 575022 | 575021 | 237015     |
| R²                     | 0.035  | 0.041  | 0.072  | 0.119      |
| Year dummies           | Yes    | Yes    | Yes    | Yes        |
| Age²*Skills            | No     | No     | Yes    | Yes        |

* p < 0.10, ** p < 0.05, *** p < 0.01
4.1 Causality

In this Section we empirically test our policy simulations by evaluating a reform that lifted several EPL restrictions on standard FTCs. The Italian labor market is characterized by a marked insiders/outsiders structure. Dismissal restrictions are among the strongest in the OECD, and there exist a plethora of different temporary work arrangements. A simple descriptive analysis reveals the existence of a veritable "contract jungle". Since the mid-nineties, almost every government has tried to remodel the existing labor structure. A few milestones have marked the history of temporary contracts in Italy. FTCs were first introduced in 1962, surviving 40 years without any major reform. Stipulation was allowed for a determined list of cases (negative liberty); in 1987, a new legislation allowed industry negotiation to identify quantitative limits on their use. Their length was limited to 6 months, extensible to a cumulated maximum of 12 months. However, in 1999, a European Union Directive issued guidelines for the liberalization of FTCs, shifting their liberty of stipulation from negative to positive. Each member state was left free to tailor the implementation of the Directive; Italy adopted its new measures on October 24, 2001\textsuperscript{19}. The new discipline abolished quotas for FTCs stipulated to replace absent workers, for seasonal needs or productive peaks, and at the start of new businesses. The cumulative length of FTCs increased up to 36 months. However, within this length, contracts could only be extended a single time. Furthermore, all quantitative restrictions were lifted from FTCs used for ordinary activities, if their length (extension included) was inferior to 7 months. Finally, the workforce computation for the application of EPL on permanent jobs was restricted to contracts longer than 9 months.

Before this reform, another major event had strongly affected the nature of temporary employment. Indeed, in 1997, the "Treu Law" introduced interim (TWA) contracts in the attempt to slow down the rapidly increasing unemployment rate. Figure 11 summarizes the evolution of the labor market over the last 30 years. The decrease in EPT\textsuperscript{20} is mirrored by a proportional increase in the share of FTCs. This trend seems to diverge even more after the introduction of the "Biagi

\textsuperscript{19}Legislative Decree 6 September 2001, n. 368.

\textsuperscript{20}Employment Protection Legislation on Temporary contracts.
Law” (October 24, 2003). This reform is less pertinent to our theoretical analysis. Indeed, the new legal provision only further liberalized TWA jobs, and introduced new 'project contracts' or 'work missions' that can be assimilated to self-employment. Our focus being on dependent employment only, we will target our analysis on the 2001 reform. Furthermore, to avoid any confounding effect with the Treu and Biagi Laws, we restrict our sample between the beginning of 1999 and the end of 2003.
Within this context, we implement a difference-in-difference strategy to test the results of our simulations on the 2001 reform. The main difficulty is the creation of treatment and control groups. We exploit the institutional context to circuit this obstacle. In Italy, contractual freedom for each occupation is regulated by general agreements known as CCNL, negotiated at the national level between firms associations, unions, and government representatives. New regulation modifying any
of the conclusions reached through the CCNL becomes effective only at their expiration. These agreements also regulate the limits imposed on the use of FTCs. Hence, the treated group will only include new hires belonging to occupations whose CCNL was either expired at the announcement of the reform, or renewed after the reform.

The specification is the following:

$$1_{OEC} = cons + \beta_s S_i + \beta_t T_j + \beta_{s,t} S_i T_j + \eta G + \phi Y + \tau G \ast Y + \gamma X + \psi Z + \alpha + \varepsilon_j \quad (19)$$

All terms are equivalent to Eq. 18, but two. $G$ identifies whether the newly stipulated contract within a national agreement that belongs to the treated group. $Y$ is the explicit year fixed effect (previously contained in $\alpha$). The strategy is simple. If belonging to the treatment after the implementation of the reform has any impact, than the coefficient $\tau$ of the group $(G) \ast$ year $(Y)$ interaction will be significant. We expect to observe a negative sign after 2001: as FTCs can be more easily stipulated and last longer, the likelihood for a new worker to be hired with an OEC should decrease.
Table 5: Reform impact on probability of a New Hire as OEC

<table>
<thead>
<tr>
<th></th>
<th>Match</th>
<th>Sector</th>
<th>Demo</th>
<th>Experience</th>
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<td>-0.583***</td>
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* p < 0.10, ** p < 0.05, *** p < 0.01
5 Conclusions

In this paper we have investigating sorting of new hires into open-ended and fixed-term contracts. Explaining why firms offer tenure to workers despite the firing costs they can incur has been proven theoretically difficult. We propose an explanation which hinges on heterogeneous match productivity. As workers are more productive in their job, firms have an incentive to retain them by committing to job stability. Temporary contracts are preferred for low-productivity matches, instead. Further, we argue that match productivity represents the fit between workers’ skills and task requirements. This assumption is motivated by descriptive empirical evidence from a matched employer-employee dataset from a large Italian region. Our data show that neither workers’ nor occupation characteristics can explain the probability of stipulating an OEC when taken in isolation. Regressions confirm that the probability of stipulating an OEC is decreasing in the level of skill mismatch. Our theoretical setup allows us to perform policy simulations. The model predicts that the liberalization of fixed-term contracts should encourage their use, especially at higher degrees of mismatch. We also show that these policies can have non-linear effects on aggregate unemployment, whose minimum level is attained for moderate flexibility of the market. We exploit a reform lifting restrictions on FTCs in Italy to test the first prediction. Our diff-in-diff strategy shows that the reform significantly diminished the probability of hiring under a permanent contracts, but the effect is slightly delayed.
References


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Portugal, P. and J. Varejao (2009). *Why Do Firms Use Fixed-Term Contracts?* 4380. IZA.


Appendices

A Theoretical Appendix

A.1 Proofs and Computations

A.1.1 Value functions

Stage 1

Consider the firm’s value function of a permanent job in stage 1.

\[
rJ_1(\alpha, \varepsilon, w_1) = y(\alpha) + \varepsilon - w_1 + s(J^V - J_1(\alpha, \varepsilon, w_1)) + \\
\mu E_{\varepsilon'} \left[ \max\{J(\alpha, \varepsilon', w'); J^V - K\} - J_1(\alpha, \varepsilon, w_1) \right]
\]  
(20)

Similarly for the worker:

\[
rW_1(\alpha, w_1) = w_1 + s(U - W_1(\alpha, w_1)) + \mu E_{w'} \left[ \max\{W(\alpha, w'); U\} - W_1(\alpha, w_1) \right]
\]  
(21)

Combining equations (20) and (21) and rearranging terms we obtain eq. (1) in the main text.

For FTCs we have:

\[
rJ_1^F(\alpha, \varepsilon, w_1^F) = y(\alpha) + \varepsilon - w_1^F + s(J^V - J_1^F(\cdot)) + \mu E_{\varepsilon'} \left[ \max\{J(\alpha, \varepsilon', w'); J^V - J_1^F(\cdot)\} \right]
\]  
(22)

\[
rW_1^F(\alpha, w_1^F) = w_1^F + s(U - W_1^F(\cdot)) + \mu E_{w'} \left[ \max\{W(\alpha, w'); U\} - W_1^F(\cdot) \right]
\]  
(23)

Combining eq. (22) and (23), we obtain eq. (3) in the main text.

Stage 0
The values of a new open-ended contract to the firm and the worker are, respectively:

\[
\begin{align*}
r_J(\alpha, y_0, w_0, \varepsilon_u, w_1) &= y_0 - w_0 + s(J^V - J_0(\cdot)) + \mu_0 \left[ \max\{J_1(\alpha, \varepsilon_u, w_1); J^V\} - J_0(\cdot) \right] \quad (24) \\
r_W(\alpha, w_0, w_1) &= w_0 + s(U - W_0(\alpha, w_0, w_1)) + \mu_0 \left[ \max\{W_1(\alpha, w_1); U\} - W_0(\alpha, w_0, w_1) \right] \quad (25)
\end{align*}
\]

Adding up equations (24) and (25) and rearranging terms we get eq. (4) in the main text.

Regarding new FTCs, the value functions of the firm and the worker are, respectively:

\[
\begin{align*}
r_{J^F}(\alpha, y_0, w^F_0, \varepsilon_u, w^F_1) &= y_0 - c^F - w^F_0 + s(J^V - J^F_0(\cdot)) + \mu_0 \left[ \max\{J^F_1(\alpha, \varepsilon_u, w^F_1); J^V\} - J^F_0(\cdot) \right] \quad (26) \\
r_{W^F}(\alpha, w^F_0, w^F_1) &= w^F_0 + s(U - W^F_0(\cdot)) + \mu_0 \left[ \max\{W^F_1(\alpha, w^F_1); U\} - W^F_0(\cdot) \right] \quad (27)
\end{align*}
\]

from which we derive equation (5) in the text.

Finally, the flow value of unemployment is:

\[
r_U = b + \theta q(\theta)E_{\alpha} \left[ \max\{W_0(\alpha, y_0, w_0, \varepsilon_u, w_1); W^F_0(\alpha, y_0, w^F_0, \varepsilon_u, w^F_1); U\} - U \right] \quad (28)
\]

where \( b \) represents unemployment benefits and utility derived from other non-market activities and leisure. Combining (6) with (28) and (15) allows us to express the value of unemployment as follows:

\[
r_U = b + \frac{\beta}{1 - \beta} \theta \kappa
\]

The reservation wage must cover the value of unemployment benefits and non-market activities - summarized by the parameter \( b \) - and a fraction of the vacancy posting costs depending on the workers’ relative bargaining power.

A.1.2 Additional computations on value functions

It is convenient to express the surplus of a fixed-term and a permanent contract highlighting the dependence on \( \alpha \) in the continuation value.
Consider the surplus of an open-ended job in stage 1 (eq. (2) in the main text):

\[(r + s + \mu)S_1(\alpha, \varepsilon_u) = y(\alpha) + \varepsilon_u - r(J^V + U) + (r + s)K + \mu G(\tilde{S}(\alpha))
= y(\alpha) + \varepsilon_u - r(J^V + U) + (r + s)K + \mu \int_{\varepsilon_1}^{\overline{1}} \max\{S(\alpha, \varepsilon'); 0\} dF(\varepsilon')
= y(\alpha) + \varepsilon_u - r(J^V + U) + (r + s)K + \mu \int_{\varepsilon_d(\alpha)}^{\varepsilon_u} S(\alpha, \varepsilon')dF(\varepsilon')\]

(30)

where \(\varepsilon_d(\alpha)\) is the job destruction threshold for open-ended job defined in Lemma 1. Consider the last integral in eq. (30) and solve by parts:

\[
\int_{\varepsilon_d(\alpha)}^{\varepsilon_u} S(\alpha, \varepsilon')dF(\varepsilon') = \left[S(\alpha, \varepsilon')\right]_{\varepsilon_d(\alpha)}^{\varepsilon_u} - \int_{\varepsilon_d(\alpha)}^{\varepsilon_u} \frac{\partial S(\alpha, \varepsilon')}{\partial \varepsilon'} F(\varepsilon')d\varepsilon'
= S(\alpha, \varepsilon_u)F(\varepsilon_u) - S(\alpha, \varepsilon_d(\alpha))F(\varepsilon_d(\alpha)) - \frac{1}{r + s + \mu} \int_{\varepsilon_d(\alpha)}^{\varepsilon_u} F(\varepsilon')d\varepsilon'
= S(\alpha, \varepsilon_u) - \frac{1}{r + s + \mu} \int_{\varepsilon_d(\alpha)}^{\varepsilon_u} F(\varepsilon')d\varepsilon'
= \frac{1}{r + s + \mu} \int_{\varepsilon_d(\alpha)}^{\varepsilon_u} (1 - F(\varepsilon'))d\varepsilon'
\]

where in the step from the second to the third row we have applied the definition of \(\varepsilon_d(\alpha)\). Including this result in eq. (30) yields:

\[(r + s + \mu)S_1(\alpha, \varepsilon_u) = y(\alpha) + \varepsilon_u - r(J^V + U) + (r + s)K + \frac{\mu}{r + s + \mu} \int_{\varepsilon_d(\alpha)}^{\varepsilon_u} (1 - F(\varepsilon'))d\varepsilon'\]

(31)

We can perform similar computations for the surplus of a fixed-term contract in stage 1 (eq. (3) in
Using the previous result:

\[
(r + s + \mu^F) S_1^F(\alpha, \varepsilon_u) = y(\alpha) + \varepsilon_u - r(J^V + U) + \mu^F E_{\varepsilon'} \left[ \max \{ S(\alpha, \varepsilon') - K; 0 \} \right]
\]

\[
= y(\alpha) + \varepsilon_u - r(J^V + U) + \mu^F \int_{\varepsilon_u}^{\varepsilon'_{\alpha}} \max \{ S(\alpha, \varepsilon') - K; 0 \} d\varepsilon'
\]

\[
= y(\alpha) + \varepsilon_u - r(J^V + U) + \mu^F \int_{\varepsilon_u}^{\varepsilon'_{\alpha}} [S(\alpha, \varepsilon') - K] d\varepsilon'
\]

\[
= y(\alpha) + \varepsilon_u - r(J^V + U) - \mu^F (1 - F(\varepsilon_d(\alpha))) K + \mu^F \int_{\varepsilon'_{\alpha}}^{\varepsilon_u} S(\alpha, \varepsilon') d\varepsilon'
\]

(32)

Consider the last integral in the previous equation and solve it by parts:

\[
\int_{\varepsilon'_{\alpha}}^{\varepsilon_u} S(\alpha, \varepsilon') d\varepsilon' = [S(\alpha, \varepsilon')]_{\varepsilon'_{\alpha}}^{\varepsilon_u} - \int_{\varepsilon'_{\alpha}}^{\varepsilon_u} \frac{\partial S(\alpha, \varepsilon')}{\partial \varepsilon'} F(\varepsilon') d\varepsilon'
\]

\[
= S(\alpha, \varepsilon_u) F(\varepsilon_u) - S(\alpha, \varepsilon'_{\alpha}(\alpha)) F(\varepsilon'_{\alpha}(\alpha)) - \frac{1}{r + s + \mu} \int_{\varepsilon'_{\alpha}}^{\varepsilon_u} F(\varepsilon') d\varepsilon'
\]

Notice that it is not possible to simplify the second term as we did for the surplus of an OEC. However, combining eq. (12) with the definition of \( \varepsilon'_{\alpha} \) in Lemma 3, we can write:

\[
S(\alpha, \varepsilon'_{\alpha}) = \frac{\varepsilon'_{\alpha} - \varepsilon_d}{r + s + \mu}
\]

\[
= \frac{\varepsilon_d + (r + s + \mu)K - \varepsilon_d}{r + s + \mu} = S(\alpha, \varepsilon_d) + K
\]

Using the previous result:

\[
\int_{\varepsilon'_{\alpha}}^{\varepsilon_u} S(\alpha, \varepsilon') d\varepsilon' = [S(\alpha, \varepsilon')]_{\varepsilon'_{\alpha}}^{\varepsilon_u} - \int_{\varepsilon'_{\alpha}}^{\varepsilon_u} \frac{\partial S(\alpha, \varepsilon')}{\partial \varepsilon'} F(\varepsilon') d\varepsilon'
\]

\[
= S(\alpha, \varepsilon_u) - S(\alpha, \varepsilon_d(\alpha)) F(\varepsilon_d(\alpha)) - K F(\varepsilon_{\alpha}(\alpha)) - \frac{1}{r + s + \mu} \int_{\varepsilon'_{\alpha}}^{\varepsilon_u} F(\varepsilon') d\varepsilon'
\]

\[
= \left( 1 - F(\varepsilon'_{\alpha}(\alpha)) \right) K + \frac{1}{r + s + \mu} \int_{\varepsilon'_{\alpha}}^{\varepsilon_u} (1 - F(\varepsilon')) d\varepsilon'
\]

where in the step from the second to third row we have used \( \int_{\varepsilon'_{\alpha}}^{\varepsilon_u} \frac{\partial S(\alpha, \varepsilon')}{\partial \varepsilon'} d\varepsilon' = S(\alpha, \varepsilon_u) - S(\alpha, \varepsilon_d(\alpha)) F(\varepsilon_d(\alpha)) - K F(\varepsilon_{\alpha}(\alpha)) \).
\[ S(\alpha, \varepsilon^F_u(\alpha)) = S(\alpha, \varepsilon_u) - K. \] Going back to eq. (32), we can finally write:

\[
(r + s + \mu^F) S_1^F(\alpha, \varepsilon_u) = y(\alpha) + \varepsilon_u - r(J^V + U) + \frac{\mu^F}{r + s + \mu} \int_{\varepsilon_u}^{\varepsilon^F_u(\alpha)} (1 - F(\varepsilon')) d\varepsilon'.
\]

### A.1.3 Conditions for the existence of a pooling equilibrium

In period -1 the agents compare the surpluses of a new OEC, a new FTC and the value of an unfilled vacancy (which is driven to 0 by the free entry condition). Then, they choose the option that provide them the highest value. We want to focus on the interesting case of FTCs being preferred for low productivity matches and permanent contracts being used for the high-productivity ones. In this Section we study the conditions that need to be fulfilled to obtain such an outcome. Firms compare the surplus of a new FTC with the surplus of a new open-ended.

By computing the derivatives of \( S_0^F(\cdot) \) and \( S_0(\cdot) \) one can easily verify that they are both increasing in \( \alpha \). Consider the surpluses as functions of \( \alpha \). Then, two conditions are needed to obtain a pooling equilibrium where FTCs are proposed to low-\( \alpha \) workers and open-ended contract to the more skilled: i) the surplus of a new FTC starts above the surplus of a new open-ended job, namely \( \alpha^F < \alpha \); ii) the surplus of a FTC is less elastic to \( \alpha \), namely \( \frac{\partial S_0^F(\alpha, \varepsilon_u)}{\partial \alpha} < \frac{\partial S_0(\alpha, \varepsilon_u)}{\partial \alpha} \).

When these two conditions are satisfied, \( S_0^F(\alpha, \varepsilon_u) \) lies above \( S_0(\alpha, \varepsilon_u) \) for low values of \( \alpha \) and the two functions display the single-crossing property. We shall denote the crossing point as \( \tilde{\alpha} \).

Using the results from the previous section, we can explicitly derive constraints on the configuration of parameters which ensure that the required conditions are met. To this aim, we introduce the following assumption:

**H 1.** We assume:

i) \[
\frac{r + s + \mu^F}{\mu_0} c^F - \frac{\mu^F}{r + s + \mu} \int_{\varepsilon_u}^{\varepsilon^F_u(\alpha)} (1 - F(\varepsilon')) d\varepsilon' < \mu \left[ K - \frac{1}{r + s + \mu} \int_{\varepsilon_u}^{\varepsilon^F_u(\alpha)} (1 - F(\varepsilon')) d\varepsilon' \right].
\]
This ensures: \( \alpha^F < \alpha \).

ii) \( \mu F(\varepsilon_d) < \mu^F F(\varepsilon^F_u). \) This ensures: \( \frac{\partial S_0^F(\alpha, \varepsilon_u)}{\partial \alpha} < \frac{\partial S_0(\alpha, \varepsilon_u)}{\partial \alpha} \).

With respect to the profitability threshold for open-ended contract, fixed-term contract are more profitable because firms are not afraid of paying the firing costs when the match ends. However,
destruction occurs more often, thus implying higher losses, and EPL on FTCs aims at discouraging their usage. The first point of Assumption H1 guarantees that the first effect is the dominating one. The second point requires that permanent contracts last longer than FTCs in expectation. This makes them more elastic to $\alpha$, since agents could profit from additional output for a longer period of time. Under Assumption H1, the values of the two contracts display the single-crossing property.

**Lemma 4.** Under Assumption H1, there exists a unique $\tilde{\alpha}$ such that

\[
\begin{aligned}
S^F_0(\alpha, \varepsilon_u) > S_0(\alpha, \varepsilon_u) & \quad \forall \alpha \in [\alpha_l, \tilde{\alpha}) \\
S^F_0(\alpha, \varepsilon_u) = S_0(\alpha, \varepsilon_u) & \quad \text{if } \alpha = \tilde{\alpha} \\
S^F_0(\alpha, \varepsilon_u) < S_0(\alpha, \varepsilon_u) & \quad \forall \alpha \in [\tilde{\alpha}, \infty)
\end{aligned}
\]

Then, $\tilde{\alpha}$ denotes the intersection between $S_0(\cdot)$ and $S^F_0(\cdot)$. Matches which are characterized by idiosyncratic productivity below $\tilde{\alpha}$ are stipulated as temporary, while permanent contracts are more convenient for matches with $\alpha > \tilde{\alpha}$.

**A.1.4 Equilibrium**

The results presented in Section 3 can be collected in the following definition of stationary equilibrium.

**Definition 1.** An equilibrium is a 6-tuple of scalars $(\theta, u, \alpha^F, \tilde{\alpha}, w_0, w^F_0)$ and a triple of functions $(\varepsilon_d(\alpha), w(\alpha, \varepsilon), w^F(\alpha, \varepsilon))$, such that

1. Inflows into unemployment equal outflows.
2. The value of any job relationship is constant over time.
3. Free entry holds: $J^V = 0$.
4. Firms and workers jointly take decisions over match formation, contract type and job destruction (expiration of a FTC which is not converted or layoff of a permanent worker) to maximize their expected surplus.
5. Wages are established through Nash bargaining.

The first point implies that the following flow-balance equation holds:

\[ sN + (1 - \tilde{p})N \int_{\alpha_L}^{\bar{\alpha}} \bar{s}^F(\alpha) dG(\alpha) + \tilde{p}N \int_{\bar{\alpha}}^{\alpha_u} \bar{s}(\alpha) dG(\alpha) = \theta q(\theta) (1 - G(\alpha^F)) u \]  \hspace{1cm} (33)

where \( N \) is total employment. In eq. (33), inflows into unemployment are represented by quits, expiring FTCs which are not converted and layoffs; outflows are new matches\(^{21}\).

Define the composite separation rate as

\[ \bar{s} \equiv s + (1 - \tilde{p}) \int_{\alpha_L}^{\bar{\alpha}} \bar{s}^F(\alpha) dG(\alpha) + \tilde{p} \int_{\bar{\alpha}}^{\alpha_u} \bar{s}(\alpha) dG(\alpha) \]

Then, from eq. (33) we can derive the modified version of the Beveridge curve (eq. 17 in the text):

\[ u = \frac{\bar{s}}{f(\theta) + \bar{s}} \]  \hspace{1cm} (34)

Point 2 of Definition 1 was already implicit in the definition of the Bellman equations provided above, which were assumed to be time invariant. Free entry (point 3 of Definition 1) was imposed to derive the job creating condition (16). Point 4 implies that: i) match formation obeys equations (13) and (14); ii) provided that the match is profitable, the type of contract is chosen as described in Proposition 1; iii) endogenous separations are characterized in Lemmas 1 and 3. Finally, the last point affirms that the equilibrium wages are represented by equations (7)-(10).

A.2 Extension: Endogenous Investment in Human Capital

In this Section we extend the benchmark model by considering the possibility of endogenous accumulation of human capital. Workers and firms jointly decide upon the investment in human capital (\( h \)) to raise the productivity of the match. We assume human capital is match-specific, so that it

\(^{21}\)N can be taken out of the integral because we assume random matching and the value of \( \alpha \) is discovered upon meeting. Had firms the possibility of directing their search according to the value of \( \alpha \), the distribution of \( \alpha \) among the employed would differ from the distribution in the population.
is completely lost once the match is severed. The decision is taken once and for all in stage 0. The cost is paid during the same period and we assume that a fraction $t$ is paid by the worker\footnote{One can interpret the joint decision of investment as made by two separate components. On the one hand, workers exert effort to acquire firm-specific skills; on the other hand, firms provide on-the-job training. However, both components contribute to a unique input in the production function ($h$). Furthermore, the associated cost is computed by taking into account the sum of the two contributions.}. We further assume complementarity between ability and investment in human capital in the production function:

$$y = y(\alpha, h) + \varepsilon$$  \hfill (35)

where $\partial y / \partial \alpha > 0$, $\partial y / \partial h > 0$, $\partial^2 y / \partial h \partial \alpha > 0$ and $\varepsilon$ is a firm specific component. The production function (35) is similar to the one adopted by Wasmer (2006), where output is the sum of a firm’s component and the worker’s human capital. The complementarity between the match-specific component and human capital is reminiscent of the specification adopted by Acemoglu and Pischke (1998) and by Lise, Meghir, and Robin (2013)\footnote{Barron, Black, and Loewenstein (1989) find evidence that employers try to fill positions which require more on-the-job training with workers’ with higher ability. Their concept of on-the-job training incorporates worker’s investment in human capital too.}. The cost function is assumed increasing and convex\footnote{We adopt this specification: $c(h) = e^h$.}.

The expressions for the surpluses of a new open-ended and a new FTC need to be modified to take into account the cost of investment. We can rewrite equations (4) and (5) as follows:

$$(r + s + \mu_0)S_0(\alpha, \varepsilon_u) = \mu_0 \left[ \max \{S_1(\alpha, \varepsilon_u) - K; 0\} \right] - c(h)$$

$$(r + s + \mu_0)S_F^0(\alpha, \varepsilon_u) = -c^F - c(h) + \mu_0 \left[ \max \{S_1^F(\alpha, \varepsilon_u); 0\} \right]$$

The Nash bargained wages in stage 0 become:

$$w_0 = rU - \beta \mu_0 K + (t - \beta)c(h)$$

$$w_0^F = rU - \beta c^F + (t - \beta)c(h)$$
Notice that \( w_0 \) and \( w_0^F \) are the same as in absence of human capital accumulation (see equations (9) and (10)) if the fraction of the cost paid by the worker equals her bargaining power, i.e. if \( t = \beta \). Otherwise the worker is either subsidized (if \( t > \beta \)) or penalized (if \( t < \beta \)) to ensure that the jointly optimal decision upon human capital investment is incentive compatible for both parties.

Workers and firms maximize the value of any new job relationship:

\[
\max_h S_0(\alpha, h, \varepsilon_u) \\
\max_h S_0^F (\alpha, h, \varepsilon_u)
\]

The optimal investment level satisfies the first order conditions:

\[
-\frac{\mu_0}{r + s} \frac{\partial \varepsilon_d(y(\alpha, h)) \partial y(\alpha, h)}{\partial h} + \frac{\partial y(\alpha, h)}{\partial h} = c'(h) \tag{36}
\]

\[
\frac{\mu_0}{r + s + \mu F} \frac{\partial y(\alpha, h)}{\partial h} \left[ 1 - \frac{\mu F}{r + s + \mu} \frac{\partial \varepsilon_d(y(\alpha, h))}{\partial y(\alpha, h)} \right] \left[ 1 - F \left( \varepsilon_d^F (y(\alpha, h)) \right) \right] = c'(h) \tag{37}
\]

where the first row is the first order condition for OECs whereas the second row refers to temporary contracts. Equation (36) and (37) say that optimality requires equating the marginal cost of investing to the marginal benefit, represented by lower destruction and increased match productivity.

Replacing \( \frac{\partial \varepsilon_d(y(\alpha, h))}{\partial y(\alpha, h)} \) as defined in Lemma 2 and rearranging terms we get:

\[
\frac{\mu_0}{r + s + \mu F} \frac{\partial y(\alpha, h)}{\partial h} = c'(h) \tag{38}
\]

\[
\frac{\mu_0}{r + s + \mu F} \left[ r + s + \mu F \left( \varepsilon_d(y(\cdot)) + \mu F \left[ 1 - F \left( \varepsilon_d^F (y(\cdot)) \right) \right] \right] \frac{\partial y(\cdot)}{\partial h} = c'(h) \tag{39}
\]

In the next sub-section we discuss the existence and uniqueness of the solutions to eq. (38)-(39).

We further introduce Assumption H2 which restricts the class of admissible functions in order to achieve clearcut predictions about the effects of mismatch and EPR on human capital accumulation.

**Lemma 5.** Under Assumption H2, the optimal level of investment \( h^* \) positively depends on the
match-specific productivity component $\alpha$ and the level of firing costs $K$. Formally,

$$\frac{\partial h^*}{\partial \alpha}, \frac{\partial h^*}{\partial K} > 0 \quad \text{and} \quad \frac{\partial (h^F)^*}{\partial \alpha}, \frac{\partial (h^F)^*}{\partial K} > 0$$

Intuitively, both a good fit with the occupation and EPL provisions increase the expected length of the match, thus encouraging human capital accumulation. In fact, firing costs lower $\varepsilon_d(y)$ and reduce job destruction. The (inverse) mismatch index influences the job destruction threshold in two ways: i) directly, because, *ceteris paribus*, matches with higher $\alpha$ are more productive; ii) indirectly, through the complementarity with human capital in the production function which fosters investment and further reduces the job destruction rate.

Therefore, the optimal level of investment is a positive function of $\alpha$:

$$h^* = h(\alpha) \quad \text{with} \quad h'(\alpha) > 0$$

$$(h^F)^* = h^F(\alpha) \quad \text{with} \quad h'^F(\alpha) > 0$$

By comparing the first order conditions (38)-(39) we can gauge which type of contract induces more accumulation of human capital. The result is summarized by the following Proposition.

**Proposition 2.** Assume $c''(h) > 0$ and Assumption H1 holds. Then, workers in temporary contracts invest less in human capital than workers in permanent matches. Formally,

$$h^F(\alpha) \leq h(\alpha) \quad \forall \quad \alpha \in [\alpha_l, \alpha_u]$$

Recall that the second point of Assumption H1 implies that the average duration of a job starting as temporary is shorter than the expected length of a permanent match. Proposition 2 thus makes it clear that the firm-worker pair chooses to invest more in the job matches expected to last longer,
since HC is lost upon separation\textsuperscript{25}. Interestingly, the condition needed to obtain such a result is the same which guarantees the existence of a pooling equilibrium. Given our assumptions on the production function, the presence of human capital accumulation sharpens the heterogeneity in match productivities. This happens to a higher degree in permanent jobs whose convenience thus increase with $\alpha$ at a faster pace. The graphical intuition is provided by Figure 12, which compare the surplus of a new OEC in the benchmark model (blue solid line) and in the model with HC (red dashed line). In the benchmark model $S_0(\alpha)$ is linearly increasing in the match specific productivity, while it displays increasing returns in $\alpha$ when we add investment in HC.

\textsuperscript{25}This prediction of the model has been validated empirically. Booth, Francesconi, and Franck (2002) show that workers in FTCs are less likely to receive training. This finding is confirmed by Albert, Garcia-Serrano, and Hernanz (2005) on Spanish data. Moreover, the empirical estimates reveal that more educated workers are more likely to receive training: this could be interpreted as an indication of complementarity between worker’s individual ability and investment in firm specific skills.
**Optimal investment in HC**

Consider the decision on human capital accumulation in open ended contracts. Define

\[ G(h) = \frac{1}{r + s + \mu F(\varepsilon_d(y(\alpha, h)))} \frac{\partial y(\alpha, h)}{\partial h} - c'(h) \]  

The optimal level of investment is such that \( G(h^*) = 0 \). To obtain an internal solution we need to ensure that there exists \( h^* \) such that the marginal benefit equals the marginal cost. Given our convexity assumption on the cost function, \( c'(\cdot) \) is increasing in \( h \). If we differentiate the first term of the \( G(\cdot) \) function with respect to \( h \) we obtain:

\[ \Gamma(h) = \frac{\partial^2 f(\alpha, h)}{\partial h^2} \left( r + s + \mu F(\varepsilon_d(y(\alpha, h))) \right) + \mu f(\varepsilon_d(y(\alpha, h))) \left( r + s + \mu \right) \left( \frac{\partial y(\alpha, h)}{\partial h} \right)^2 \]

(41)

The sign of \( \Gamma(h) \) is uncertain, depending on the shape of the production function. Notice that there exist two corner solutions. The first occurs when the marginal cost always overcomes the marginal benefit and implies zero investment in HC (\( h^* = 0 \)). This verifies whenever \( \Gamma(h) < c''(h) \forall h \) and \( c'(0) > G(0) \). The second corner solution emerges when the marginal benefit of investing is always higher than the marginal cost and entails an infinite amount of investment (\( h^* = \infty \)). Formally, \( \Gamma(h) > c''(h) \forall h \) and \( c'(0) < G(0) \). This case can occur iff \( \frac{\partial^2 f(\alpha, h)}{\partial h^2} > 0 \), that is for a production function displaying increasing marginal returns to human capital. Furthermore, the possibility of multiple equilibria cannot be excluded a priori. However, our choices of production and cost functions and our calibration ensure the existence and the uniqueness of an interior solution.

Figure 13 provides a graphical representation for two different specifications of the production function. The red dashed line represents the marginal cost, increasing and convex. The schedules representing the marginal benefit for two distinct values of \( \alpha \) are plotted in blue. The intersection between marginal benefit and marginal cost gives the optimal \( h \). In all cases represented in Figure 13 the solution is interior.

Now consider the effect of firing costs and match-specific productivity on investment in human capital. For the implicit function theorem we have \( \frac{\partial h}{\partial K} = -\frac{\partial G(\cdot)/\partial K}{\partial G(\cdot)/\partial h} \). It can be easily shown that
The red dashed line is the marginal cost of investing in human capital, \( c'(h) = \exp(h) \). In any panel, the blue lines represent the marginal benefit of accumulating \( h \) for two distinct values of \( \alpha \). The left panel assumes a Cobb-Douglas production function: \( y(\epsilon) = \alpha^\zeta h^{1-\zeta} + \epsilon \), with \( \zeta = 0.5 \). The right panel shows the result for the same production function adopted by Acemoglu and Pischke (1998), \( y(\epsilon) = \alpha h + \epsilon \).

\( \partial G(\cdot)/\partial K \) is always positive, so that the sign depends on \( \partial G(\cdot)/\partial h = \Gamma(h) - c''(h) \). A similar reasoning applies to the influence of the idiosyncratic productivity component. We thus make the following assumption:

**H 2.** We assume a specification of the production function and the cost function of investment in human capital such that:

\[
\Gamma(h^*) = \frac{\left[ \frac{\partial^2 f(\alpha, h)}{\partial h^2} \right]_{h=h^*} (r + s + \mu F(\epsilon_d(y))) + \mu f(\epsilon_d(y))(r + s + \mu) \left[ \frac{\partial y(\alpha, h)}{\partial h} \right]_{h=h^*}^2}{[r + s + \mu F(\epsilon_d(y))]^3} < c''(h^*)
\]

This assumption allows us to introduce Lemma 5 in the previous Section.
A.3 Extension: Probationary Periods and Learning

In the analysis conducted in the main text, we have considered a setting in which there is a clear dichotomy between FTCs, not subject to firing costs, and permanent contracts, which are covered by EPL from their very beginning\textsuperscript{26}. However, the difference is less pronounced in reality: indeed, the law generally allows firms to start a permanent contract with a trial period, during which dismissals can happen at no cost. In the light of the modeling strategy adopted above, probationary periods (PPs) appear very similar to FTCs. Therefore, we face the challenge of explaining the co-existence of two comparable contracts.

We argue that FTCs differ from probationary periods in two fundamental dimensions: the separation rate and the length. Separations are assumed to occur more often in FTCs rather than in PPs. There are number of reasons to believe that this is a sensible assumption: workers hired with temporary contracts feel more insecure about their future career and are likely to search more intensely for another job\textsuperscript{27,28}. This hypothesis is important to preserve an essential feature of the model: OECs are expected to last longer, so that firms are especially interested in using them to hire high skilled workers.

Furthermore, we assume FTCs to be on average longer than PPs ($\mu_F < \mu_P$). While in reality the actual length of both is a chosen by the firm, the maximum length is regulated by law and it is much shorter for PPs\textsuperscript{29}. While empirically a large number of very short FTCs is observed, our model actually applies to those contracts which are closely substitutes to permanent positions. Indeed, Tables ?? and ?? show that the average length of FTCs conditional on conversion is generally higher than 6 months, which is the maximum extension of trial periods according to the Italian law.

\textsuperscript{26}Firing costs are not present in stage 0. However, as discussed in text, this initial phase is just an intermediary step whose value deterministically depends on the surplus in stage 1.

\textsuperscript{27}For a formal justification of this assumption and evidence based on European data, see Kahn (2012).

\textsuperscript{28}Although we assume $s_F > s_P$ for simplicity, one should not necessarily believe that quits occur more often in FTCs rather than in permanent jobs. An equivalent interpretation requires that at the expiration of a temporary contract, there is a non-zero probability that the match cannot be continued even if the surplus is positive. This can occur because, for instance, the worker has found another match in the meanwhile or because the firm needed the worker only for a short-term project or to replace another worker on leave.

\textsuperscript{29}See Table 6 in Appendix B.2 for the law provisions on PPs and FTCs in several European countries.
From the combination of the separation rate and the length of the contract we can compute the expected duration of the match, which represents the only difference between FTCs and PPs. It follows that one of the two contracts is expected to last longer and is therefore preferred to the other for all values of $\alpha$. We thus investigate a complementary explanation which is the main reason why probationary periods exist in the first place. The mechanism we are going to introduce is based on the concept of the job as "experience good", in Jovanovich (1979)'s terminology: the only way to determine the quality of the match is to experience it. However, differently from Jovanovich (1979), we postulate that the match quality is not entirely unknown before starting production. When meeting a worker for the first time, the firm observes a noisy signal of the match-specific productivity component $\alpha$. We think to the signal as the information the firm can get through interviews and cv. To avoid additional complications, we assume that at any point in time the worker shares the same information and beliefs of the firm; this allows us to leave aside the issue of asymmetric information and adverse selection. While certainly restrictive, this assumption is consistent with our interpretation of the $\alpha$ parameter, which captures the correspondence between the worker's skill and her fit for the position she is supposed to fill. More formally, upon meeting, the firm holds a subjective belief of the $i$-th match-productivity distribution: $\alpha_i \sim G_0^i$, with mean $\hat{\alpha}_i$ and standard deviation $\sigma_0$.

At first, we do not present a formal model of learning but we rather adopt a more intuitive reduced-form approach. However, in the following Section we show how our assumptions can be justified on the ground of a model of Bayesian learning$^{30}$. We assume that the firm observes the worker during the trial period or the FTC and refines its initial estimate as time goes. The longer it can follow the worker, the more precise its estimate will be at the moment of taking the decision on whether upgrading the contract or not. Then, at the moment of hiring, the firm already expects it will have a better knowledge of the match at the expiration of the FTC rather than at the end of the trial period. Since we assume the initial estimate to be unbiased, in expectation the subjective

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$^{30}$For an application of the Bayesian learning model in the labor market see Jovanovich (1979) and Nagypal (2002). Learning in a dual labor market is also considered by Faccini (2014), who instead adopts an "all-or-nothing" learning scheme based on the results by Pries (2004).
distribution of $\alpha_i$ will have the same mean as the initial one ($\hat{\alpha}_i$) but lower variance, with

$$\sigma^F < \sigma^P$$

where $\sigma^F$ and $\sigma^P$ are the standard deviations of the firm’s belief on the productivity of match $i$ at expiration of the FTC and the trial period, respectively.

The precision of the estimate is particularly important for those matches which have signaled a productivity close to the threshold for conversion. In fact in this case the consequences of a mistake may be more serious, leading to losses and more frequent layoffs. For simplicity, we assume that the firm acquires a perfect knowledge of $\alpha$ after having taken a decision on conversion. Suppose that the firm has decided to convert a match but then it realizes that has overstated its productivity and it is actually convenient to fire the worker. Since the match has already been converted to permanent, the layoff entails the payment of the firing costs. Additionally, we assume that the firm is concerned about hiring workers with very low productivity, such as, for instance, those with a fit to their task inferior to the profitability threshold. If it turns out that a worker upgraded to a permanent position has such a low productivity, a cost is imposed on the firm. It follows that the gains from learning are higher for productivity values around the profitability threshold.

We are now able to introduce the value functions in case of imperfect observation of $\alpha$. Consider

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31 Consider the situation of a firm which has converted a contract of expected productivity $\hat{\alpha}_i$. Clearly, $\hat{\alpha}_i > \alpha$. Framing the problem in statistical terms, the hypotheses considered by the firm are:

$$\begin{cases} H_0 : \alpha = \hat{\alpha}_i \\ H_1 : \alpha \leq \hat{\alpha}_i < \alpha \end{cases}$$

A type I error occurs when the firm does not convert a match whose productivity is indeed sufficiently high. However, in expectation this situation does not occur if $\hat{\alpha}_i > \alpha$. Conversely, a type II error occurs when the firm erroneously converts a low productive match. In expectation, this happens with posterior probabilities $G^F_i(\alpha)$ and $G^P_i(\alpha)$ for FTCs and OECs, respectively.

Then, the cost we introduce in the firm’s value function can be interpreted as a cost on type II errors committed in case of erroneous conversion. The specular case of erroneous missed conversion (i.e. a match which is not converted despite its high productivity) is not considered here, since we think that the foregone benefits implied by this case represent a minor issue with respect to the problems created by a too low productive worker mistakenly introduced in the productive unit.
a contract in probationary period which has signaled a productivity $\alpha_i$:
\[
(r + s + \mu P) S(\hat{\alpha}_i, \varepsilon_u) = y(\hat{\alpha}_i) + \varepsilon_u - rU + \mu P \mathbb{E}_{\alpha, \varepsilon'} \left[ \max\{S(\alpha, \varepsilon'); 0\} - c^{\text{learn}}(\alpha, \varepsilon') \right] \tag{42}
\]

The previous equation can be rewritten as it follows:
\[
(r + s + \mu P) (S(\hat{\alpha}_i, \varepsilon_u)) = y(\hat{\alpha}_i) + \varepsilon_u - rU + \mu P \left[ \int_{\alpha_l}^{\alpha_u} \int_{\varepsilon_u \hat{\alpha}_i}^{\varepsilon_u} S(\alpha, \varepsilon') dG^P_i(\alpha) dF(\varepsilon') - c^{\text{learn}} \int_{\alpha_l}^{\alpha_i} \int_{\varepsilon_u \hat{\alpha}_i}^{\varepsilon_u} dG^P_i(\alpha) dF(\varepsilon') - K \int_{\alpha_l}^{\alpha_i} \int_{\varepsilon_u \hat{\alpha}_i}^{\varepsilon_u} dG^P_i(\alpha) dF(\varepsilon') \right] \tag{43}
\]

where $G^P_i(\alpha)$ is the posterior distribution of $\alpha$ with mean $\hat{\alpha}_i$ and standard deviation $\sigma_i$. Furthermore, $\alpha_d(\varepsilon')$ is such that $\varepsilon_d(\alpha) = \varepsilon'$. In words, $\alpha_d(\varepsilon')$ is the minimum value of $\alpha$ such that it is not convenient to break a permanent match with firm’s productivity component $\varepsilon'$. Equation (43) represents the modified version of eq. (1), which takes into account the imprecision in the estimate of the true productivity value. The belief about the distribution of $\alpha$ depends on the contract, featuring lower dispersion for FTCs, that are assumed to last longer than PPs. $c^{\text{learn}}(\cdot)$ represents the cost of having converted a match whose actual productivity lies below the profitability threshold. The last term shows what happens when the firm upgrades a match whose actual productivity is lower than the value which guarantees a positive surplus. In this case, the firm prefers to fire the worker and pay $K$. The surplus of a temporary contract needs to be modified accordingly.

To have a sense on how the model changes with the introduction of probationary periods and learning, we can take as given the endogenous outcomes of the benchmark two tier model ($\theta$, $U$) and compute the value of FTCs and PPs in the new setting. The new parameters are calibrated as follows. The quite rate in FTCs is 0.02; PPs are about 6 months long ($\mu P = 0.16$); $c^{\text{learn}} = 10000$; the subjective distributions of $\alpha$ are assumed to be uniform, centered on the initial signal $\hat{\alpha}_i$, with
standard deviation double for the matches ending the trial period\textsuperscript{32}.

The results are reported in Figure 14. The blue solid line represents the surplus of an OEC starting with a trial period, while the red dashed line is the surplus of a FTC. With perfect information about \( \alpha \), permanent matches without initial firing costs always dominate FTCs because the lower quit rate implies that they last longer and they are thus more convenient. However, when the screening motive is introduced, there is scope for using FTCs in an intermediate range of \( \alpha \). At the lowest productivity values, the firm is not interested in screening because it already plans not to convert the match. When conversion becomes an interesting option, however, the firms does not want to commit mistakes and prefers observing the worker for a longer period of time: FTCs are preferred to PPs. As the initial signal becomes more and more positive, there is little chance that the firm erroneously converts a good match and the need for screening diminishes; then, permanent contracts are again preferred against temporary ones.

\subsection*{A.3.1 Bayesian Learning}

So far, we have introduced learning in an informal way. Importantly, we have assumed that the precision of the updated estimate of productivity positively depends on the time elapsed between the initial and the final observation. In this Section, we show how this assumption can be justified through a model of Bayesian learning.

Upon meeting a worker, the firm observes a noisy signal of the match productivity:

\[ s^0 = \log(\alpha_i) + \delta \]

where \( \alpha_i \) is drawn from the productivity distribution \( g(\alpha) \) and \( \delta \) has pdf \( f(\delta) \). To keep things simple,

\textsuperscript{32}Evaluating eq. (43) is computationally intensive for the presence of the double integrals. Rigorously, the integrals cannot be split, because the value of the match-specific productivity under which the firm prefers to fire the worker \( (g(\varepsilon')) \) depends on the realized value of the firm-specific productivity component \( \varepsilon' \). However, we can take a shortcut which has a minor impact on the final result and has the advantage of greatly speeding up calculus. Instead of computing a destruction threshold for each value of \( \varepsilon \), we consider an average \( \bar{\alpha} \) and \( \bar{\alpha}^F \). We thus impose that the firing threshold is always equal to the value that one would observe for \( \varepsilon = \varepsilon_u \), irrespective of the actual realization of the firm-specific productivity component.
we assume that $\log(\alpha) \sim N(\mu_\alpha, \sigma^2_\alpha)$ and $\delta \sim N(0, \sigma^2_\delta)$\textsuperscript{33}. Firms then utilize Bayesian updating to obtain a first estimate of the unknown match quality $\alpha_i$. Estimated productivities are denoted with a hat; the superscript stands for the number of updates; the very first estimate, which comes before stipulating the contract, is indicated with 0. The first estimate of $\alpha_i$ is thus distributed as follows

$$\hat{\alpha}_i^0 \sim N\left(\frac{\tau_\alpha m_\alpha + \tau_\delta s_0^0}{\tau_\alpha + \tau_\delta}, \frac{1}{\tau_\alpha + \tau_\delta}\right)$$

where $\tau_\alpha = \frac{1}{\sigma^2_\alpha}$ and $\tau_\delta = \frac{1}{\sigma^2_\delta}$ are the precision of the prior and the signal, respectively.

Upon meeting, firms already anticipate that they will be able to observe $n^c$ other signals before the end of the contract. In expectation, the match quality would still be $\hat{\alpha}_i^0$, but the confidence in the estimate would be higher. More specifically, the expected posterior distribution of match quality $\alpha_i$ after $n^c$ updates is:

\textsuperscript{33}We thus have that the mean and variance of $\alpha$ are $\bar{\alpha} = e^{\mu_\alpha + \sigma^2_\alpha / 2}$ and $\nu_\alpha = e^{2\mu_\alpha + \sigma^2_\alpha (e^{\sigma^2_\alpha} - 1)}$, respectively. The log specification is adopted to ensure the positivity of $\alpha$.
\[ \mathbb{E}_0(\hat{\alpha}_i^{\text{nc}}) \sim \mathbb{E}(\tilde{g}^{\text{nc}}(\alpha_i)) = \mathcal{N}\left(\hat{\alpha}_i^0, \frac{1}{\tau_\alpha + (\bar{n}^{\text{nc}} + 1)\tau_\delta}\right) \]

If, for instance, we make the hypothesis that the productivity of the match can be observed once a month, the number of updates will be higher the longer the contract. It follows that FTCs will allow firms to estimate \( \alpha_i \) with higher precision, as we assumed in the extension of the model.

\section*{B Empirical Appendix}

\subsection*{B.1 Data Sources}

The empirical part of this paper makes use of three databases of Italian data, which we use for different purposes. We are now going to describe them in detail.

\textbf{LoSai Database}

This is a random sample of all contracts stipulated by any firm in Italy from 1985 to 2012. These data are collected by the Italian Social Security System (INPS) for administrative purposes. Workers and firms are identified through a unique id. For any observation, we know what follows: worker’s qualification (blue collar, white collar, manager, principal); days worked, daily hours worked (full time, part-time), monthly wage, contract type (open-ended, temporary, seasonal), starting date, termination date, policy (this variable allows us to further disaggregate the different types of temporary jobs), reason for hiring (only from 2005 onwards), reason for termination (only from 2005 onwards), class size of the firm, firm’s sector (2 digits ATECO 1981 classification).

Since this is random sample, this database does not allow to study the flows of hirings by contract type at the firm level. However, we can study workers’ transitions controlling for the firm’s sector and class size.
Veneto Working Histories (VWH) and Planet

VWH is a longitudinal panel built at the department of Economics of the University of Venice on the ground of the Social Security administrative data of the Italian Social Security System (Inps). It refers to the entire population of a large Italian region, Veneto, which is a dynamic territory based on manufacturing, with a large population of small firms (the average establishment size is 12 employees). The database covers each single plant and worker employed in the private sector from 1975 to 2001. Inps data include register-based information on all establishments and employees that have been hired by those establishments for at least one day during the period of observation, independent of the worker’s place of residence. The entire working life for all employees that have worked at least one day in Veneto, has been reconstructed, considering the occupational spells out of Veneto as well. Employers are identified by their identification number, which changes if ownership, in a strict sense, changes. This has been amended: any time more than 50% of all employees are taken over by the new legal employer, the employment spell is said to be continuing. Similarly, if there are short breaks in the employment spell, as long as the worker continues at the old employer, his spell is considered uninterrupted.

The variables present in the dataset are the following:

- On the worker side: worker’s id, gender, age, birth place, nationality, address
- For the job: year and month of work, working weeks, working days, place of work, gross wage, qualification, contract type, level.
- On the firm side: firm’s id, name, activity description, address, sector code (3-digits ATECO, 1981 classification), establishment date, cessation date, artisan firm, area code.

VWH can be matched to another database, developed by the Veneto Employment Agency (Osservatorio Veneto Lavoro) and called Planet. While VWH contains more informations regarding the firm, Planet is richer on the worker’s side, providing, for instance, the education level. Importantly, Planet allows to considerably extend the temporal range, given that the data go from 1998 to 2013. Then, the two databases overlap for 4 years, thus allowing to build a consistent panel of working
histories from 1975 onwards.

An important selection issue may emerge when only part of the observations can be matched. This can be due to many different reasons: e.g., firms that ended their activities or workers who retired before 1998 are present in VWH but not in Planet; similarly, workers who entered the labor market or firms which initiated their activity after 2001 are present in Planet but not in VWH. Other sources of missed matching derive from the fact that in VWH the unit of observation is the worker, who is followed even when he went to work outside the region; in Planet this possibility is rather limited. Furthermore, in VWH firms operating in the agricultural and public sectors are not observed, while they are present in Planet.

The working histories built through the linkage between VWH and Planet are particularly useful for our analysis because they contain the universe of the employment contracts at each firm for any time period. Then, we can precisely compute the share of temporary employment and flow of hirings at the firm level (which correspond to $p$ and $\tilde{p}$ in the model) and study how they are affected by the co-variates we can control for.

### B.2 Additional Empirical Evidence
Table 6: Legislation on probationary periods and use of temporary contracts (TC): EU - U.S. cross-country comparison

<table>
<thead>
<tr>
<th></th>
<th>Blue collar</th>
<th>White collar</th>
<th>Max prob length (months)</th>
<th>Valid reasons required for TC use</th>
<th>Quotas on TCs</th>
<th>Max number cumulated TCs</th>
<th>Max cum TC length (months)</th>
<th>Employees threshold for dismissal costs</th>
<th>Workforce under TC</th>
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<td>no limits</td>
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<td>9.8</td>
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<td>6 / 12</td>
<td>no for first</td>
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<td>36</td>
<td>1</td>
<td>8.3</td>
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<td>no limits</td>
<td>1</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
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<td>cla</td>
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<td>48 / no limits</td>
<td>-</td>
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</table>


The probationary period, or 'qualifying period of employment', defines the initial contract time during which employees are excluded from the protection against unfair dismissal. In some countries unlimited renewals on FTC are permitted if justified by an objective reason or when the FTC has an uncertain term (Portugal).

In the quotas' column, "cla" signifies regulated by collective labour agreement. Eurostat temporary job definition: "A job may be considered temporary if employer and employee agree that its end is determined by objective conditions such as a specific date, the completion of a task or the return of another employee who has been temporarily replaced (usually stated in a work contract of limited duration). Typical cases are: (a) persons with seasonal employment; (b) persons engaged by an agency or employment exchange and hired to a third party to perform a specific task (unless there is a written work contract of unlimited duration); (c) persons with specific training contracts." In the U.S., the short-term contracts estimate includes temporary help and contract company workers, as well as self-employed and independent contractors who work for one firm at a time and expect this arrangement to last for 1 year or less.