

# Who gains from labour market flexibility at the margin?\*

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## Abstract

Since the 1980s, restrictions on the use of fixed-term contracts were relaxed in some European countries, but strict employment protection legislation governing permanent contracts was not reformed. This flexibility at the margin led to strong labour market segmentation with fixed-term contracts representing the majority of the employment contracts used in new hires and a significant share in total employment. In this paper, I develop a partial equilibrium search model of the labour market where workers and firms choose their employment contract upon forming a match. The decision of whether to invest in job-specific human capital is also endogenously determined. The model is estimated using French matched employer-employee data from 2005 to 2008. I use the model to evaluate whether low skilled workers have benefited from the greater flexibility due to the introduction of fixed-term contracts and to provide insights into the heterogeneity of the effects of an employment protection legislation reform. I find that fixed-term contracts do not function as stepping-stones to better jobs. Decreasing the dismissal cost of permanent contracts by 10% would reduce the share of fixed-term contracts in new hires by half a percentage point, if the destruction rate of permanent contracts were to remain unchanged. The workers that would benefit most from the decrease in the firing cost are those in the upper part of the ability distribution, namely between the 60th and 80th percentiles. Nonetheless, taxing fixed-term contracts seems more effective in reducing the share of fixed-term contracts than reducing the dismissal cost. Finally, larger gains in total output can be achieved by reducing the cost of training workers on-the-job rather than by reducing the dismissal cost of permanent contracts and the share of fixed-term contracts in new hires.

Keywords: Employment Protection Legislation; Temporary contract; Permanent contract; Labour market reform.

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# 1 Introduction

Following the high and persistent levels of unemployment experienced during the 1980s, restrictions on the use of fixed-term contracts were relaxed in some European countries, while strict employment protection legislation governing permanent contracts was left practically untouched (Fialho, 2017). The general belief was that a too stringent employment protection legislation discouraged the creation of new jobs or firms from expanding during good economic times. However, as a result of the strong social opposition to lower levels of job protection, policy makers opted for liberalising the use of fixed-term contracts for positions that were not necessarily of a temporary duration by nature. These alternative employment contracts introduced additional flexibility, without affecting the *status quo* of the workers already employed in permanent contracts. Since then, the share of these atypical contracts has raised substantially. Fixed-term contracts represent nowadays from 15% to 30% of total dependent employment in continental European countries. The share of fixed-term contracts in the flows towards employment is even more remarkable, reaching up to 90% in some countries, such as France and Spain (Fialho *et al.*, 2017). The growth of these atypical employment contracts led to what is often referred to as segmented labour markets. In fact, these reforms at the margin affected mostly labour market entrants or workers searching for a job, while leaving existing employment contracts or the “insiders”<sup>1</sup> practically unaffected. The consequences of this segmentation are still to be fully understood. Empirical evidence suggests that workers employed in fixed-term contracts earn less (Bentolila and Dolado, 1994; Bentolila *et al.*, 2012; Blanchard and Landier, 2002), receive less training on-the-job (Arulampalan *et al.*, 2004; Cabrales *et al.*, 2014) and enjoy worse career prospects (Garcia-Perez *et al.*, 2013). The impact of this marginal flexibility on unemployment is also unclear. Some findings suggest that it boosted the job creation rate but also the job destruction rate, leading simply to higher turnover and no clear impact on unemployment (Garcia-Serrano, 1998) or even higher unemployment (Cahuc and Postel-Vinay, 2002). Nevertheless, fixed-term contracts could still function as a stepping stone for low-skilled workers. On one hand, low-skilled workers may find employment more easily than if only highly protected permanent contracts are available. On the other hand, while employed, even if precariously, those workers remain active, accumulate experience and could increase their chances of contacting other employers for potentially more stable jobs. In the current global context of growing wage inequality (ILO *Global Wage Report* 2016/2017), it becomes increasingly important to understand whether fixed-term contracts have benefited low-skilled individuals. It is also fundamental to evaluate how reforming employment protection legislation would affect different individuals in the labour market.

The objective of this paper is twofold. First, it aims at understanding whether low-skilled workers have benefited

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<sup>1</sup>Term originally used by Bentolila *et al.* (2012)

from the flexibility at the margin permitted by the introduction of fixed-term contracts. Second, it provides insights into the heterogeneous effects of an employment protection legislation reform. In particular, it analyses how workers and firms sort themselves across the different types of contracts, how lowering the dismissal cost of permanent contracts affects that sorting pattern, and which individuals would particularly benefit from such policy.

For that purpose, I develop a partial equilibrium model of the labour market, with frictions, in which two-sided heterogeneous agents optimally decide the employment contract type. Worker and firm can decide to engage into a fixed-term contract - with a lower dismissal cost but lower duration - or a permanent contract - with a higher dismissal cost but higher expected duration. The agents can also decide to convert the fixed-term contract into a permanent contract at its expiry date. Another particularity of the model presented in this paper is that the decision of whether to invest in job-specific human capital is also modelled. If worker and firm agree to invest in the accumulation of job-specific skills, the match has higher total factor productivity. Such investment has a fixed cost, which is irreversible and non-transferrable to other jobs. The purpose of modelling investment in job-specific skills is to replicate the stylised fact that workers in fixed-term contracts are less likely to receive training sponsored by their employers (Fialho *et al.*, 2017). Ultimately, depending on the share of fixed-term contracts over total employment, this will be reflected in the total output produced. Accommodating the decision of whether to invest in job-specific skills into the model, therefore brings interesting implications for productivity. Finally, wages are determined by sequential auction, as in Cahuc, Postel-Vinay and Robin (2006), which performs remarkably well in replicating the empirical earnings distribution. Adapting the sequential auction wage determination mechanism to a context of multiple employment contracts brings additional advantages. For example, Fialho *et al.* (2017), using administrative data for France and Portugal, report that a significant fraction of movements from fixed-term to permanent contracts are associated with a fall in the hourly wage rate. With wages determined by sequential auction, the model developed in this paper provides a rational for that empirical finding. In fact, when a worker is converted to a permanent contract, or moves to a new firm from a fixed-term to a permanent contract, the model predicts that the worker suffers a wage cut if the move entitles a higher continuation value, *i.e.* better opportunities for moving along the wage ladder in the future.

Using French matched employer-employee data from 2005 to 2008, the model is estimated using Simulated Method of Moments (SMM). By structurally estimating the parameters of the model, this paper is the first one to quantify the red-tape cost of dismissing workers in permanent contracts - the cost associated with administrative procedures, legal expenses, additional financial penalties and the uncertainty about the outcome

of a process in the labour court. The model with its parameters set at their point estimates is then used in counterfactual policy analysis.

There are only a few studies that focus on analysing how the duality in the labour market emerges and allow for the choice between fixed-term and open-ended contracts to be endogenously determined. Most studies regarding labour market segmentation impose an exogenous share of fixed-term contracts in the economy. To the extent of my knowledge, the studies that model the employment contract choice are Kettemann, Kramarz and Zweimüller (2017), Guglielminotti and Nur (2016), Cahuc, Charlot and Malherbert (2016), Bertron and Garibaldi (2012), Tealdi (2012) and Caggese and Cuñat (2008). However, none of these papers takes simultaneously into account that both workers and firms are heterogeneous and that workers search on-the-job. With *ex-ante* heterogeneous workers, one can draw different conclusions about the effects of facilitating the use of fixed-term contracts depending on the workers' characteristics, which is the main objective in this paper. On the other hand, including on-the-job search in the model internalises the impact that voluntary quits can have on the sorting of workers between fixed-term and permanent contracts. As argued by Postel-Vinay and Turon (2013), on-the-job search provides a mean for employers to avoid firing costs, as workers may leave voluntarily upon receiving an outside offer. By ignoring it, one may overestimate the impact of firing costs on the segmentation in the labour market.

The main findings are the following. First, in the model presented in this paper, fixed-term contracts appear not to function as stepping-stones. In fact, the estimated contact rate for workers employed in fixed-term contracts is very similar to the estimated contact rate for unemployed workers. Both are significantly lower than the contact rate estimated for workers in permanent contracts. Therefore, it seems that reaching employment through a fixed-term contract does not necessarily open doors to employment at other firms. Nevertheless, this result should be interpreted with caution. In fact, the model abstracts from general human capital accumulation while employed. Second, according to the estimation, the red-tape component of the dismissal cost represents approximately 1% of the match output if the match would last one year. If the match only last a quarter, the red-tape firing cost represents about 4% of the match output. Decreasing this component of the dismissal cost in 10% would reduce the share of fixed-term contracts in new hires by half a percentage point, if the destruction rate of permanent contracts would remain unchanged. In other words, this result is conditional on the lower firing cost not resulting into more frequent dismissals from permanent contracts. The workers that mostly benefit from the decrease in this firing cost are those in the upper part of the ability distribution, namely between the 60<sup>th</sup> and 80<sup>th</sup> percentiles. These workers become more likely to be directly hired under a permanent contract, which increases their lifetime utility. Nonetheless, taxing fixed-term contracts seems

much more effective in reducing the share of fixed-term contracts in the economy than reducing the red-tape component of the dismissal cost. Finally, much larger gains in total output can be achieved by reducing the cost of training workers on-the-job rather than by reducing the firing cost and the share of fixed-term contracts in new hires. In fact, the training cost is estimated to represent approximately 6% of the match output if the match lasts one year and 25% of the match output if it only lasts one quarter. Even a small decrease in the training cost would generate a significant increase in total output.

The rest of the paper is structured as follows. The model is presented in section 2. Section 3 discusses the identification strategy, the estimation protocol and describes the different data sources used for the estimation. The results are exposed and interpreted in section 4. Finally, the counterfactual policy analysis is performed in section 5 and section 6 concludes.

## 2 Model

The model presented in this section departs from Lise, Meghir and Robin (2016). The framework developed by these authors is simplified with exogenous separations and vacancy creation. Alternatively, it is extended in two directions. First, by allowing for workers and firms to choose between two possible employment contracts: a fixed-term contract, with limited duration and no firing tax, and a permanent contract, which can last longer but is costly to destroy. Second, in the present model, worker and firm can also decide whether they want to invest in job-specific human capital. Investment in job-specific human capital is modelled as a discrete choice: there is either no investment or positive investment. Finally, the process of on-the-job search draws from Cahuc, Postel-Vinay and Robin (2006), with the necessary adaptations as subsequently explained.

### 2.1 Environment

#### 2.1.1 Workers and firms

The economy is populated by a continuous mass of infinitely lived and risk-neutral workers, normalised to 1. Workers differ in their personal ability  $x$ , which is not observed by the econometrician. The ability  $x$  is independent and identically distributed across workers and can be interpreted as the worker's rank. I assume that the types are fully observable to all agents in the economy and constant over time. This means that there is no learning about the worker's ability, neither general human capital accumulation or depreciation. Fixed-term contracts can also be used as a screening device, to learn about the worker's ability before engaging in a binding permanent contract. See, for instance, Tealdi (2012) and Nagypál (2002, 2007). Nevertheless, the existence of long probationary periods and the high destruction rate of fixed-term contracts reported in Fialho *et al.* (2017) suggest that a large fraction of fixed-term contracts could be used to avoid firing costs rather than

learning about the worker's ability. Individuals can be either unemployed and actively searching for a job, or employed and searching on-the-job. Workers discount future flows at the exogenous rate  $r > 0$  and they aim at maximising their expected discounted life-time utility.

On the demand side of the labour market, there is a continuous mass of firms that also live infinitely. Every firm differ in a productivity parameter  $y \in [0, 1]$  which is independently drawn across firms. The firm characteristic  $y$  can be interpreted as the firm's productivity rank. I assume that the firm productivity is constant over time. The firm's type is also fully observable and all agents agree on the ranking of the firms: the higher  $y$ , the more productive is the firm. Each firm represents only one potential job. Firms' objective is to maximise lifetime expected discounted profits and firms are also risk-neutral.

### 2.1.2 Labour market institutions

When unemployed, workers receive the unemployment benefit  $b$ . The law governing employment relationships considers that two types of employment contracts can be used: fixed-term contracts and permanent contracts. Both contracts are destroyed exogenously<sup>2</sup>. Fixed-term contracts are destroyed at rate  $\delta^F$  and permanent contracts at rate  $\delta^P$ . The arrival rate  $\delta^F$  reflects the impossibility to remain on a fixed-term contract indefinitely: these contracts must stipulate an expiry date. Alternatively, one could make fixed-term contracts last only one period, like in Cahuc and Postel-Vinay (2002). However, since we observe different durations for fixed-term contracts in the data, assuming a stochastic destruction rate provides a better empirical fit. This was previously done in Wasmer (1999). When the fixed-term contract reaches its expiry date, there are two possible scenarios. With probability  $1 - \mu$ , worker and firm are given the option to continue the employment relationship with a permanent contract. In this case, the conversion decision is jointly taken by the worker and the firm so as to maximise their value functions. If one of the parties does not find it optimal to convert the fixed-term contract to permanent, the match is destroyed: the worker returns to unemployment and the job disappears. With probability  $\mu$ , the fixed-term contract cannot be converted to permanent. The probability  $\mu$  represents the risk that the position is no longer justified at the end of the fixed-term contract or that the firm is unable to convert the contract into permanent for exogenous reasons. Consequently, there is no guarantee that a fixed-term contract can be converted into permanent, even for highly productive matches.

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<sup>2</sup>Endogenous separations, in the presence of firing costs and on-the-job search, would generate inefficient matches in equilibrium and prevent job-to-job movements that would otherwise be optimal. Wages, instead of the match surplus, would become the main determinant of job-to-job movements, making the model more difficult to solve numerically. In fact, the current wage would become another state variable in the optimisation problem. Postel-Vinay and Turon (2013) tackle this issue by introducing severance packages and the existence of a minimum wage. Since their purpose is to show that ignoring on-the-job search will overstate the negative impact of firing costs on employment, endogenous separations are crucial feature of their model. Nonetheless, in their model, agents are homogeneous, there are no fixed-term contracts, nor choice of contract type. Furthermore, they do not solve for wages in equilibrium. In this paper, since the focus is on the sorting pattern across different employment contract types, the setting is simplified with exogenous separations.

Costs associated to the destruction of fixed-term or permanent contracts are different. The cost of dismissing a worker on a permanent contract has two components: a transfer from the firm to the worker ( $t^P$ ) and a red-tape cost ( $\tau$ ). The transfer component includes severance payments, other monetary compensations and also, requirements of advance notification, for example. On the other hand, the red-tape component includes costs associated with administrative procedures, legal expenses, additional financial penalties and the uncertainty over the outcome of a process in the labour court. In this model, with linear utility, perfect transferability of utility between worker and firm and a flexible wage setting, the transfer component will have no impact on the agents' decision to match and on the contract choice. This is usually referred to as the “Bonding Critique”, following Lazear (1990). Nevertheless, the severance payment to the worker will have an impact on equilibrium wages. The cost of dismissing a worker on a fixed-term contract consists only of a transfer from the firm to the worker ( $t^F$ ). Finally, firms must pay contributions to the social security, for every period that they employed someone to produce the final good. Social security contributions differ by type of contract: it is  $\nu^F$  on a fixed-term contract and  $\nu^P$  on a permanent contract.

## 2.2 Meetings, matching, and contract choice

Search is random, sequential and time consuming. Every period, an unemployed worker contacts a vacant firm at rate  $\lambda^U$ . Employed workers are searching on-the-job. The contact rate for employed workers depends on their contract type. A worker employed in a fixed-term contract contacts a vacant firm at rate  $\lambda^F$  and a worker employed in a permanent contract at rate  $\lambda^P$ . The contact rates are taken as exogenous and structurally estimated.

If after meeting, worker and firm decide to form a match, the output of the match is given by  $f(x, y)$ , multiplied by a total factor productivity parameter. The function  $f$  is increasing in both arguments. The total factor productivity will depend on if worker and firm agree to invest in job-specific human capital. If they agree to invest in on-the-job training, the match becomes highly productive and the total factor productivity (or match-specific productivity) is given by  $\theta^H$ . If they do not invest in on-the-job training, the match is less productive and the total factor productivity is given by  $\theta^L$ . However, on-the-job training is costly. If they agree to invest in job-specific human capital, there is an initial cost of  $\xi$  upon forming the match. The training cost is a sunk cost and I assume it is instantaneously paid at the start of the match. Finally, I assume that investment in job-specific human capital is irreversible. Such investment is lost whenever the worker leaves to another firm or returns to unemployment. Therefore, an employment contract must stipulate a duration: fixed-term (F) or permanent (P), and a match-specific productivity level: high (H) or low (L). The state space for the employment contract is given by  $C \in \{F, P\} \times \{H, L\}$ .

The contact rate, is given by:

$$\lambda^c = \begin{cases} \lambda^F & \text{if } c \in F \times \{H, L\} \\ \lambda^P & \text{if } c \in P \times \{H, L\}. \end{cases} \quad (1)$$

The decision of whether to form a match will depend on the value of the surplus that the worker and the firm can generate. What the worker and the firm can jointly produce is a function of their types, of the match-specific productivity and of the expected continuation value after different scenarios. That is, it will also be a function of how long they expect the match to last and what would be the flow of utility or profit after each potential event. For example, after the worker receives another offer, after the worker leaves for another firm, or after the contract is destroyed for exogenous reasons. Therefore, the exact surplus that a specific match can generate also depends on if it is fixed-term or permanent. Worker and firm optimally decide which contract to form by maximising the surplus of the match, given their types. Consider the surplus of a match between worker  $x$  and firm  $y$  with employment contract  $c$ :

$$S(x, y, c) = \left( W^1(w, x, y, c) + \Pi^1(w, x, y, c) - \xi(c) \right) - W^0(x) \quad (2)$$

All value functions  $W$  refer to the worker. Value functions  $\Pi$  refer to the firm.  $W^0(x)$  represents the value for a worker type  $x$  from being unemployed.  $W^1(w, x, y, c)$  stands for the value for a worker type  $x$  of being employed at wage  $w$  and contract type  $c$  with firm type  $y$ .  $\Pi^1(w, x, y, c)$  is the value for a firm type  $y$  of having a job filled with worker type  $x$  paid at wage  $w$  in contract type  $c$ . When a job is destroyed, the position disappears. Therefore, the outside option for the firm has no value. The outside option for the worker is always the same, regardless of the contract type. What changes is what is jointly produced when a worker type  $x$  and a firm type  $y$  are together under different arrangements. Equation (2) will be carefully defined in section 2.4, as well as the respective value functions for the worker. The function  $\xi(c)$ , which represents the training cost, is given by:

$$\xi(c) = \begin{cases} \xi & \text{if } c \in \{F, P\} \times H \\ 0 & \text{if } c \in \{F, P\} \times L. \end{cases} \quad (3)$$

It will be null when there is no investment in on-the-job training and positive otherwise. The match formation decision can be summarised as follows. A match between an unemployed worker  $x$  and a firm  $y$  will be formed whenever:



$$\max_C S(x, y, C) \geq 0 \quad (4)$$

The contract will be fixed-term if the argument that maximises equation (4) is  $c \in F \times \{H, L\}$  and permanent if the argument is instead  $c \in P \times \{H, L\}$ . For each contract type, the worker will receive on-the-job training if the argument that solves equation (4) is  $c \in \{F, P\} \times H$ . At the expiry of a fixed-term contract, provided that the match is not exogenously destroyed with probability  $\mu$ , worker and firm can still agree on converting the contract to permanent instead of separating. An existing fixed-term contract between worker type  $x$  and firm type  $y$ , where the worker already received on-the-job training, will be upgraded to permanent whenever:

$$S(x, y, PH) + \xi \geq 0 \quad (5)$$

Since the training cost had already been paid and it is a sunk cost, it is not taken into account for the conversion decision. It must therefore be added back to equation (2). On the other hand, if the worker had not received on-the-job training yet, the contract is upgraded to permanent if:

$$\max_{C \in P \times \{H, L\}} S(x, y, C) \geq 0 \quad (6)$$

where the set over which the surplus is maximised only includes permanent contracts. The worker will receive job-specific training together with the conversion if  $S(x, y, PH) \geq S(x, y, PL)$ .

### 2.3 Wage determination, on-the-job search and wage renegotiation

Wages are determined by sequential auction, adapted from Cahuc, Postel-Vinay and Robin (2006). The agreed wage determines how the surplus of the match is split between the worker and the firm, but the surplus is not a function of the wage<sup>3</sup>. This is a common feature amongst models of on-the-job search where wages are determined by sequential auction, following the work of Postel-Vinay and Robin (2002). It provides computational advantages since wages do not need to be computed to characterise the equilibrium of the model.

In this paper, there is one additional computational advantage. Since investment in job-specific human capital is incorporated into the model, the surplus to be considered when negotiating the wage at the match formation stage is  $S(x, y, c)$  as defined in equation (2), while it becomes  $S(x, y, c) + \xi(c)$  immediately after the start of the

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<sup>3</sup>Lise, Meghir and Robin (2016) provide a mathematical proof that the surplus is independent of the wage.

match, since the investment in job-specific skills has already been paid for and is irreversible. If wages would be determined by Nash bargaining and renegotiated every period, they would be renegotiated immediately after the start of the match and increase. Instead, when wages are determined by sequential auction and are only renegotiated by mutual consent, one of the parties must have a credible threat to trigger the renegotiation process. It turns out that, even if the training cost is a sunk cost and the investment is irreversible, the worker would not have a credible threat to force the firm to renegotiate a higher wage once the training has been provided, as long as the initial wage was set such that he is still better off than if unemployed.

There are also benefits from determining wages by sequential auction in terms of empirical fit. Search models of the labour market, where wages are determined by sequential auction, have been shown to provide a better fit to the data than models where wages are determined by Nash bargaining (Cahuc, Postel-Vinay and Robin, 2006). Adapting the sequential auction wage determination mechanism to a context of multiple employment contracts brings additional desirable features. For example, Fialho *et al.* (2017), using administrative data for France and Portugal, report that a significant fraction of movements from fixed-term to permanent contracts are associated with a fall in the hourly wage rate. With wages determined by sequential auction, the model developed in this paper provides a rational for that empirical finding. In fact, when a worker is converted to a permanent contract, or moves to a new firm from a fixed-term to a permanent contract, the model predicts that the worker suffers a wage cut if the move entitles a higher continuation value, *i.e.* better opportunities for moving along the wage ladder in the future.

### 2.3.1 Wages coming from unemployment

When a worker type  $x$  comes from unemployment, the wage is negotiated such that the worker receives the value of being unemployed and a fraction  $\beta$  of the surplus generated. The parameter  $\beta$  consists in the workers' bargaining power. The implied wages  $\phi_0^c$  for  $c \in \{F, P\} \times \{H, L\}$ , solve:

$$W^1(\phi_0^c(x, y), x, y, c) = W^0(x) + \beta S(x, y, c) \quad (7)$$

where  $S(x, y, \cdot)$  is defined in equation (2).

### 2.3.2 Wages after receiving an offer from another firm

Workers keep on searching for better opportunities while on-the-job. Consider a worker type  $x$  employed at a firm type  $y$  and in contract type  $i$ , where  $i \in \{F, P\} \times \{H, L\}$  has already been determined. Suppose that this worker contacts an outside firm  $y'$ . The contact will result in an outside offer if equation (4) is satisfied for  $x$

and  $y'$ . The worker will move to (or stay with) the firm with whom the surplus generated is higher and keep the other firm, with whom the surplus is lower, as outside option to potentially negotiate a higher wage (or renegotiate the current wage). The worker will move to firm  $y'$  if and only if:

$$\max_{C'} S(x, y', C') > S(x, y, i) + \xi(i) \quad (8)$$

The surplus considered at the incumbent firm is not discounted with eventual training costs since these have already been paid and are irreversible. The training cost is therefore added back to the current surplus. For the poaching firm, however, the training cost would still have to be paid. The wage at the new firm is determined by:

$$W^1(\phi_i^{C'}(x, y', y), x, y', C') = W^0(x) + S(x, y, i) + \xi(i) + \beta \left( \max_{C'} S(x, y', C') - \left( S(x, y, i) + \xi(i) \right) \right) \quad (9)$$

It will be such that the worker receives the entire surplus at his previous firm and a fraction  $\beta$  of the additional surplus generated with the new employer. If the worker stays at the incumbent firm instead, the wage might be renegotiated. This will be the case whenever:  $W^1(w, x, y, i) - W^0(x) < \max_{C'} S(x, y, C')$ . In words, whenever the value the worker receives currently falls short of the minimum he could receive with the outside firm. In this case the renegotiated wage will solve:

$$W^1(\varphi_{C'}^i(x, y, y'), x, y, i) = W^0(x) + \max_{C'} S(x, y', C') + \beta \left( S(x, y, i) + \xi(i) - \max_{C'} S(x, y', C') \right) \quad (10)$$

In some cases, renegotiated wages for “stayers” are different than the negotiated wages for “movers”. Therefore, I use the notation  $\phi$  for wages after a job-to-job movement (for “movers”) and  $\varphi$  for renegotiated wages within the same firm and keeping the same contract type (for “stayers”). This is a necessary adaptation to Cahuc, Postel-Vinay and Robin (2006) given the introduction of on-the-job training.

One final note is worth mentioning. When the worker with a fixed-term contract receives an outside offer, the best thing that the current firm can do to retain the worker is to offer the entire surplus of the fixed-term match. The firm would never offer a permanent contract in that case. In fact, if worker and firm choose to be on a contract  $i$ , it must have been the case that  $i = \arg \max_C S(x, y, C)$ . Therefore, offering the entire current surplus  $S(x, y, i)$  is the incumbent firm’s best counter-offer.

### 2.3.3 Wages after being converted to permanent within the same firm

If the contract is converted to permanent, the new wage is determined as if the worker would come from unemployment. In fact, if the conversion doesn't happen, the worker must return to unemployment, which therefore represents his outside option. The negotiated wage will depend on whether the worker already received training or not. If investment in on-the-job training already took place, the wage after conversion will solve:

$$W^1(\psi_H^{PH}(x, y), x, y) = W^0(x) + \beta \left( S(x, y, PH) + \xi \right) \quad (11)$$

and the worker is upgraded to a permanent contract with high match-specific productivity. If, on the other hand, no investment in on-the-job training has been made yet, the wage after conversion will solve:

$$W^1(\psi_L^C(x, y), x, y) = W^0(x) + \beta \max_{C \in P \times \{H, L\}} S(x, y, C) \quad (12)$$

where the worker is upgraded to a permanent contract with high or low match-specific productivity, depending on the argument that maximises the surplus.

## 2.4 Value functions

In this section, I define every value function for the worker and for the match surplus. The value functions reflect the model environment described in the previous subsections. The value functions for the firm are implicitly defined by subtracting the value functions for the worker to the value functions for the match surplus. The model is defined in continuous time.

### 2.4.1 Value for an unemployed worker

The present value for an unemployed worker with ability  $x$  is given by:

$$rW^0(x) = b + \lambda^U \beta \int \max \left\{ \max_C S(x, y, C), 0 \right\} v(y) dy \quad (13)$$

where  $\lambda^U$  is the rate at which a worker contacts a firm and  $v(y)$  is the probability density of drawing an offer from a firm type  $y$ . The match is only formed if one of the potential surpluses is positive. Otherwise, the worker continues to receive the unemployment benefit  $b$ . The continuation value is the average of all potential surpluses, depending on which firm type the worker will meet.

### 2.4.2 Value for an employed worker

The value for a worker type  $x$  of being employed with firm  $y$  in an employment contract  $c$ , which can be any of the state space  $\{F, P\} \times \{H, L\}$ , solves:

$$\begin{aligned}
& \left( r + \delta^c + \lambda^c \int_{\Omega(\omega, x, y, c)} v(y') dy' \right) \left( W^1(w, x, y, c) - W^0(x) \right) = w - rW^0(x) + \delta^c \mu^c t^c \\
& + \lambda^c \int_{\Omega(\omega, x, y, c)} \left( \beta \max \left\{ S(x, y, c) + \xi(c), \max_{C'} S(x, y', C') \right\} + (1-\beta) \min \left\{ S(x, y, c) + \xi(c), \max_{C'} S(x, y', C') \right\} \right) v(y') dy' \\
& + \mathbb{1}\{c \in FL\} \left( \delta^F (1-\mu) \left[ \mathbb{1} \left\{ \max_{C \in P \times \{H, L\}} S(x, y, C) \geq 0 \right\} \beta \max_{C \in P \times \{H, L\}} S(x, y, C) + \mathbb{1} \left\{ \max_{C \in P \times \{H, L\}} S(x, y, C) < 0 \right\} t^F \right] \right) \\
& + \mathbb{1}\{c \in FH\} \left( \delta^F (1-\mu) \left[ \mathbb{1} \left\{ S(x, y, PH) + \xi \geq 0 \right\} \beta (S(x, y, PH) + \xi) + \mathbb{1} \left\{ S(x, y, PH) + \xi < 0 \right\} t^F \right] \right) \quad (14)
\end{aligned}$$

where some parameters depend on the contract type  $c$ :

$$\delta^c = \begin{cases} \delta^F & \text{if } c \in F \times \{H, L\} \\ \delta^P & \text{if } c \in P \times \{H, L\} \end{cases} \quad \mu^c = \begin{cases} \mu & \text{if } c \in F \times \{H, L\} \\ 1 & \text{if } c \in P \times \{H, L\} \end{cases} \quad t^c = \begin{cases} t^F & \text{if } c \in F \times \{H, L\} \\ t^P & \text{if } c \in P \times \{H, L\} \end{cases}$$

The wage  $w$  represents the current flow the worker receives each period, as long as the match continues. With probability  $\delta^c$  that the match is destroyed. In this case, the worker may receive the severance payment  $t^c$ . The worker will receive the severance payment if he is in a permanent contract or if he is in fixed-term contract that cannot be converted to permanent (with probability  $\mu$ ). However, if the match is on a fixed-term contract, with probability  $1 - \mu$  the contract can still be converted into permanent. This is expressed in the last two elements of equation (14). The continuation value in such case will depend upon if the worker already received training on-the-job or not. In the first case, the decision of whether to convert the contract to permanent is not affected by the training cost which is added back to the surplus  $S(x, y, PH)$ . In the later case, the worker can still receive on-the-job training when converted to permanent, hence the maximisation over  $C \in P \times \{H, L\}$  which represents the optimal permanent contract, after conversion, with the current firm  $y$  (the incumbent firm).

With probability  $\lambda^c$  the worker contacts another firm type  $y'$ . The second line of equation (14) defines the continuation value in this case. The continuation value will, of course, depend on the firm type that the worker meets. It must therefore be averaged, taking into account the probability that the worker meet each firm type  $v(y')$ . The integration set is a function of the current wage, the worker type, the current firm type and the current contract type:

$$\Omega(\omega, x, y, c) = \left\{ y' : W^1(w, x, y, c) - W^0(x) < \max_{C'} S(x, y', C') \right\} \quad (15)$$

To be precise, the average is taken over all firms with productivity  $y'$  such that the current wage is at least worth being renegotiated, even if the worker stays at the incumbent firm. Otherwise, the worker continues to receive the wage  $w$  and nothing changes.  $C'$  represents the optimal employment contract with a potentially new firm  $y'$  (the poaching firm).

The value for the employed worker is just a fraction of the surplus. The equilibrium wage  $w$  is implicitly defined by equation (14). Nevertheless, the equilibrium wage does not influence the decision about which contract type to choose.

### 2.4.3 Surplus of a match

The surplus of a match between worker  $x$  and firm  $y$ , who choose the employment contract  $c$ , solves:

$$\begin{aligned} (r + \delta^c)S(x, y, c) = & \theta^c f(x, y) - \nu^c - rW^0(x) - (r + \delta^c)\xi(c) \\ & + \lambda^c \beta \int \max \left\{ \max_{C'} S(x, y', C') - (S(x, y, c) + \xi(c)), 0 \right\} v(y') dy' - \mathbb{1}\{c \in P \times \{H, L\}\} \delta^P \tau \\ & + \mathbb{1}\{c \in FL\} \delta^F (1 - \mu) \max \left\{ \max_{C \in P \times \{H, L\}} S(x, y, C), 0 \right\} + \mathbb{1}\{c \in FH\} \delta^F (1 - \mu) \max \{S(x, y, PH) + \xi, 0\} \end{aligned} \quad (16)$$

where:

$$\theta^c = \begin{cases} \theta^H & \text{if } c \in \{F, P\} \times H \\ \theta^L & \text{if } c \in \{F, P\} \times L \end{cases} \quad \nu^c = \begin{cases} \nu^F & \text{if } c \in F \times \{H, L\} \\ \nu^P & \text{if } c \in P \times \{H, L\} \end{cases}$$

Equation (16) is key to understand the trade-off between fixed-term and permanent contracts, as well as the decision of whether to invest in on-the-job training.

Let's start by considering the model without on-the-job search, i.e. setting  $\lambda^c = 0$ . If one sets  $\tau = 0$ ,  $\mu = 0$  and  $\delta^P = \delta^F$ , worker and firm will be indifferent between the two contracts which are virtually equivalent. In this case, all matches will start immediately on a permanent contract if worth forming, and the only decision left to be taken concerns investment in on-the-job training. However, as soon as the destruction rates  $\delta^F$  and  $\delta^P$  differ (still with  $\tau = 0$  and  $\mu = 0$ ), not all matches will start as a permanent contract anymore. In fact, the better the match compared to the alternatives, the longer worker and firm will want to stay together and avoid exogenous destruction. In this case, for  $\mu = 0$ , meaning that fixed-term contracts can always be converted to permanent,

the matches with highest quality will prefer to start with a fixed-term contract and convert it to permanent when the fixed-term contract is exogenously destroyed. Indeed, starting with a fixed-term contract that can always be converted later on to permanent, allows for the match to have a longer expected duration. As  $\mu$  becomes positive and increases, the risk of not being able to convert the fixed-term contract into permanent at its expiry date becomes too high and more matches are directly formed as permanent contracts. At the other extreme, when  $\mu = 1$  and fixed-term contract can never be converted into permanent, keeping  $\tau = 0$ , all matches will start directly as a permanent contract. Introducing a positive value for  $\tau$  in such a context will generate that the matches with lowest quality will be formed as a fixed-term contract instead, despite the inability to convert it into permanent at the expiry date.

From the above discussion, it becomes clear that the fraction of fixed-term contract in new hires will crucially depend on the estimated value for the destruction rates, the firing tax and the probability of being able to convert fixed-term contracts into permanent at their expiry date. Introducing on-the-job search, i.e. setting  $\lambda^c \neq 0$  for all contract types, for given values of  $\tau$ ,  $\mu$  and  $\delta^c$ , will increase the fraction of matches that start directly with a permanent contract if  $\lambda^P > \lambda^F$  or increase the fraction of fixed-term contracts in new hires if  $\lambda^P < \lambda^F$ . For example, if  $\lambda^P > \lambda^F$ , permanent contracts become comparatively more attractive as their continuation value increase relatively more than fixed-term contracts. In fact, contact with further firms allow workers to move to better matches faster and to renegotiate higher wage rates.

The decision of investing in on-the-job training, on the other hand, will depend mostly on the estimated value for the training cost  $\xi$ . Nonetheless, the destruction rates  $\delta^F$  and  $\delta^P$ , as well as the probability of being able to convert a fixed-term contract into permanent  $\mu$ , will also impact the optimal investment in training. This is the result of such parameters influencing the expected duration of a match. Since the training cost is a lump-sum payment made at the beginning of the match, the longer the expected duration of the match, the larger the incentives to invest in on-the-job training. Changes in the firing tax  $\tau$  will have no effect on the share of matches that decide to invest in on-the-job training since jobs are exogenously destroyed in this model. In a model with endogenous separations, an increase in  $\tau$  would probably increase the expected duration of permanent contracts and, therefore, increase the share of workers who receive training.

### 3 Estimation

Identification of the worker type  $x$  and the firm type  $y$  can be very difficult in the presence of assortative matching, even with the availability of matched employer-employee data. In fact, within a given employer, it will not necessarily be the most able worker who receives the highest wage. If there is a high degree of

complementarity between the worker and the firm type in production and the worker is mismatched, his wage might be lower than that of lower-skilled individuals. Non-parametric estimation procedures for this type of models have been recently proposed. The most prominent contributions are those of Hagedorn, Law and Manovskii (2017), Bagger and Lentz (2015), and Lamadon, Lise, Meghir and Robin (2016). In this paper, non-parametric identification is further complicated by the presence of on-the-job training, which leads to some matches having higher total factor productivity than others, within the same firm. Consequently, the relationship between wages, worker ability and firm productivity is not monotonic. As a result, I will impose parametric assumptions regarding the distributions of the types in the economy, and structurally estimate aggregate parameters that do not depend on the worker type  $x$  and the firm type  $y$ . The parametric assumptions, the estimation method, the data sources and the identification, are now explained in detail.

### 3.1 Parametric assumptions

I assume that both the worker type ( $x$ ) and the vacancy type ( $y$ ) are drawn from a beta distribution, respectively  $I_x(\alpha_0^x, \alpha_1^x)$  and  $I_y(\alpha_0^y, \alpha_1^y)$ , in the interval  $[0, 1]$ . The beta distribution is parametrised by two positive parameters, that control its shape. These parameters are estimated. I also assume a Constant Elasticity of Substitution (CES) production function, such that:

$$f(x, y) = \theta \left( 0.5x^\rho + 0.5y^\rho \right)^{1/\rho} \quad (17)$$

The total factor productivity  $\theta$  depends on whether the worker and the firm decided to invest in match-specific human capital. It can be either  $\theta^H$  or  $\theta_L$ .  $\rho$  is the parameter that depends on the elasticity of substitution between  $x$  and  $y$ .  $\rho$  determines if the production function is super modular ( $\rho > 1$ ), sub modular ( $\rho < 1$ ) or modular ( $\rho = 1$ ). In other words, the parameter  $\rho$  determines how much complementarity there is between the worker and the firm in the production process. These parameters are all estimated.

The model is estimated imposing that  $\nu^F = 0$  and  $\nu^P = 0$  since these are policy parameters that can be calibrated. Positive values for social security contributions in both types of contracts will be introduced as a counterfactual analysis exercise. The value of the severance payments in fixed-term and permanent contracts,  $t^F$  and  $t^P$ , is arbitrarily set to 0.01 since there is no institutional difference in severance payments across contract type in France. Again, these parameters can be changed in the counterfactual analysis.

### 3.2 Estimation method and protocol

The vector of parameters to be estimated is given by:



$$\Theta = \{\alpha_0^x, \alpha_1^x, \alpha_0^y, \alpha_1^y, \delta^F, \delta^P, \mu, b, t^F, t^P, \tau, \theta^H, \theta^L, \rho, \xi, \beta, \lambda^U, \lambda^F, \lambda^P\} \quad (18)$$

There are 19 parameters to estimate. The parameters are estimated by Simulated Method of Moments (SMM). For an initial set of parameters  $\Theta$ , the fixed-point of the surplus (2) is computed by value function iteration for every possible contract  $c \in \{F, P\} \times \{H, L\}$  and a discretised grid of worker and firm productivities<sup>4</sup>. The equilibrium values of all surpluses, for every potential worker and firm, are then used to simulate a representative sample of workers' histories. From the simulated data, I compute a set of moments  $m_n$  and the distance between the simulated moments and the data moments  $m(\Theta)$ . Some moments are based on individual data and some are based on aggregation at the firm level. However, the simulated moments are not a smooth function of the parameters. Therefore, it is not appropriate to use a derivative based method to find the minimum of the objective function, which consists in a metric of distance between the vector of simulated moments and simulated data. Following Lise, Meghir and Robin (2016), Lamadon (2016) and Oswald (2017), I use the method developed by Chernozhukov and Hong (2003) and extended by Baragatti, Grimaud and Pommeret (2013). This method consists in constructing several Markov chains in parallel that converge to a stationary process of which the ergodic distribution has a mode that is asymptotically equivalent to the Simulated Method of Moment estimator. Each chain has a different order. Chains of higher order (with high tolerance level) move over the entire parameter space, while chains of lower order (with low tolerance level) focus on giving a precise estimate of the target distribution. Because the chains of lower order can end up trapped in a local mode, the algorithm allows for chains to swap. This method insures that the solution found is a global minimum.

The estimation is performed over a number of steps<sup>5</sup>. In the first stage, all the transition parameters are estimated for *ex-ante* fixed values of the remaining parameters. This includes the contact rates  $\lambda^U$ ,  $\lambda^F$  and  $\lambda^P$ , the destruction rates  $\delta^F$  and  $\delta^P$ , as well as the probability that fixed-term contracts cannot be converted into permanent  $\mu$ . In a second stage, fixing the transition rates at their point estimates from the first stage, the parameters from the production function  $\rho$ ,  $\theta^L$  and  $\theta^H$ , and the policy parameters  $\tau$ ,  $b$  and  $\xi$  are estimated. Finally, the parameters from the distribution of workers and firms' type, as well as the workers' bargaining power, are estimated. For this final step, the remaining parameters are all fixed at their point estimates from the first and second stage. These three steps are continuously iterated on until all parameter estimates appear stable.

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<sup>4</sup>The grid is discretised with  $100 \times 100$  points.

<sup>5</sup>The reason a multi-stepped estimation is implemented is because it performed better when testing the estimation routine than if estimating all parameters in a single stage. Using simulated data moments for which the exact set of parameters was known, the multi-stepped estimation protocol always produced more precise estimates.

### 3.3 Data sources and sample selection

The structural parameters of the model are estimated using data from different sources. The main data source is the DADS (*Déclarations Annuelles des Données Sociales*). This data set is a large matched employer-employee panel, collected by the French Statistical Institute INSEE (*Institut National de la Statistique et des Études Économiques*). It is an administrative data set with compulsory completion by all private firms and establishments of all sizes. It contains information about the worker characteristics, such as age, gender, tenure at the current job, where the worker is natural from or the worker's residence. It also contains information that is specific to the job. For instance, one knows exactly the occupation, the hourly wage, the number of hours worked, the exact number of days for each employment spell, the tenure, if the position is part-time or full-time, and also the contract type. Finally, the data set also covers the firm's characteristics: how many employees and establishments the firm has, between which deciles of the distribution the firm is ranked in terms of volume of sales, the total wage bill per calendar year, the sector of activity, the exact location and the creation date, among other things. The DADS panel is available between the years 1976-2010. For confidentiality purposes, INSEE extracts a 1/25<sup>th</sup> sub-sample of the whole universe covered. This sub-sample is selected based on the individual's birth dates: it consists of individuals born in October of each even numbered year. Those individuals are followed over time, across different jobs and different firms. Nevertheless, the information on the type of contract for each employment spell is only available since 2005. I therefore use the years from 2005 to 2008, to avoid the financial crisis period and the subsequent sovereign debt crisis in Europe.

One advantage of this data set is the low measurement error on wages and the low attrition given mandatory completion. The absence of declared earnings can be interpreted as zero earnings in the private sector. However, there is one drawback associated with the DADS. The DADS panel aggregates the individual's experiences at the calendar year level. This means that if the worker experienced a wage renegotiation within the year or a change of contract, the DADS panel will only record the characteristics of the job as it was held for longer during the year. The consequence is that many fixed-term contracts, later converted in permanent, will appear as permanent for the entire duration of the employment spell. This means that the share of fixed-term contracts in new hires, in overall employment and the conversion rate of fixed-term contracts into permanent will be underestimated. Therefore, I complement the information provided by the DADS with additional data sources. ACOSS publishes the total number of entries into employment in France, every quarter, by contract type and duration, from 2000 to 2014. This information, publicly available on the internet, is based on mandatory registries to all firms<sup>6</sup>. This registry only concerns first hirings with the firm. When a contract is renewed or

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<sup>6</sup>Data can be found and downloaded at <http://www.acoss.fr/home/observatoire-economique/publications/acoss-stat/acoss-stat-n207.html>. It is based on the *Déclaration préalable à l'embauche (DPAE)*.

upgraded, there is no additional record. With this additional information, I can compute the exact share of fixed-term contracts in new hires. The share of fixed-term contract in the stock of employment, on the other hand, is taken from *OECDStat*. In both cases, I average the share of fixed-term contracts over time between 2005 and 2008.

Finally, full identification of the model's parameters also requires some information regarding on-the-job training. This information is not available at the micro level in the DADS Panel. Therefore, the overall amount of training provided by firms in fixed-term and permanent contracts is obtained from the European Survey of Working Conditions (ESWC) from 2010. I use the fifth wave of that survey instead of using the data from the fourth wave in 2005, because this is the only wave for which detailed data has been published online for each country and contract type separately.

The sample used to compute the data moments with the DADS comprises prime age workers between 25 and 50 years old for whom information on the spell start and end date, earnings, contract type and employment status are known. The sample is further restricted so that employment spells correspond only to full-time jobs as employees, excluding: apprenticeships, internships, jobs in the extra-territorial and domestic sectors, jobs where the number of hours worked per day is superior to 16 on average, jobs where the number of hours worked per year is lower than 260 or higher than 4160, and jobs where the log hourly wage is lower than half the log of the institutional minimum hourly wage.

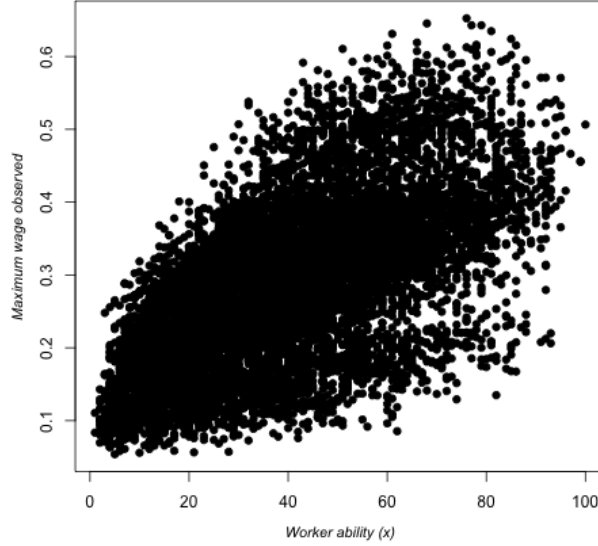
### 3.4 Identification and choice of moments

The moments  $m_n$  and  $m(\Theta)$  must be sensitive to the model's parameters. To identify the parameters associated to the distribution of worker types  $\alpha_0^x$  and  $\alpha_1^x$ , I choose moments from the distribution of the maximum wage observed over time for each worker in the data, following the work of Hagedorn, Law and Manovskii (2017). Figure 1 shows the relationship between the worker ability  $x$  and the maximum wage observed over time in a simulated data set from the model. There is a clear positive relationship between the two, although it would not be possible to rank the workers based on the maximum wage observed and obtain the correct rank.

Figures 2 and 3 show how the histograms of the worker ability and the maximum wage observed evolve for different parameters  $\alpha_0^x$  and  $\alpha_1^x$ . The two distributions move along in the same direction for every combination of  $\alpha_0^x$  and  $\alpha_1^x$ . Based on that observation, and since the beta distribution is fully characterised by its mean and variance, I use the mean and variance of the distribution of the maximum wage observed.

For the distribution of the vacant jobs' productivity  $\alpha_0^y$  and  $\alpha_1^y$ , I look at characteristics associated to the existing jobs: the jobs that were vacant and successfully filled. In particular, I look at the maximum wage paid by a firm each year and take the average of that statistic over time, for as long as that firm is observed in the

Figure 1: Correlation between worker ability and maximum wage received in simulated data



data. I then take the cross-sectional average and variance of that distribution across all firms. I repeat the same procedure for the average wage paid within each firm. Figure 4 shows the correlation between the job productivity and wages at the firm level (the average wage and the maximum wage paid within each firm) for simulated data. There is a clear positive association between the two. As in Bagger and Lentz (2015), I also use compute the percentage of workers who are poached from other firms out of the inflow of workers to each firm every period. I average that percentage for each firm over time. I then take the cross-sectional average and variance of the distribution of this percentage across all firms.

The cross-sectional mean and variance of the wage growth distribution after a renegotiation with the same employer are also very sensitive to the parameters that shape the distribution of the worker's ability. I also use the cross-sectional mean and variance of the wage growth distribution after conversion from fixed-term to permanent and after a job-to-job movement. The later is particularly sensitive to values of the bargaining power  $\beta$ . The red-tape cost component of the dismissal cost  $\tau$ , on the other hand, directly influences the average percentage of fixed-term contracts out of all employees at the firm level. The higher is  $\tau$ , the higher the share of fixed-term contracts at every firm. Therefore, I also use the cross-sectional mean and variance of the percentage of fixed-term contracts at the firm level. There are two other moments that help to pin down the value of  $\tau$ : the percentage of fixed-term contracts in the flows from unemployment to employment and the percentage of fixed-term contracts in the stock of employment overall. The parameters associated to the decision of whether to invest in job-specific human capital or not (that is  $\theta^H$ ,  $\theta^L$  and  $\xi$ ) are identified as follows. The

Figure 2: Histogram of the worker ability and maximum wage observed - Different  $\alpha_0^x$

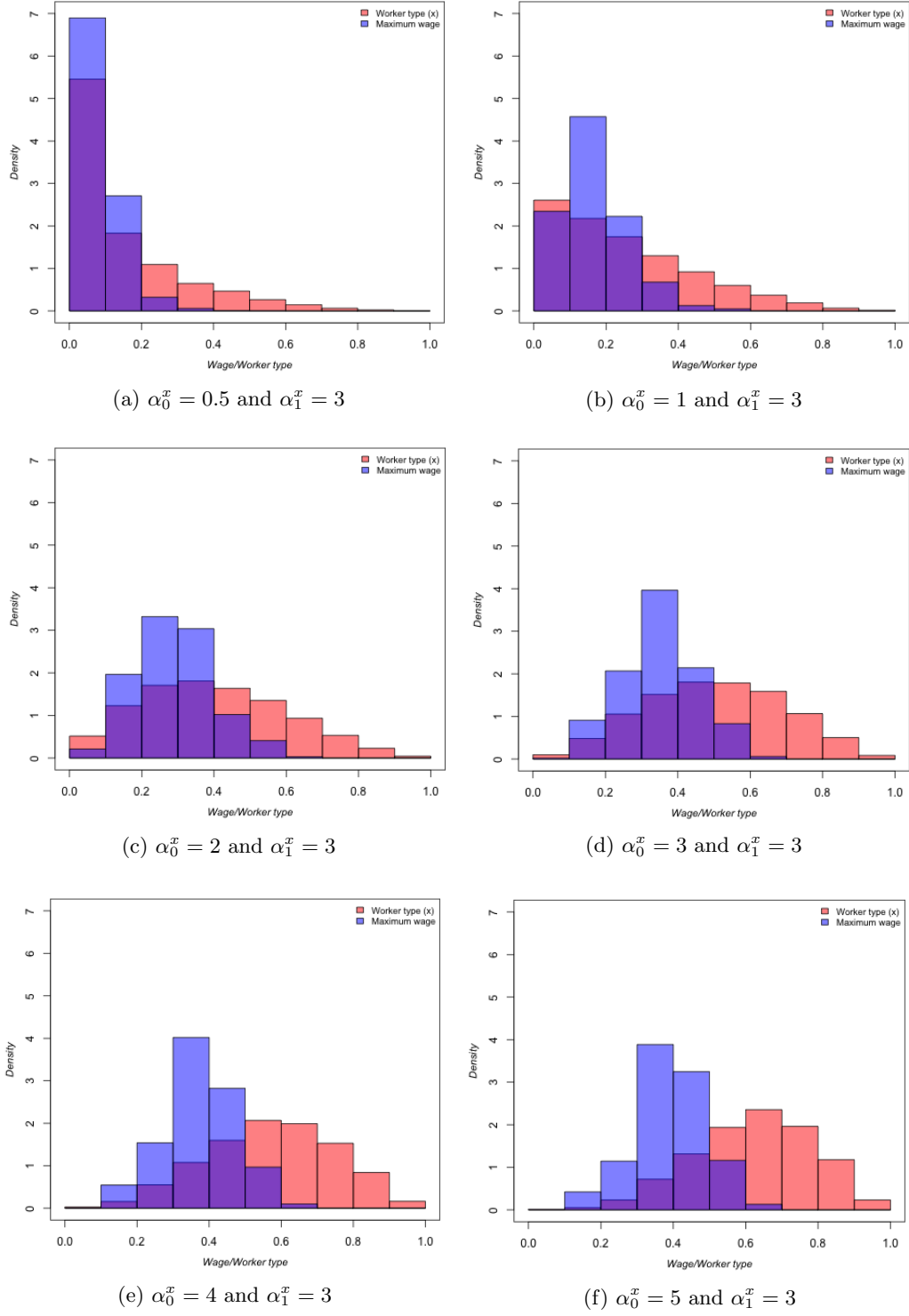


Figure 3: Histogram of the worker ability and maximum wage observed - Different  $\alpha_1^x$

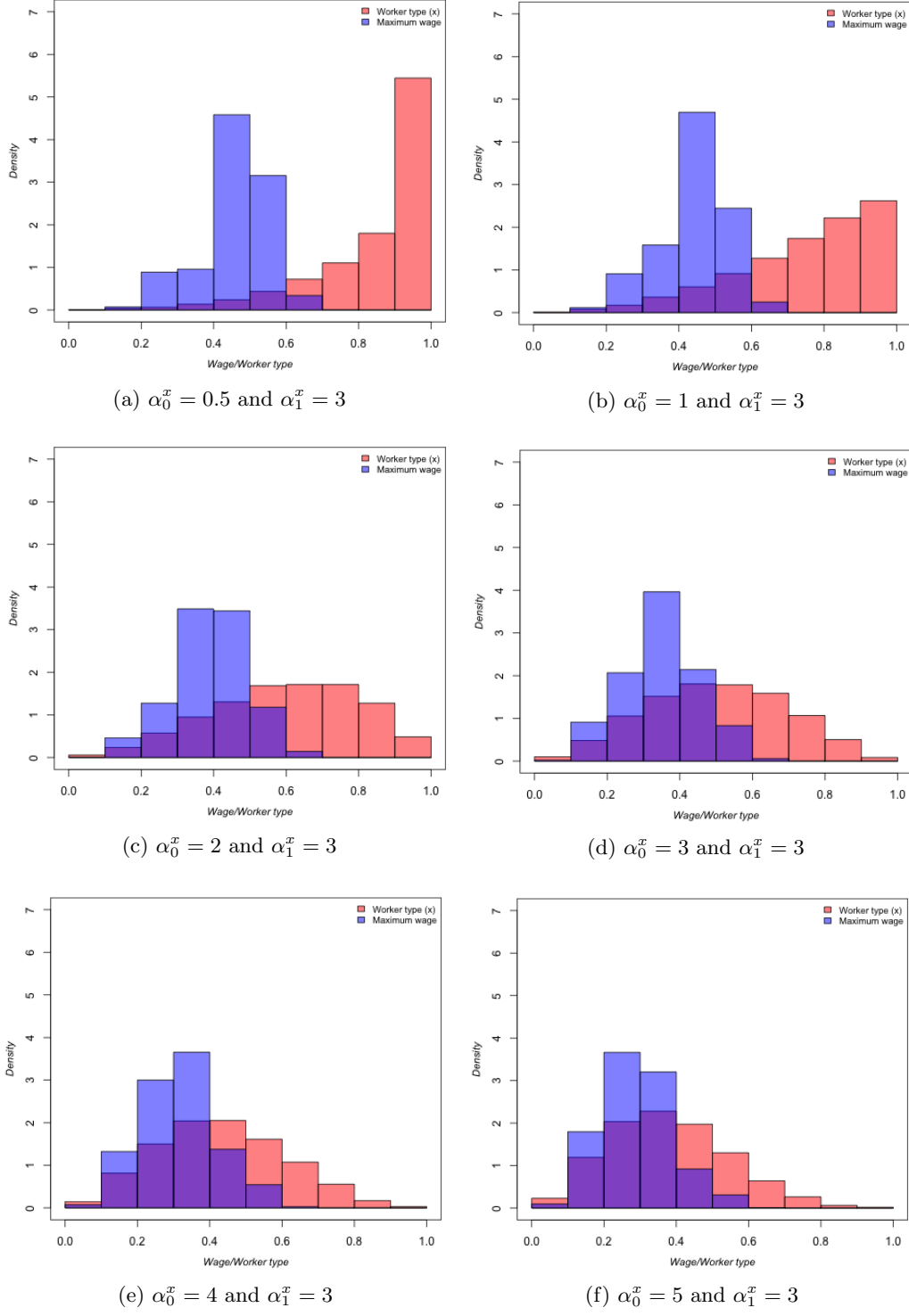
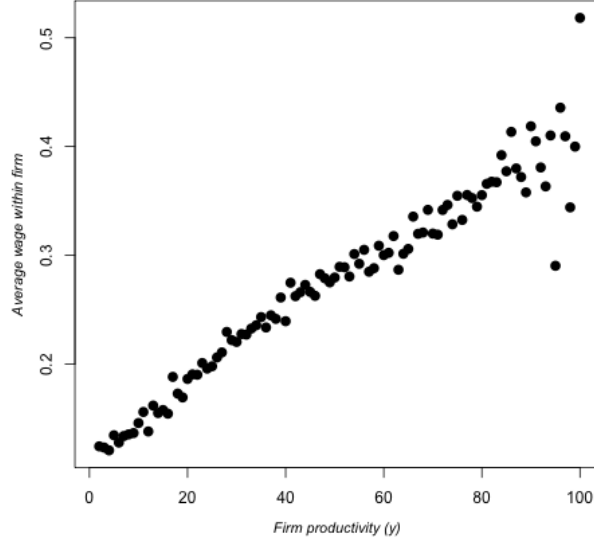
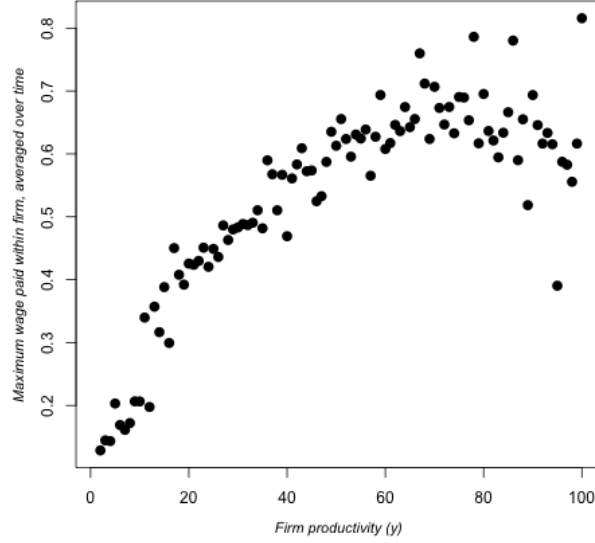


Figure 4: Correlation between firm productivity and wages paid at the firm level



(a) Average wages within each firm

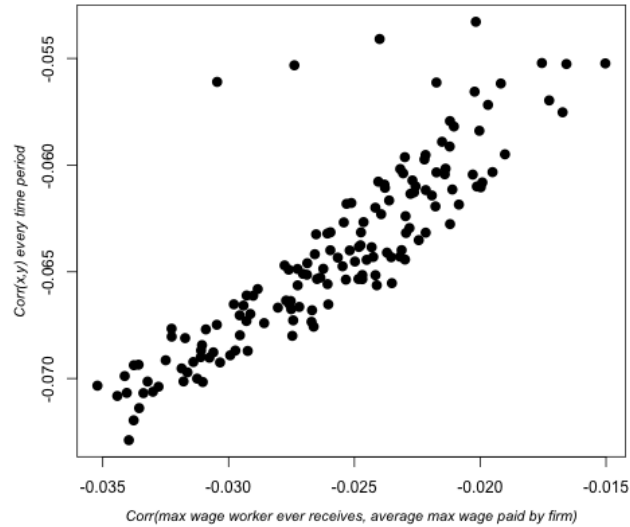


(b) Maximum wage paid within each firm

two productivity parameters help determine the percentage of workers that will receive training in a fixed-term contract and a permanent contract. The cost of training also influences these percentages. But, on top of that, it also plays a role in the average and variance of wages in permanent contracts and the wage growth after conversion from fixed-term to permanent. The unemployment benefit parameter  $b$  influences the average and variance of wages when coming from unemployment. The transition rates  $\lambda^U$ ,  $\lambda^F$  and  $\lambda^P$  are identified by

their empirical counterfactual. That is, the transition rate from unemployment to employment (at any contract type), the job-to-job transition rate when departing from a fixed-term contracts and the job-to-job transition rate when departing from a permanent contract. The overall unemployment rate is also extremely sensitive to the parameter  $\lambda^U$  which determines the rate at which unemployed workers are contacted by firms. The destruction rates  $\delta^F$  and  $\delta^P$  are respectively identified with the transition rate from a fixed-term contract to either unemployment or conversion to a permanent contract, and the transition rate from a permanent contract to unemployment. Finally, the probability that a fixed-term contract cannot be converted into permanent at its expiry date  $\mu$  is identified with the conversion rate of fixed-term contracts into permanent at the same employer. The relationship between that particular parameter and moment is clearly monotonic, linear and decreasing. The last parameter that remains to identify is  $\rho$  which determines the degree of substitutability between worker ability and firm productivity in the production process. To identify this parameter, I use the covariance between the maximum wage ever received by a worker and the average wage paid within each firm, for all the observed matches. Figure 5 shows the correlation between this covariance and the covariance between the actual worker ability and firm productivity in simulated data. There is a clear positive association between the two.

Figure 5: Correlation between the true covariance of worker and firm types and the covariance of maximum wage received with average wage paid

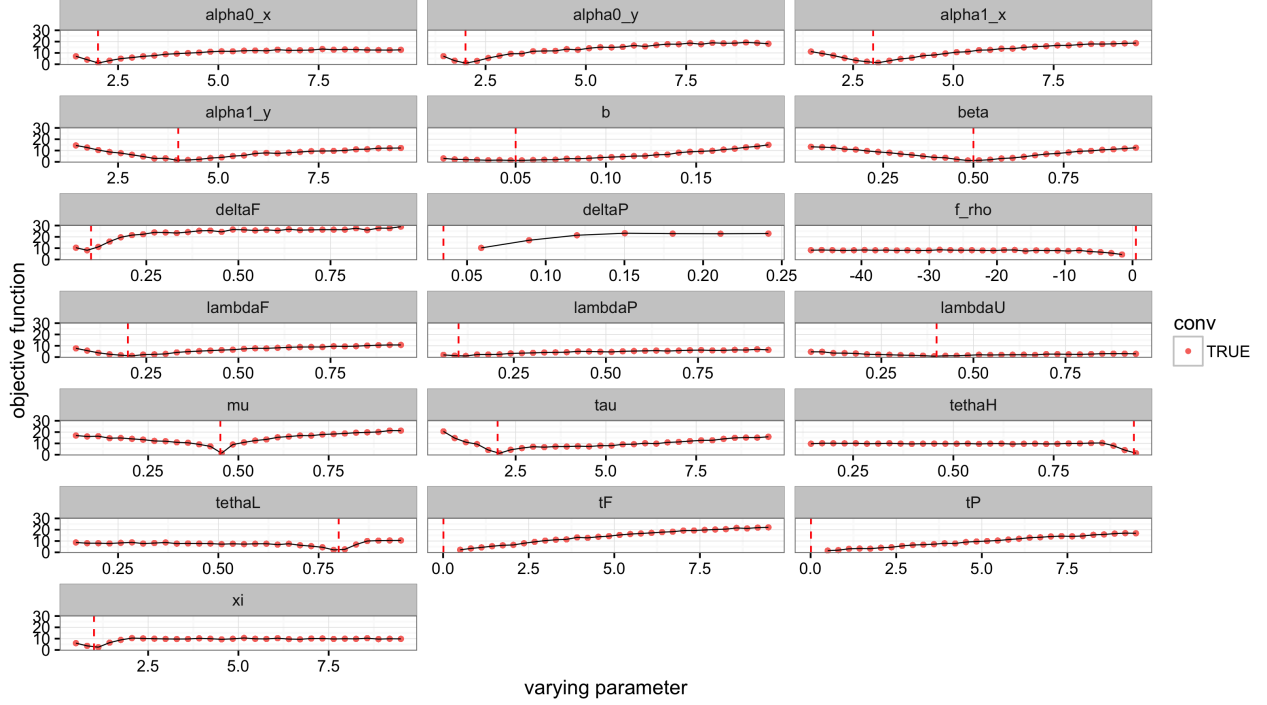


To conclude on the discussion of the identification strategy, Figure 6 shows the evolution of the objective function that computes the distance between data and simulated moments for varying parameters. In each sub-panel, only one parameter is changing while the remaining parameters are fixed. A vertical, red and dashed line in each sub-panel represents the exact value used to fake the data moments. The model's parameters are identified



if the objective function is minimised at that value for each of the parameters.

Figure 6: Value of the objective function for different parameter values



The following section presents the parameter estimates and discusses the results.

## 4 Results

### 4.1 Parameter estimates

Table 1 presents the point estimates of the parameters in the model. The values in the parentheses underneath each point estimate correspond to the standard deviations of the Markov chain.

The transitional parameters given in the first row of Table 1 are all quarterly Poisson rates. The contact rates  $\lambda^U$ ,  $\lambda^F$  and  $\lambda^P$  are in line with quarterly job finding rates estimated in the previous literature. In Petrongolo and Pissarides (2008), they find a job finding rate in the United States that is close to the point estimate for  $\lambda^P$  and a job finding rate in the United Kingdom that lies between the estimates for  $\lambda^U$  and  $\lambda^P$ . For Spain, which also has a labour market strongly segmented between fixed-term and permanent contracts, Petrongolo and Pissarides (2008) estimate two job finding rates separately for the periods 1990-1994 and 1994-2006. After 1994, when fixed-term contracts became more common in the Spanish labour market, they found a quarterly job finding rate of 0.337. The average of the point estimates for  $\lambda^U$ ,  $\lambda^F$  and  $\lambda^P$  is exactly 0.3358. For the

Table 1: Parameter Estimates

$\lambda^U$	$\lambda^F$	$\lambda^P$	$\delta^F$	$\delta^P$	$\mu$
0.2426 (0.1896)	0.2240 (0.0894)	0.5408 (0.1634)	0.2363 (0.0611)	0.0414 (0.0042)	0.1142 (0.0478)
$\rho$	$\theta^L$	$\theta^H$	$\tau$	$b$	$\xi$
0.3102 (0.4963)	5.6573 (0.4366)	6.0363 (0.4038)	0.6650 (1.9568)	1.9804 (0.2564)	4.0474 (1.6294)
$\alpha_0^x$	$\alpha_1^x$	$\alpha_0^y$	$\alpha_1^y$	$\beta$	
4.0604 (0.7112)	4.8048 (0.9439)	3.0800 (0.7954)	4.4080 (0.9577)	0.9723 (0.0305)	

Note: Standard errors correspond to the standard deviation of the parameters in the last 500 iterations of the Markov Chain.

job destruction rates, Petrongolo and Pissarides (2008) find a slightly lower rate than the estimated  $\delta^F$  for the United States and the United Kingdom. For Spain, nonetheless, they find an overall quarterly job destruction rate of 0.23 between 1994 and 2006, which is very close the point estimate for  $\delta^F$ .

In terms of economic interpretation, the estimate for  $\lambda^U$  implies that unemployed workers, on average, contact a potential employer every year<sup>7</sup>. Workers in a fixed-term contract also contact a potential employer every year, and workers in a permanent contract approximately every six months. Since the estimated contact rates for unemployed workers and workers employed in fixed-term contracts are similar, and significantly lower than for workers in permanent contracts, this suggests that fixed-term contracts are not functioning as a stepping stone to other jobs. With the estimated destruction rate  $\delta^F$ , fixed-term contracts are destroyed every year, on average, while permanent contracts are only destroyed approximately every six years. According to the point estimate for  $\mu$ , 11.42% of the fixed-term contracts that expire every year cannot be converted to permanent.

The point estimate for  $\rho$  from the production function implies an elasticity of substitution between the worker's ability and firm's productivity of 1.45<sup>8</sup>. Since this is higher than unity, it would imply that worker and firm characteristics are substitute in the production process rather than complements. Lise, Meghir and Robin (2016) obtain a similar result for a sample of low-skilled workers in the United States. However, for college graduates, they find an elasticity of substitution of 0.53, implying a high degree of complementarity. The estimated parameters for the total factor productivity when workers receive on-the-job training ( $\theta^H$ ) or not ( $\theta^L$ ), imply that non-trained workers attain approximately 93.7% of the productivity associated with trained workers.

The estimated red-tape cost of dismissing workers in a permanent contract ( $\tau$ ), compared with the average match product in a simulated economy at the estimated parameters, represents approximately 4% of the match

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<sup>7</sup>  $\frac{1}{4 \times \lambda^U} = 1.03$   
<sup>8</sup>  $\frac{1}{1-\rho} = 1.45$

output in a quarter or 1% of what the match output would be in a year<sup>9</sup>. Similarly, the estimated pecuniary benefit of unemployment,  $b$ , represents 75% of an average salary in a fixed-term contract and 68.6% of an average salary in a permanent contract for a quarter. The training cost, finally, amounts to approximately 25.2% of the average match output in a quarter or 6.3% of what would be the average match output in a year.

To conclude with the discussion of the point estimates, the estimated worker bargaining power  $\beta$ , is extremely high compared to similar estimates in the literature. It would imply that workers obtain 97.23% of the match surplus. Lise, Meghir and Robin (2016), for example, estimated a bargaining power of 0.188 for low skilled individuals and 0.272 for college graduates.

## 4.2 The fit

Table 2 compares the targeted moments as computed in the data and resulting from the model at the estimated parameters.

Some moments fit extremely well. It is the case for the rate at which fixed-term and permanent jobs are destroyed, the transition rate from unemployment to employment, as well as the percentage of workers who receive training by their employer in both types of contracts. The mean and variance of the maximum wage that workers received over time and the average of the annual wage growth within the same job also fit quite well. Overall, there is also a fairly good fit for the percentile of wages, as well as the mean and variance of wages in both types of contracts. Finally, there is not much variation in the percentage of fixed-term contracts within each firm in the data, and this is well reflected in the model.

Other moments, however, appear to be poorly fitted. For instance, the model predicts a higher conversion rate of fixed-term contracts into permanent contracts than measured in the data. Nonetheless, the conversion rate computed using the DADS is imprecisely measured and most likely underestimated due to the annual aggregation of employment spells. The model also predicts more job-to-job movements than in the data. In particular, while in the data workers in a fixed-term contract are more likely to experience a job-to-job transition than permanent workers, the model predicts the opposite. It is possible that the job-to-job transition rate computed in the data is overestimated. If some workers who lose their job regain employment very quickly, this could be captured as direct movements from one job to the other instead of two transitions between employment and unemployment. Another moment that fits very poorly is the average wage growth after a job-to-job movement. In the data, the average is negative, while in the model it is high and positive. The data moment might be driven by the presence of some outliers or extreme values of wage growth when changing employers. It could have been more adequate to use the median in this case. Finally, the covariance between the maximum wage paid by the firm and the

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<sup>9</sup>  $\frac{0.665}{16.0522} = 0.04$  and  $\frac{0.665}{4 \times \text{Average match Product}} = 0.0104$

Table 2: Fit of the moments used in the estimation

Moment		Model	Data	Difference
Workers cross-sectional moments				
Wage across all the newly hired from unemployment	Mean	2.4268	2.5683	0.1415
	Variance	0.0945	0.1339	0.0394
Wage across all fixed-term workers	Mean	2.6331	2.5134	0.1197
	Variance	0.0956	0.1125	0.0169
Wage across all permanent workers	Mean	2.8881	2.7635	0.1246
	Variance	0.2298	0.1949	0.0349
Wage growth after conversion to permanent	Mean	0.0105	0.0542	0.0437
	Variance	0.0161	0.0209	0.0048
Wage growth after a job to job movement	Mean	0.2005	-0.0334	0.2339
	Variance	0.0774	0.0837	0.0063
Annual wage growth within the same job	Mean	0.0716	0.0702	0.0014
	Variance	0.1066	0.0109	0.0957
Maximum wage received over time	Mean	2.9150	2.8160	0.0990
	Variance	0.1989	0.1987	0.003
1st percentile of all wages		2.0208	2.1466	0.1258
5th percentile of all wages		2.1583	2.2398	0.0815
10th percentile of all wages		2.2851	2.3060	0.0209
Firms cross-sectional moments				
Percentage of fixed-term employees across firms	Mean	0.3121	0.0566	0.2555
	Variance	0.0444	0.0458	0.0014
Nr. of workers poached out of inflow of new workers	Mean	0.5146	0.4669	0.0477
	Variance	0.1188	0.2116	0.0929
Nr. of workers poached out of stock of employees	Mean	0.0878	0.0458	0.0420
	Variance	0.0252	0.0366	0.0114
Within firm average wage	Mean	2.7463	2.6586	0.0877
	Variance	0.2730	0.1505	0.1225
Within firm maximum wage paid	Mean	3.3779	2.7538	0.6241
	Variance	0.5670	0.2370	0.3300
Within firm variance of wages	Mean	0.1245	0.1027	0.0218
	Variance	0.0290	0.0357	0.0066
Worker and firm cross-sectional moments				
Covariance between maximum wage received by the worker and maximum wage paid by the firm		0.0760	0.1688	0.0929
Rates				
Conversion rate from fixed-term to permanent		0.2202	0.0694	0.1508
Destruction rate of fixed-term contracts		0.2531	0.2310	0.0221
Destruction rate of permanent contracts		0.0340	0.0277	0.0064
Job-to-job movement rate from a fixed-term contract		0.0515	0.0492	0.0023
Job-to-job movement rate from a permanent contract		0.0610	0.0203	0.0407
Job finding rate for unemployed workers		0.1768	0.1954	0.0186
Unemployment rate		0.1726	0.0800	0.0926
Rate at which wages are renegotiated in permanent contracts		0.0443	0.1427	0.0984
Other moments				
Percentage of fixed-term contracts in entries		0.9891	0.8100	0.1791
Percentage of fixed-term contracts in stock of employment		0.3414	0.1000	0.2414
Percentage of workers who receive training in fixed-term contracts		0.1497	0.1500	0.0032
Percentage of workers who receive training in permanent contracts		0.2965	0.2900	0.0065

maximum wage received by the worker is lower in the model compared with the data. This could explain why the point estimate for  $\rho$  implies that there is not a very high degree of complementarity between worker and firm characteristics in the production process, which is at odds with other estimates in the literature.

## 5 Counterfactual Analysis

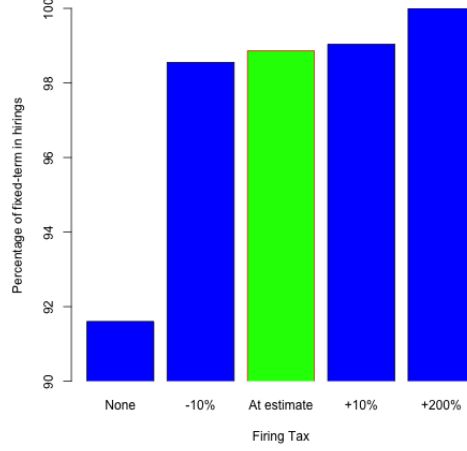
In this section, the parameters of the structural model are all set at their estimated values. One by one, I change some policy parameters so as to explore their impact in the share of fixed-term contracts in new hires, as well as in the sorting pattern of workers and firms between fixed-term and permanent contract.

### 5.1 Labour market segmentation and selection across different contract types

As a first counterfactual exercise, I look at how the red-tape component of the firing cost and the probability that fixed-term contracts can be converted into permanent affect the share of fixed-term workers in new hires. For that purpose, I keep all other parameters constant, and in particular, the destruction rates. Figure 7 shows that a 10% decrease in the red-tape cost  $\tau$  generates a decrease in the share of fixed-term contracts in new hires by about half a percentage point. This is not a small effect if one considers that  $\tau$  at its estimated value represented 1% of the annual match output. In fact, a 10% decrease in the red-tape cost of firing means only an additional 0.1% of the annual match output left untaxed. Nonetheless, as explained in subsection 2.4.3, for a positive value of the probability that fixed-term contracts can be converted to permanent, even the total removal of the red-tape cost would not be enough to totally eliminate fixed-term contracts from new hires. Setting  $\tau = 0$  and all other parameters at their estimated value would generate a share of fixed-term contracts in new hires of about 91%, compared to 99% at the estimated value for  $\tau$ .

Figure 8 shows the matching patterns for different values of the red-tape component of the firing cost  $\tau$ . The horizontal axis represents the worker ranking in the ability distribution ( $x$ ). The vertical axis, on the other hand, depicts the firm ranking in the productivity distribution ( $y$ ). Every small quadrant in the figure depicts the outcome when that particular worker  $x$  and firm  $y$  meet in the labour market. There are eight possible outcomes: (i) the match is not worth forming, worker and firm return to the search process; (ii) the match is worth forming under a fixed-term contract without investing in on-the-job training and the contract is not worth converting to permanent if the opportunity arises at the expiry date of the fixed-term contract; (iii) the match is worth forming under a fixed-term contract with investment in on-the-job training and the contract is not worth converting to permanent if the opportunity arises at the expiry date of the fixed-term contract; (iv) the match is worth forming under a fixed-term contract and worth converting to permanent if the opportunity arises at the expiry date of the fixed-term contract. Nevertheless, it is neither worth investing in on-the-job

Figure 7: Percentage of fixed-term contracts in new hires for different values of the firing tax  $\tau$

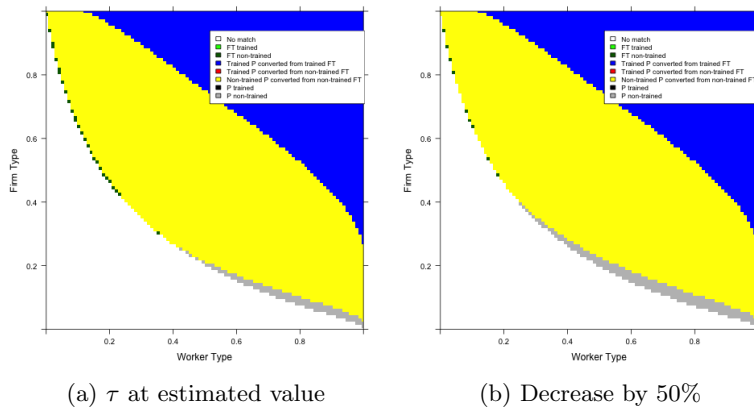


training at the initial stage of the match nor at the conversion stage; *(v)* the match is worth forming under a fixed-term contract and worth converting to permanent if the opportunity arises at the expiry date of the fixed-term contract. Investment in on-the-job training is only worth at the conversion stage; *(vi)* the match is worth forming under a fixed-term contract with investment in on-the-job training from the beginning and the contract is worth converting to permanent if the opportunity arises at the expiry date of the fixed-term contract; *(vii)* the match is worth forming under a permanent contract without investing in on-the-job training; and finally, *(viii)* the match is worth forming under a permanent contract with investment in on-the-job training. To be precise, the figure does not depict the *de facto* outcome for each particular worker and firm. Instead, the figure represents the optimal outcome, conditional on the match not being destroyed in the meantime for other reasons. For example, it is possible that a fixed-term contract would have been optimal to convert to permanent, but never reaches that stage because the worker receives an outside offer and moves to a new firm. In equilibrium, it is optimal to convert fixed-term contracts into permanent in most of the cases. However, this does not mean that all these matches will eventually be converted into permanent. Workers can leave to other firms before the fixed-term contract expires and is converted, or the fixed-term contract might be exogenously destroyed together with the position, preventing the worker and firm to carry on with a permanent contract. Finally, in equilibrium, outcomes *(iii)* and *(v)* never occur. In fact, if the fixed-term contract is not worth converting to permanent at its expiry date, investment in on-the-job training is never optimal. Similarly, if the fixed-term contract is expected to be converted to permanent at its expiry date and investment in on-the-job training is worth it, then it must be optimal to provide such training from as early as possible so as to collect the benefits from a higher total factor productivity for as long as possible. Therefore, whenever the investment

in on-the-job training is made, it is always at the hiring stage and never at the conversion stage.

As depicted in Figure 8, the model predicts that if the firing cost decreases, further matches are directly formed with a permanent contract (area in grey) and the fraction of fixed-term contracts that are not optimal to convert to permanent at their expiry date (dark green area) goes down. The workers that mostly benefit from the decrease in the red-tape cost of firing are the workers in the upper part of the ability distribution, between the 60<sup>th</sup> and 80<sup>th</sup> percentiles, as they are more likely to be hired directly with a permanent contract.

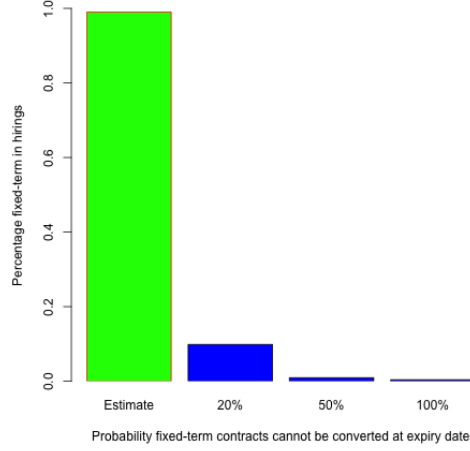
Figure 8: Match formation in equilibrium - Different values of the red-tape cost ( $\tau$ )



Curiously, the increased likelihood of being hired directly with a permanent contract is mostly felt when meeting lower productivity firms. When contacting highly productive firms, these workers will still be hired with a fixed-term contract first, even though that contract will be converted to permanent if nothing happens in the meantime. For this particular combination of estimated parameter values, this is mostly driven by the higher on-the-job contact rate that workers experience in permanent contracts. Since high ability workers have a very high opportunity cost when unemployed, they are willing to accept a contract from a lower productivity firm, despite the potential mismatch. Nevertheless, they will favour a permanent contract over a fixed-term contract since it allows them to contact potentially better firms more frequently. When high ability workers meet high productivity firms, starting the match with a fixed-term contract and convert it into permanent at the expiry date of the contract is still the preferred option. There are two reasons for this: the fixed-term contract in the first years of the match reduces the overall expected firing tax and it increases the expected duration of the match since these workers are unlikely to leave to another firm.

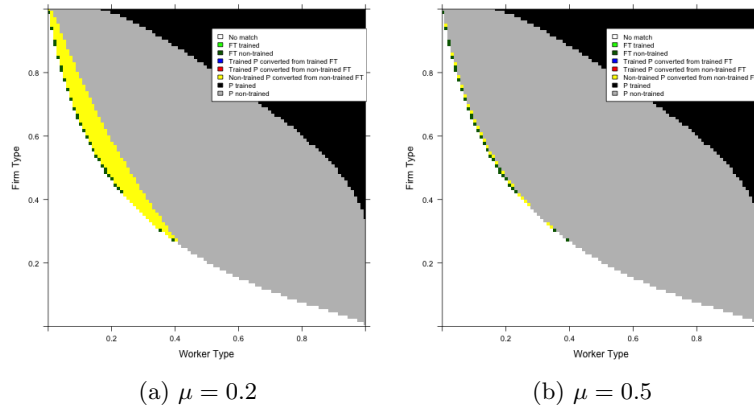
Figure 9 shows the impact of a decrease in the probability that fixed-term contracts cannot be converted to permanent at their expiry date for exogenous reasons, on the percentage of fixed-term contracts in entry flows towards employment. The effect is very large. An increase in the probability  $\mu$  from its estimated value of

Figure 9: Percentage of fixed-term contracts in new hires for different values of the probability  $\mu$



approximately 11% to 20% leads to a fall in the percentage of fixed-term contracts in new hires from almost 100% to less than 20%. Figure 10 represents the changes in the optimal matching and conversion patterns for different values of  $\mu$ . The last workers to benefit from an increase in the probability that fixed-term contracts cannot be converted to permanent are low ability workers. In particular, when these workers meet with highly productive firms.

Figure 10: Match formation in equilibrium - Different probabilities that fixed-term can be converted ( $\mu$ )

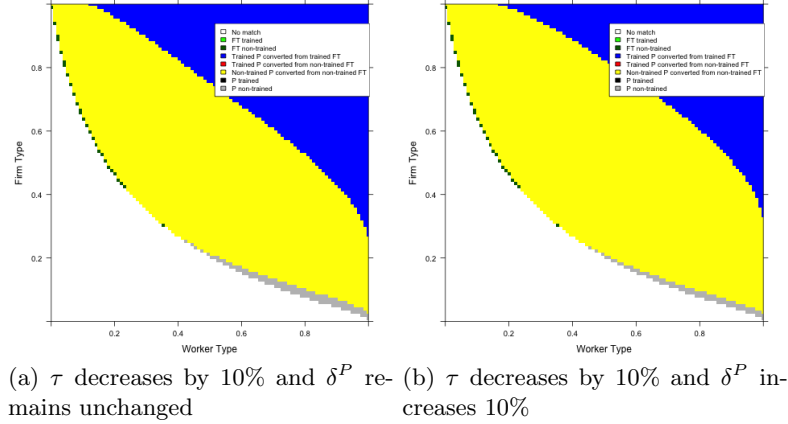


However, as discussed previously in subsection 2.4.3., since separations are kept exogenous, the model cannot quantify the amount of jobs that would be destroyed when the firing cost goes down. Therefore, as an additional counterfactual exercise, I look at the matching and conversion patterns when the red-tape firing cost decreases in 10% and the destruction rate of permanent contracts increases in 10%. Figure 11 shows that the positive



effect from a reduced firing cost on the share of permanent contracts in hiring and employment is fully reverted by an increase in the destruction rate of permanent contracts.

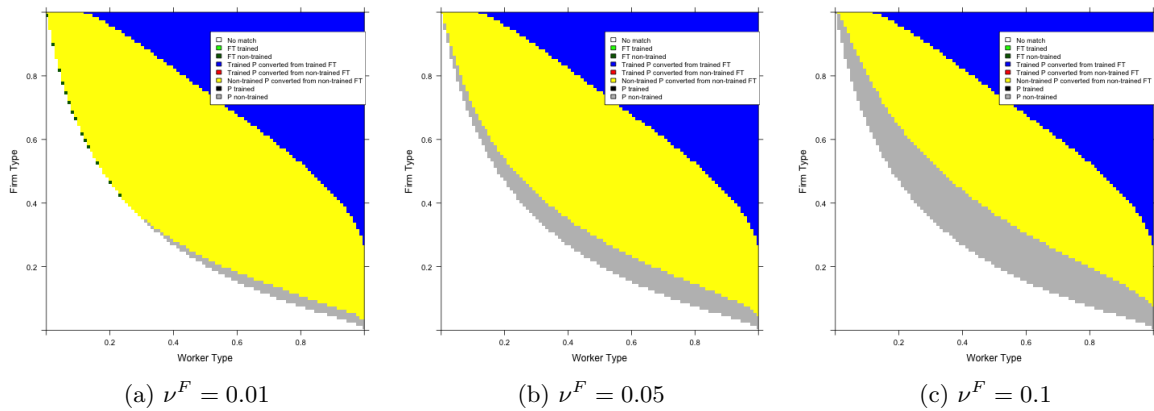
Figure 11: Match formation in equilibrium - When the destruction rate of permanent contracts adjusts



## 5.2 Taxing fixed-term contracts

For the estimation and in the counterfactual exercises discussed previously, the parameters  $\nu^F$  and  $\nu^P$  were kept to zero. These parameters measure the amount of social security contributions that must be paid each period that a fixed-term or permanent contract is in place. A potentially interesting counterfactual is to analyse how much increasing the taxation of fixed-term contracts relative to permanent contracts affects labour market segmentation. Figure 12 shows the matching and conversion patterns for different small values of  $\nu^F$  when  $\nu^P = 0$ .

Figure 12: Match formation in equilibrium - Introducing higher social security contributions in fixed-term contracts

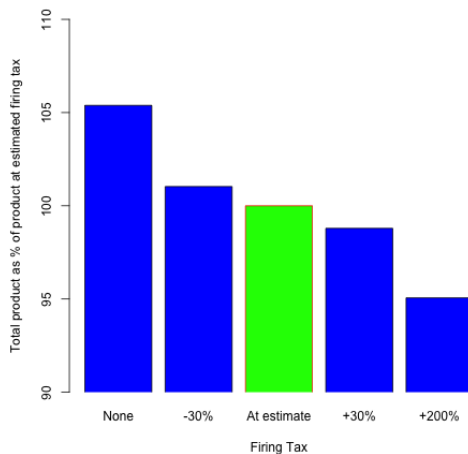


Increasing the taxation of fixed-term contracts while permanent contracts are left untaxed has a significant effect in the percentage of workers that are hired directly with a permanent contract. The effect of increasing the taxation of fixed-term contract is much more effective in reducing the share of fixed-term contracts in hiring than reducing the firing tax.

### 5.3 Training, productivity and labour market segmentation

Another pertinent question is whether the total that is produced in the economy increases when the firing cost goes down, more matches start directly with a permanent contract, and more fixed-term contracts are converted to permanent at their expiry date. Figure 14 depicts the effect of a change in the firing cost  $\tau$  on the total product, normalised by the total product in a simulated economy at the estimated parameters. It shows that a 30% decrease in the red-tape component of the firing cost, for example, would increase total product by 1%, keeping all other parameters constant. A total removal of the firing tax would increase total product in approximately 6%.

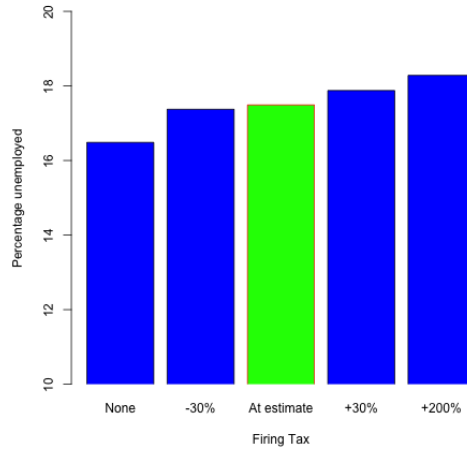
Figure 13: Total product for different values of the firing tax  $\tau$



The increase in total product comes from three channels. First of all, the increase in the share of permanent contracts in the economy means that matches last longer on average. Consequently, individuals go less often through periods of unemployment and more is produced. Second, although the effect is barely visible from figure 8, there are more worker-firm pairs willing to form a match when the firing cost is lower. Namely, matches directly with a permanent contract. In fact, the unemployment rate goes slightly down, as shown in figure 14. Finally, since there are more permanent contracts in the economy, it is also more likely that for a given match, the worker receives on-the-job training. Since on-the-job training increases the match-specific productivity, total

output becomes larger.

Figure 14: Unemployment rate for different values of the firing tax  $\tau$



It is worth stressing that the decreased unemployment rate is driven by an increase in job creation only. Since job destruction is exogenous and kept constant, the effect of a decrease in the firing cost on overall unemployment ignores the possibility that further destructions would occur as a result.

Finally, figure 15 depicts the percentage of workers who receive on-the-job training for different values of the training cost  $\xi$ , while figure 16 shows how the total product in the economy would change.

Figure 15: Percentage of workers who receive training in each contract type for different values of the training cost  $\xi$

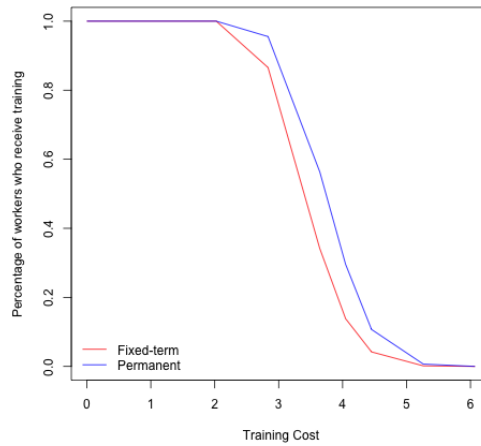
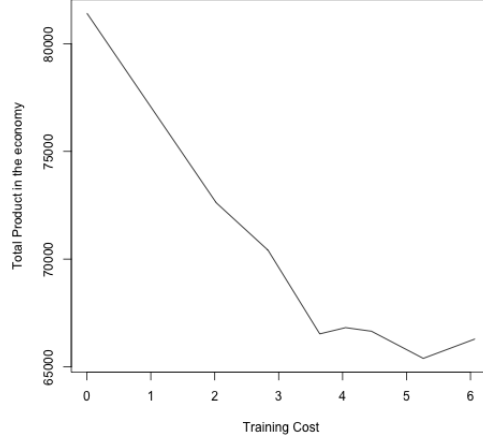


Figure 16: Total product for different values of the training cost  $\xi$



As evidenced by figure 15, the model predicts that for most values of the training cost, workers in a permanent contract are more likely to receive training on-the-job than workers in fixed-term contracts. More interestingly, as evidenced by figure 16, decreasing the training cost has a significant impact on the total product of the economy. As the cost decreases, more individuals receive on-the-job training and the total factor productivity of several matches increases. Added up at the aggregate level, this results in a significant increase in production. In fact, the gains in total output that can be achieved by reducing the cost of on-the-job training are more significant than the gains from reducing the red-tape component of the dismissal cost.

## 6 Conclusion

This paper develops a partial equilibrium model of the labour market, with frictions, in which two-sided heterogeneous agents optimally decide the employment contract type and whether to invest in on-the-job training. The model rationalises the co-existence of fixed-term and permanent contracts in equilibrium, even if there is no learning about the workers' ability. In other words, the model is able to explain the labour market segmentation between different types of contracts, even assuming that workers and firms' real productivity are fully observable to everyone in the economy. In this model, the trade-off between fixed-term and permanent contracts depends on the expected duration of each contract, the expected dismissal cost, the likelihood that the worker leaves for another firm in the meantime, the likelihood that the fixed-term contract can still be converted to permanent at its expiry date, as well as the worker ability, the firm productivity and how much complementarity there is between worker and firm in the production process.

Using French matched employer-employee data from 2005 to 2008, the model is estimated using Simulated Method of Moments (SMM). By structurally estimating the parameters of the model, this paper is the first one to quantify the red-tape cost of dismissing workers in permanent contracts - the cost associated with administrative procedures, legal expenses, additional financial penalties and the uncertainty about the outcome of a process in the labour court. According to the point estimates obtained, the red-tape component of the dismissal cost represents approximately 1% of the match output if the match would last one year. If the match only last a quarter, the red-tape firing cost represents about 4% of the match output. Decreasing this component of the dismissal cost in 10% would reduce the share of fixed-term contracts in new hires by half a percentage point, if the destruction rate of permanent contracts would remain unchanged. That is, if there is no surge in dismissals in permanent contracts after the decrease in the firing cost. The workers that would mostly benefit from such reform are those in the upper part of the ability distribution, namely between the 60<sup>th</sup> and 80<sup>th</sup> percentiles. These workers become more likely to be directly hired under a permanent contract, which increases their lifetime utility, measured as the value of being unemployed in this economy. Nevertheless, if the objective is to reduce the share of fixed-term contracts in new hires, the model with the structural parameters at their estimated values, predicts that taxing fixed-term contracts seems more effective than reducing the red-tape component of the dismissal cost. Finally, while there are potential gains in output by reducing the red-tape component of the firing cost, much larger gains in total output can be achieved by reducing the cost of training workers on-the-job. In fact, the training cost is estimated to represent approximately 6% of the match output if the match lasts one year and 25% of the match output if it only lasts one quarter. Even small decreases in the training cost from its currently estimated value would increase total output significantly.

There are several ways in which the analysis discussed in this paper could be improved. To begin with, the counterfactual policy analysis would require re-estimating the structural model with the red-tape component of the dismissal cost fixed and increased by 10%. One could then take into account how the remaining parameters would respond when the firing cost increases. Furthermore, the process of vacancy creation is taken as exogenous in the model. It is assumed that there exists a pool of available vacancies and the parameters that shape the distribution of the productivity for these vacancies are estimated. Nevertheless, a reform of employment protection legislation could also impact the vacancy creation process, apart from the decision of when and how to fill these vacancies. For instance, strict employment protection legislation, together with the existence of fixed-term contracts, may provide an incentive for firms to create vacancies of low productivity rather than high productivity. In other words, policy parameters could also influence the distribution of the vacancies' productivity. Ultimately, to evaluate the model fit, it would also be interesting to compare the earnings distributions

in different types of contracts implied by the model at the estimated parameters with the empirical earnings distributions as described in Fialho *et al.* (2017). In particular, one could compare the implied earnings growth after conversion and after a job-to-job transition from a fixed-term to a permanent contract.

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