MATCH QUALITY, LABOR MARKET PROTECTION, AND TEMPORARY EMPLOYMENT *

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Abstract

Labor market regulations in several countries mandate firing costs. Those same regulations allow fixed-term contracts under which, after a short period of time, dismissing a worker is costless. This paper emphasizes differences in match-quality to explain why some firms find it optimal to offer permanent contracts to new hires. Under search and matching frictions firms offer high-quality matches a permanent contract to reduce the risk of losing the worker. The paper characterizes the firm's hiring and firing rules. Using aggregate and micro-level data to estimate the model's parameters, it finds that increasing the level of firing costs increases wage inequality and decreases the unemployment rate. The increase in inequality results from a larger fraction of temporary workers and not from an increase in the wage premium earned by permanent workers.

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1 Introduction

The existence of two-tiered labor markets in which workers are segmented by the degree of job protection they enjoy is typical in many OECD countries. Workers under temporary or fixed-term contracts enjoy little or no protection. They are paid relatively low wages and they experience high turnover, transiting among jobs at relatively high rates. Meanwhile, other workers enjoy positions where at dismissal the employer faces a firing tax or a statutory severance payment. These workers' jobs are more stable, they are less prone to being fired, and they are paid relatively higher wages. The menu and structure of available contracts is oftentimes given by an institutional background who seeks some policy objective. Workers and employers, however, may choose from that menu and begin the type of relationship that best suits them.

Previous research has been concerned with the transition of temporary to permanent employment or with the separation from both types of employment into unemployment. Nonetheless, evaluation of labor market policies requires an understanding of what determines the level of temporary employment in the first place. This paper studies the choice of contract when a firm and a worker first meet, examining the conditions under which they decide whether to enter a permanent or a temporary relationship. Intuitively firms should always opt for offering workers the contract in which dismissal is free, not to have their hands tied in case the worker underperforms. This intuition is misleading if finding a good match is costly. This paper emphasizes match-quality in a labor market with search and matching frictions as the main determinant of the initial choice of contract. By match quality we refer to the component of a worker's productivity that remains fixed as long as the firm and the worker do not separate. That component is revealed at the time the firm and worker meet. Firms offer workers with low match-quality a fixed-term contract, which can be terminated at no cost after one period and features a relatively low wage. If it is not terminated, the firm agrees to promote the worker and upgrade the contract into a permanent one. A permanent worker enjoys a higher wage and is relatively protected by a firing tax. On the other hand, firms find it optimal to offer high-quality matches a permanent contract at the time they meet. The firm ties its hands promising to pay the tax in case of termination and compensating the worker with a higher wage. The rationale for the firm is to avoid losing a good match easily given the lower turnover rate of permanent positions.

Our set-up is tractable enough to allow us to characterize three cut-off rules. These rules summarize the hiring and firing decisions of firms. First, we show that there exists a cut-off point in the distribution of match-specific shocks above which the firm offers a permanent contract. Below that cut-off point the firm offers a temporary contract. There is also a cut-off point in the distribution of the time-varying component of productivity below which the relationship between a temporary worker and a firm ends and above which it continues. Finally, we show the existence of a cut-off point also in the distribution of the time-varying component of productivity. Below that point the relationship between a permanent worker and a firm ends; above that point it continues.

This paper does not examine the social or policy goals that lead some societies to establish firing costs or to regulate the relationships between workers and employers. Rather, we build a framework in which the menu of possible contracts is given by an institutional background that we do not model explicitly. We then use the framework to examine how the existence of firing costs helps to shape the wage distribution. To perform this quantitative evaluation, we take our model to Canadian data. We choose to study the Canadian economy for three reasons. First, it has rich enough data to allow us to distinguish workers by type of contract. Second, it is an economy with a significant amount of temporary workers who represent 14% of the total workforce. And third, the Canadian labor market features mild employment protection of permanent workers and the lowest amount of regulation on temporary workers (see Venn (2009)). These facts suggest that our model, which emphasizes the choice among different contracts when match-quality differs, is perhaps more relevant for Canada than for other OECD countries (where firms and workers could have less freedom in which contract to choose).

We use the Workplace and Employee Survey (WES), a matched employer-employee dataset, to link wages of workers to average labor productivities of the firms that employ them. This relationship, together with aggregate measures of turnover for permanent and temporary workers, forms the basis of the mapping between data and the model. We employ a simulated method of moments approach to structurally estimate the parameters of the model. The method uses a Markov Chain Monte Carlo algorithm proposed by Chernozhukov and Hong (2003) that overcomes computational difficulties often encountered in simulation-based estimation.

Having estimated the vector of structural parameters, we perform two experiments. In the first experiment, we use the model to assess the impact of firing costs on income inequality. We find that a 50% increase in the level of firing costs increases the standard deviation of the wage distribution by 20%. This rise in inequality is due entirely to the increase in the fraction of temporary workers, which earn relatively lower wages. The "permanent worker premium", the ratio of the wage a permanent worker earns relative to that of a temporary worker, remains roughly the same. The fraction of temporary workers rises with higher firing costs because their relative price drops; permanent workers are more expensive since undoing a permanent match costs more. The wage premium changes little because of two conflicting effects. On the one hand, employers want to hire high productivity permanent workers (to avoid having to hire them and pay the cost). On the other hand it is more costly to destroy existing matches, even when workers have relatively low productivity. We also find that an increase in the firing costs lowers the degree of turnover (it lowers both destruction and creation rates) but it decreases the unemployment rate. The second experiment involves evaluating the welfare impact of introducing temporary contracts, starting from an economy with firing costs. Reforms of that type were introduced in some European countries in the 1980s and 1990s.[1] The increase in welfare that results from such a policy change is caused by a decrease in the unemployment rate; some workers that would otherwise be unemployed are now employed as firms are more willing to post vacancies when temporary contracts are permitted.

This paper constructs and quantitatively evaluates an environment in which match-quality determines the initial choice between a temporary and a permanent contract. Previous literature on dual labor markets has emphasized several reasons for the use of temporary workers. For instance, some authors have associated a temporary contract with a screening device (e.g. Blanchard and Landier (2002)).[2] This hypothesis, while plausible, is not straightforward to reconcile with the observation that some workers are initially hired under permanent contracts.[3] By and large, the literature has assumed an ex-ante exogenous segmentation between temporary and permanent workers. This segmentation can be modeled in a variety of ways: as a technological assumption (e.g. assuming that workers under different contracts are different factors in the production function); due to preferences - assuming that workers value being under a permanent contract differently than being under a temporary contract, or assuming that workers search in markets subject to different frictions. Several examples in the literature in which that segmentation is prominent include Wasmer (1999), Alonso-Borrego, Fernández-Villaverde, and Galdón-Sánchez (2004), Berton and Garibladi (2006) or Bentolila and Bertola (1990).[4][5]

[1]See Aguirregabiria and Alonso-Borrego (2009) for an empirical evaluation of the Spanish reform.

[2]Faccini (2008) also assumes that workers always start a relationship with an employer under a temporary contract, motivating the existence of temporary contracts as a screening device.

[3]A theory somewhat related to ours is due to Smith (2007). In a model with spatially segmented labor markets, it is costly for firms to re-visit a market to hire workers. This leads firms to hire for short periods of time if they expect the pool of workers to improve.

[4] An alternative view of the need for temporary contracts is to face financing constraints as in Caggese and Cuñat (2008).

[5]There is a related branch of the literature that looks at the effect of increasing firing taxes on job creation, job destruction and productivity. An example is Hopenhayn and Rogerson (1993). They find large welfare losses of labor protection policies as they interfere with labor reallocation from high productivity firms to low productivity firms. Other examples would be Bentolila and Bertola (1990), Alvarez and Veracierto (2000), Alvarez and Veracierto (2012), or Garibaldi and Violante (2005).

2 Economic Environment

We present a version of Mortensen and Pissarides (1994) model with on-the-job search and two types of employment contracts: temporary and permanent. For simplicity, we assume that the on-the-job search rate is exogenous to be consistent with the empirical findings shown below.[6] A labor market is populated by a unit mass of *ex-ante* identical workers who are endowed with one unit of time each period. These workers can be either employed or unemployed as a result of being fired and hired by firms. The mass of firms is potentially infinite. Workers search for jobs and firms post vacancies with the hope of matching to searching workers. The number of meetings between employers and workers is given by a matching technology that we specify below in detail. A permanent contract, has no predetermined length, but we maintain, however, the typical assumption of wage renegotiation at the beginning of each period. Separating from this kind of contract is costly. If a firm and a worker under a permanent contract separate, firms pay a firing tax f that we assume is wasted. A temporary contract, has a predetermined length of one period. Once that period is over, separating from the match comes at no cost to the firm. If the firm and the worker decide to continue the relationship, the temporary contract is upgraded to a permanent one. This upgrade, which one could label a promotion, costs the firm a small fee c.[7] If the worker is hired on a temporary basis at the beginning of the period, job offers arrive with probability λ_T. If the worker is employed with a permanent contract job offers arrive with probability λ^P. We assume that $\lambda^T > \lambda^P$ to capture the fact as shown in the data (Table 5), which a temporary worker has more incentive to search for a job than a permanent worker. Unemployed workers receive benefits b for as long as they are unemployed, and the government finances this program by levying lump-sum taxes τ on workers and unemployed agents.

The production technology is the same for the two types of contracts. If a firm hires worker i, the match yields $z_i + y_{i,t}$ units of output in period t. The random variable z represents match-quality: a time-invariant, while the match lasts, component of a worker's productivity which

[6] In our working paper version Cao, Shao, and Silos (2011), we show that one can endogenize the search decision by adding a search cost. However, it is not possible to sensibly estimate this search cost with available data. Hence, we opt here for exogenously positing job offer arrival rates while on the job.

[7] Given that match-quality z is bounded, the introduction of a promotion cost prevents a firm from offering a temporary contract to a worker with the highest possible match-quality, only to promote the worker with certainty after one period. By doing so, the firm can save on the firing cost for at least one period without any downside. To be consistent with the hiring rules derived later, we assume that promotion is costly so that firms have an incentive to offer permanent contracts to the most suitable workers in the first place. Moreover, the cost of promotion has its empirical counterpart in Canada. For example, in Ontario before 2009, under the Employment Standards Act, 2000 (ESA), the agencies that is helping firms to recruit temporary workers charge a significant "finder's fee" to discourage a client who hires a temporary employee converting its job permanently. While this practice widely exists in the industry, it is prohibited in the new amendment of ESA.

is revealed at the time of the meeting. This match-specific shock is drawn from a distribution $G(z)$. The time-varying component $y_{i,t}$ is drawn every period from a distribution $F(y)$ and it is responsible for endogenous separations. From our notation, it should be clear to the reader that both shocks are independent across agents and time. The supports of the distributions of both types of shocks are given by $[y_{min}, y_{max}]$ and $[z_{min}, z_{max}]$ and we assume throughout that $y_{min} < y_{max} - c - f$.

A matching technology $B(v, N^S)$ determines the number of pairwise meetings between workers searching for a job (N^S) and employers (represented by the number of vacancies posted v). Specifically, we assume the matching function is Cobb-Douglas:

$$B(v, N^S) = \xi v^{1-\phi} \left(N^S\right)^{\phi}.$$

This technology displays constant returns to scale and implies a job-finding probability $\alpha^w(\theta) = \xi\theta^{1-\phi}$, and a vacancy-filling probability $\alpha^f(\theta) = \xi\theta^{-\phi}$ which are both functions of the level of market tightness $\theta \equiv \frac{v}{N^S}$. Since the matching probability is between 0 and 1, the implied market tightness must be in a bounded interval $[\theta_{min}, \theta_{max}]$ where

$$\begin{aligned} \theta_{min} &= \xi^{\frac{1}{\phi}}, \\ \theta_{max} &= \xi^{-\frac{1}{1-\phi}}. \end{aligned}$$

Every time a firm decides to post a vacancy, it must pay a cost k per vacancy posted. Finally, if a firm and a worker meet, z is revealed and observed by both parties. The realization of y, however, occurs after the worker and the firm have agreed on a match and begun their relationship.

Let us first fix some additional notation:

- Q : Value of a vacancy.
- U : Value of being unemployed.
- V^P : Value of being employed under a permanent contract.
- V^R : Value of being employed following promotion from a temporary position to a permanent one.
- V^T : Value of being employed under a temporary contract.
- J^P : Value of a filled job under a permanent contract.

- J^R : Value of a filled job that in the previous period was temporary and has been converted to permanent.
- J^T : Value of a filled job under a temporary contract.

It will be convenient to define by,

$$A \equiv \left\{ z \in [z_{min}, z_{max}] \,|E_y J^P(y,z) \geq E_y J^T(y,z) \right\}$$

the set of realizations of z for which the firm prefers to offer a permanent contract. For convenience, let $\mathbb{I}_A$ denote an indicator function defined as,

$$\mathbb{I}_A = \begin{cases} 1 & z \in A, \\ 0 & z \notin A. \end{cases}$$

2.1 Workers

We now proceed to describe the value of being unemployed or employed under different contracts. The following equation states the value of being unemployed as the sum of the flow from home production (i.e., unemployment benefits) net of the lump-sum tax $b - \tau$ plus the discounted value of either being matched to an un-filled job, which happens with probability $\alpha^w(\theta)$, or remaining unemployed.

$$\begin{aligned} U &= b - \tau + \beta\left(1 - \alpha^w(\theta)\right) U \\ &\quad + \beta\alpha^w(\theta) \int_{z_{min}}^{z_{max}} \left[\mathbb{I}_A E_y V^P(y,z) + (1 - \mathbb{I}_A) E_y V^T(y,z) \right] dG(z), \end{aligned} \tag{1}$$

The value of being employed will depend on the type of contract agreed upon between the worker and the firm. In other words, the value of being employed under a permanent contract differs from being employed under a temporary contract. We begin by describing the evolution of V^P, the value being employed under a permanent contract, given by:

$$\begin{aligned} V^P(y,z) &= w^P(y,z) - \tau \\ &\quad + \beta\lambda^P\alpha^w(\theta) \int_{z_{min}}^{z_{max}} \left[\mathbb{I}_A E_y V^P(y,x) + (1 - \mathbb{I}_A) E_y V^T(y,x) \right] dG(x) \\ &\quad + \beta(1 - \lambda^P\alpha^w(\theta)) \int_{y_{min}}^{y_{max}} \max\left(V^P(x,z), U \right) dF(x). \end{aligned} \tag{2}$$

The flow value of being employed under a permanent contract is a wage $w^P(y,z)$ and the discounted continuation value, which has two components. The first component describes the continuation value if the on-the-job search is successful. The second component is the maximum of quitting and becoming unemployed, or remaining in the relationship, if the permanent worker does not find a job. As the match-specific shock is time-invariant, only changes in time-varying productivity drive separations and changes in the wage. However, note that the firing decision occurs before production can even take place: the realization of y that determines the wage is not the realization of y that determines whether the relationship continues or not.[8]

The worker employed under a temporary contract earns $w^T(y,z)$. At the end of the period, she searches for alternative employment. Should the temporary worker not find a job, she faces the promotion decision after her new productivity level is revealed. She becomes unemployed if her realization of y falls below a threshold to be defined later. Formally,

$$\begin{aligned} V^T(y,z) &= w^T(y,z) - \tau \\ &+\beta\lambda^T\alpha^w(\theta)\int_{z_{min}}^{z_{max}}\left[\mathbb{I}_A E_y V^P(y,x) + (1-\mathbb{I}_A) E_y V^T(y,x)\right] dG(x) \\ &+\beta\left(1-\lambda^T\alpha^w(\theta)\right)\int_{y_{min}}^{y_{max}} \max\left(V^R(x,z), U\right) dF(x). \end{aligned} \tag{3}$$

Let us define V^R, the value of working under a permanent contract for the first time; in other words, the value for a just-promoted worker. After earning a wage $w^T(y,z)$ for one period, conditional on her time-varying productivity not being too low, the temporary worker is "promoted". This promotion costs the firm c and earns the worker a larger salary $w^R(y,z)$. This salary is not at the level of $w^P(y,z)$, as the firm has to face the cost c, but it is higher than $w^T(y,z)$. The worker earns this higher salary for one period, and as long as she does not separate from the firm, she will earn $w^P(y,z)$ in subsequent periods. Consequently, the value of a just-promoted worker evolves

[8] We assume that workers who search on the job forgo the opportunity to return to their current employer if their job search is successful. By successful we mean that they find any job at all, and not necessarily a better job (a job with a higher z). While this assumption is un-realistic, due to random matching the problem becomes intractable if we assume workers can meet with a new firm, not match, and return to their current employer. The approach by Menzio and Shi (2011) seems a promising avenue to tackle this difficulty.

as,

$$
\begin{aligned}
V^{R}(y,z) \;=\;& w^{R}(y,z)-\tau \\
&+\beta\lambda^{P}\alpha^{w}(\theta)\int_{z_{min}}^{z_{max}}\left[\mathbb{I}_{A}E_{y}V^{P}(y,x)+(1-\mathbb{I}_{A})E_{y}V^{T}(y,x)\right]dG(x) \\
&+\beta(1-\lambda^{P}\alpha^{w}(\theta))\int_{y_{min}}^{y_{max}}\max\left(V^{P}(x,z),U\right)dF(x), \qquad (4)
\end{aligned}
$$

2.2 Firms

We now turn to define some recursive relationships that must hold between asset values of vacant jobs and filled jobs under different employment contracts. Let us begin by describing the law of motion for the asset value of a vacancy:

$$
\begin{aligned}
Q \;=\;& -k+\beta\alpha^{f}(\theta)\int_{z_{min}}^{z_{max}}\max\left(E_{y}J^{P}(y,z),E_{y}J^{T}(y,z)\right)dG(z) \\
&+\beta\left(1-\alpha^{f}(\theta)\right)Q, \qquad (5)
\end{aligned}
$$

This equation simply states that the value of a vacant position is the expected payoff from that vacancy net of posting costs k. Both workers and firms discount expected payoffs with a factor β. With probability $\alpha^{f}(\theta)$, the vacant position gets matched to a worker. This vacancy can be turned into either a permanent job, or a temporary job, depending on the realization of the match-specific shock z. With probability $1-\alpha^{f}(\theta)$ the vacant position meets no worker and the continuation value for the firm is having that position vacant.

Regarding capital values of filled positions, the flow profit for a firm is given by the total productivity of the worker, $y+z$, net of the wage paid. And in the case of the just-promoted worker, net also of the promotion cost c. Those capital values are given by,

$$
\begin{aligned}
J^{P}(y,z) \;=\;& y+z-w^{P}(y,z)+\beta\lambda^{P}\alpha^{w}(\theta)Q \\
&+\beta\left(1-\lambda^{P}\alpha^{w}(\theta)\right)\int_{y_{min}}^{y_{max}}\max\left(J^{P}(x,z),Q-f\right)dF(x), \qquad (6)
\end{aligned}
$$

$$J^R(y,z) = y + z - w^R(y,z) - c + \beta\lambda^P\alpha^w(\theta)Q$$
$$+\beta\left(1-\lambda^P\alpha^w(\theta)\right)\int_{y_{min}}^{y_{max}} \max\left(J^P(x,z), Q-f\right)dF(x), \qquad (7)$$

$$J^T(y,z) = y + z - w^T(y,z) + \beta\lambda^T\alpha^w(\theta)Q$$
$$+\beta\left(1-\lambda^T\alpha^w(\theta)\right)\int_{y_{min}}^{y_{max}} \max\left(J^R(x,z), Q\right)dF(x). \qquad (8)$$

3 Equilibrium

It will be convenient to re-write the value of a vacancy, using the definition of $\mathbb{I}_A$, as,

$$Q = -k + \beta\alpha^f(\theta)\int_{z_{min}}^{z_{max}} \left[\mathbb{I}_A E_y J^P(y,z) + (1-\mathbb{I}_A)E_y J^T(y,z)\right]dG(z)$$
$$+\beta\left(1-\alpha^f(\theta)\right)Q. \qquad (9)$$

So far we have been silent about wage determination. Following much of the search and matching literature we assume that upon meeting, firms and workers Nash-bargain over the total surplus of the match. Clearly, the sizes of the surpluses will vary depending on whether the worker and the firm agree on a temporary contract or a permanent contract. We assume that workers and firms compute the sizes of the different surpluses and choose the largest one as long as it is positive. Since we have three different value functions for workers and firms, we have three different surpluses depending on the choices faced by employers and workers.

Denoting by ϕ the bargaining power of workers, the corresponding total surpluses for each type of contract are given by:

$$S^P(y,z) = J^P(y,z) - (Q-f) + V^P(y,z) - U,$$
$$S^R(y,z) = J^R(y,z) - Q + V^R(y,z) - U,$$
$$S^T(y,z) = J^T(y,z) - Q + V^T(y,z) - U.$$

As a result of the bargaining assumption, surpluses satisfy the following splitting rules:

$$
\begin{aligned}
S^P(y,z) &= \frac{J^P(y,z) - Q + f}{1-\phi} = \frac{V^P(y,z) - U}{\phi}, \\
S^R(y,z) &= \frac{J^R(y,z) - Q}{1-\phi} = \frac{V^R(y,z) - U}{\phi}, \\
S^T(y,z) &= \frac{J^T(y,z) - Q}{1-\phi} = \frac{V^T(y,z) - U}{\phi}.
\end{aligned} \tag{10}
$$

Free entry of firms takes place until any rents associated with vacancy creation are exhausted, which in turn implies an equilibrium value of a vacancy Q equal to zero. Replacing Q with its equilibrium value of zero in equation (9) results in the free-entry condition:

$$
k = \beta \alpha^f(\theta) \int_{z_{min}}^{z_{max}} \left[\mathbb{I}_A E_y J^P(y,z) + (1-\mathbb{I}_A) E_y J^T(y,z) \right] dG(z)
$$

The interpretation of this equation is that firms expect a per-vacancy-return equal to the right-hand-side of the expression to justify paying k. Using the surplus sharing rule in (10) and the free-entry condition, we can derive the following relationship:

$$
\int_{z_{min}}^{z_{max}} \left[\mathbb{I}_A E_y S^P(y,z) + (1-\mathbb{I}_A) E_y S^T(y,z) \right] dG(z) = \frac{k + \beta\alpha^f(\theta)\mu_G(A) f}{(1-\phi)\beta\alpha^f(\theta)}, \tag{11}
$$

where $\mu_G(A)$ is the probability measure of A. Equation (11) states that the expected surplus, before firms and workers meet, is equal to the sum of two components. The first component, given by $\frac{k}{(1-\phi)\beta\alpha^f(\theta)}$, is the expected value of a filled job divided by $(1-\phi)$. This is another way of rewriting the surplus in a model with no firing costs and obtains in other models of search and matching in labor markets. The introduction of firing costs implies the total surplus needs to include the second component, $\frac{k+\beta\alpha^f(\theta)\mu_G(A)f}{(1-\phi)\beta\alpha^f(\theta)}$. This is the "compensation" to the firm for hiring a permanent worker, which occurs with probability $\alpha^f(\theta)\mu_G(A)$, and having to pay the firing cost f. Using this relationship together with equation (10) to substitute into equation (1), one can rewrite an expression for the value of being unemployed as,

$$
U = \frac{1}{1-\beta} \left\{ b - d - \tau + \frac{\phi\alpha^w(\theta)\left(k + \beta\alpha^f(\theta)\mu_G(A) f\right)}{(1-\phi)\alpha^f(\theta)} \right\}. \tag{12}
$$

The value of unemployment can be decomposed into two components: a flow value represented by $b - d - \tau$ and an option value represented by the large fraction on the right-hand-side. Closer inspection facilitates the interpretation of that option value. Note that the expected surplus given by equation (11) equals this option value divided by $\phi\alpha^w(\theta)$. The worker, by being unemployed and searching, has the chance of finding a job, which happens with probability $\alpha^w(\theta)$, and obtaining a share ϕ of the expected surplus of that match.

Substituting equation (12) into equations (2), (3), (4), (8), (6) and (7) and using (10), yields the following convenient form of rewriting the surpluses under different contracts.

$$
\begin{aligned}
S^P(y,z) &= y + z + \beta\left(1-\lambda^P\alpha^w(\theta)\right)\int_{y_{min}}^{y_{max}} \max\left(S^P(x,z),0\right)dF(x) \\
&\quad + \left[1-\beta\left(1-\lambda^P\alpha^w(\theta)\right)\right]f - b - \left(1-\lambda^P\right)\frac{\phi\alpha^w(\theta)\left(k+\beta\alpha^f(\theta)\mu_G(A)f\right)}{(1-\phi)\alpha^f(\theta)}, \quad (13)\\
S^R(y,z) &= y + z + \beta\left(1-\lambda^P\alpha^w(\theta)\right)\int_{y_{min}}^{y_{max}} \max\left(S^P(x,z),0\right)dF(x) \\
&\quad -c - \beta\left(1-\lambda^P\alpha^w(\theta)\right)f - b - \left(1-\lambda^P\right)\frac{\phi\alpha^w(\theta)\left(k+\beta\alpha^f(\theta)\mu_G(A)f\right)}{(1-\phi)\alpha^f(\theta)}, \quad (14)\\
S^T(y,z) &= y + z - b + \beta\left(1-\lambda^T\alpha^w(\theta)\right)\int_{y_{min}}^{y_{max}} \max\left(S^R(x,z),0\right)dF(x) \\
&\quad -b - \left(1-\lambda^T\right)\frac{\phi\alpha^w(\theta)\left(k+\beta\alpha^f(\theta)\mu_G(A)f\right)}{(1-\phi)\alpha^f(\theta)}. \quad (15)
\end{aligned}
$$

We begin by deriving the firing rules, by which we mean two threshold productivity values $y^P(z)$ and $y^R(z)$. These represent the lowest draws of time-varying productivity that imply continuing permanent ($y^P(z)$) or temporary ($y^R(z)$) relationships. Proposition 1 shows the existence of these values of y, conditional on the type of contract and the specific quality of the match, such that the relationship between a worker and a firm ends. Before stating that proposition we assume the following:

Assumption 1 *The following inequalities hold for exogenous parameters:*

$$
y_{max} + z_{min} \geq b + \left(1-\lambda^P\right)\frac{\phi}{1-\phi}\left(\theta_{max}k + \beta\alpha^w(\theta_{max})f\right) - (1-\beta)f, \quad (16)
$$

$$
\begin{array}{ccc}
b + \left(1-\lambda^P\right)\frac{\phi}{1-\phi}\theta_{min}k & & y_{min} + z_{max} \\
-\left[1-\beta\left(1-\lambda^P\alpha^w(\theta_{max})\right)\right]f & \geq & +\beta\left(1-\lambda^P\alpha^w(\theta_{min})\right)\int_{y_{min}}^{y_{max}}(1-F(x))\,dx
\end{array} \quad (17)
$$

Assumption 2 *In addition,*

$$y_{max} + z_{min} - c \geq b + \left(1 - \lambda^P\right) \frac{\phi}{1 - \phi} \left(\theta_{max} k + \beta \alpha^w \left(\theta_{max}\right) f\right) + \beta f. \tag{18}$$

Proposition 1 *Under Assumption 1, for any z, there exists an unique cut-off value $y^P(z) \in (y_{min}, y_{max})$ and such that $S^P\left(y^P(z), z\right) = 0$. If Assumption 2 also holds then the unique cut-off value $y^R(z) \in (y_{min}, y_{max})$ exists where $S^R\left(y^R(z), z\right) = 0$. The cut-off values solve the following equations:* [9]

$$\begin{aligned} y^P + z + \beta\left(1 - \lambda^P \alpha^w(\theta)\right) \int_{y^P}^{y_{max}} (1 - F(x))\, dx &= b - \left(1 - \beta\left(1 - \lambda^P \alpha^w(\theta)\right)\right) f \\ &\quad + \left(1 - \lambda^P\right) \frac{\phi\left(\theta k + \beta \alpha^w(\theta) \mu_G(A) f\right)}{(1 - \phi)}, \quad (19) \\ y^P + c + f &= y^R. \quad (20) \end{aligned}$$

Proposition 2 establishes the existence and uniqueness of a cut-off point $\bar{z}$ above which a firm and a worker begin a permanent relationship.

Proposition 2 *There exists a unique cut-off value $\bar{z} \in [z_{min}, z_{max}]$ such that when $z > \bar{z}$ the firm only offers a permanent contract, while $z < \bar{z}$, only temporary contract is offered if the following conditions hold:*

$$b + \left(1 - \lambda^T\right) \frac{\phi}{1 - \phi} \left(\theta_{max} k + \beta \alpha^w \left(\theta_{max}\right) f\right) < y^P\left(z_{min}, \theta_{min}, 0\right) + z_{min} + \frac{1}{1 - \phi} f, \tag{21}$$

and

$$b + \left(1 - \lambda^T\right) \frac{\phi}{1 - \phi} \theta_{min} k > \begin{array}{c} y^P\left(z_{max}, \theta_{max}, 1\right) + z_{max} + \frac{1}{1-\phi} f \\ +\beta\left(1 - \lambda^T \alpha^w\left(\theta_{min}\right)\right) \int_{y_{min}}^{y_{max}} \left[1 - F(x)\right] dx \end{array}. \tag{22}$$

where y^P is defined in (19).

To obtain expressions for wages paid under different contracts we can substitute the value functions of workers and firms into the surplus sharing rule (10), which gives:

[9]Proofs for all propositions stated in the main body of the paper are relegated to an Appendix.

$$
\begin{aligned}
w^{P}(y,z) &= \phi(y+z)+(1-\phi)b+\phi\left(1-\beta\left(1-\lambda^{P}\alpha^{w}(\theta)\right)\right)f \\
&\quad +\phi\left(1-\lambda^{P}\right)\left(\theta k+\beta\alpha^{w}(\theta)\mu_{G}(A)f\right), \qquad (23)\\
w^{R}(y,z) &= w^{P}(y,z)-\phi(c+f), \qquad (24)\\
w^{T}(y,z) &= \phi(y+z)+(1-\phi)b+\phi\left(1-\lambda^{T}\right)\left(\theta k+\beta\alpha^{w}(\theta)\mu_{G}(A)f\right). \qquad (25)
\end{aligned}
$$

Finally, we need to explicitly state how the stock of employment evolves over time. Let u_t denote the measure of unemployment, and n_t^P and n_t^T be the measure of permanent workers and temporary workers. Let's begin by deriving the law of motion of the stock of permanent workers, which is given by the sum of three groups of workers. First, workers can search and match with other firms and become permanent workers. This happens with probability $\alpha^w(\theta_t)\mu_G(A)$. Second, after the realization of the aggregate shock, the permanent worker remains at the current job. The aggregate quantity of this case is

$$
\int_{z_{min}}^{z_{max}} \mu_F\left(\left[y^P(z), y_{max}\right]\right) dG(z)\, n_t^P \left(1-\lambda^P\alpha^w(\theta)\right). \qquad (26)
$$

Third, some of temporary workers who cannot find other jobs get promoted to permanent workers which adds to the aggregate employment pool for permanent workers by

$$
\left(1-\lambda^T\alpha^w(\theta_t)\right)\frac{1}{G(\bar{z})}\int_{z_{min}}^{\bar{z}} \mu_F\left(\left[y^R(z), y_{max}\right]\right) dG(z)\, n_t^T
$$

Notice that $\mu_G(A) = 1 - G(\bar{z})$ and $\mu_F([y, y_{max}]) = 1 - F(y)$. The law of motion for permanent workers becomes:

$$
\begin{aligned}
n_{t+1}^P &= \left(u_t+\lambda^T n_t^T+\lambda^P n_t^P\right)\alpha^w(\theta_t)(1-G(\bar{z})) \\
&\quad +\int_{z_{min}}^{z_{max}}\left[1-F\left(y^P(z)\right)\right]dG(z)\, n_t^P \\
&\quad +(1-\alpha^w(\theta_t))\frac{1}{G(\bar{z})}\int_{z_{min}}^{\bar{z}}\left[1-F\left(y^R(z)\right)\right]dG(z)\, n_t^T. \qquad (27)
\end{aligned}
$$

Workers who are unable to find high-quality matches, join the temporary worker pool the following period. Therefore the temporary workers evolve according to:

$$
n_{t+1}^T = \left(u_t+\lambda^T n_t^T+\lambda^P n_t^P\right)\alpha^w(\theta_t)\, G(\bar{z}). \qquad (28)
$$

Since the aggregate population is normalized to unity, the mass of unemployed workers is given by:

$$u_t = 1 - n_t^T - n_t^P.$$

The standard definition of market tightness is slightly modified to account for the on-the-job search activity of temporary workers:

$$\theta_t = \frac{v_t}{u_t + n_t^T}.$$

4 Data

To quantitatively explore the model, we use the Workplace and Employee Survey, a Canadian matched employer-employee dataset collected by Statistics Canada.[10] It is an annual, longitudinal survey at the establishment level, targeting establishments in Canada that have paid employees in March, with the exceptions of those operating in the crop and animal production; fishing, hunting and trapping; households', religious organizations, and the government sectors. In 1999, it consisted of a sample of 6,322 establishments drawn from the Business Register maintained by Statistics Canada and the sample has been followed ever since. Every odd year the sample has been augmented with newborn establishments that have become part of the Business Register. The data are rich enough to allow us to distinguish employees by the type of contract they hold. However, only a sample of employees is surveyed from each establishment. [11] The average number of employees in the sample is roughly 20,000 each year. Workers are followed for two years and provide responses on hours worked, earnings, job history, education, and demographic information. Firms provide information about hiring conditions of different workers, payroll and other compensation, vacancies, and separation of workers.

Given the theory laid out above, it is important that the definition of temporary worker in the data matches as close as possible the concept of a temporary worker in the model. In principle, it is unclear that all establishments share the idea of what a temporary worker is when they respond to the survey: it could be a seasonal worker, a fixed-term consultant hired for a project or a worker working under a contract with a set termination date. As a result, Statistics Canada implemented some methodological changes to be consistent in its definition of a temporary worker. This affected the incidence of temporary employment in the survey forcing us to use data only

[10]The Appendix presents a brief summary of the structure of labor market institutions in Canada.

[11]All establishments with less than four employees are surveyed. In larger establishments, a sample of workers is surveyed, with a maximum of 24 employees per given establishment.

Table 1: Worker's Compensation by Type of Contract

	Mean	Standard Deviation
Permanent		
Real Earnings	$21,847	$33,525
Real Hourly Wage (No Extra)	$21.43	$11.75
Real Hourly Wage	$22.57	$14.40
Temporary		
Real Earnings	$9,737	$26,469
Real Hourly Wage (No Extra)	$18.87	$15.22
Real Hourly Wage	$19.54	$18.85

from 2001 onwards. The definition of temporary workers we use, it is of those receiving a T-4 slip from an employer but who have a set termination date.[12] For instance, workers from temporary employment agents or other independent contractors are not included in our definition. With the use of this definition the fraction of temporary workers among all workers is 14%.

Table 1 displays some descriptive statistics on workers' compensation by type of contract held. All quantities are in Canadian dollars and we use three different measures of compensation: total earnings reported by the employee, hourly wages with reported extra-earnings, and hourly wages without the reported extra earnings. According to the three measures, permanent workers earn more but they do work more as well. As a result, while total earnings of permanent workers are roughly double of those earned by temporary workers, when converted to hourly measures, that ratio drops to 1.14-1.15. The cross-sectional distribution of wages per hour has a larger variance in the case of temporary workers than of permanent workers. The standard deviation of permanent workers' hourly wages is about half of mean hourly wages. This ratio rises to 81% for temporary workers.

[12] A T-4 slip is a document showing a worker's pay and the amount withheld in income taxes. It is equivalent to a W-2 in the United States.

In Canada, job turnover is higher for temporary workers than for permanent workers, as extensively documented by Cao and Leung (2010). We reproduce some of their turnover statistics in Table 2. As it is typical, we measure turnover by comparing job creation and job destruction rates. If we denote by $EMP_{t,i}$ the total level of employment at time t at establishment i, the creation and destruction rates between periods t and $t+1$ are calculated as:

$$Creation = \sum_i \frac{Emp_{t+1,i} - Emp_{t,i}}{0.5(Emp_{t+1} + Emp_t)} \tag{29}$$

if $Emp_{t+1,i} - Emp_{t,i} > 0$ and 0 otherwise. And,

$$Destruction = \sum_i \frac{|Emp_{t+1,i} - Emp_{t,i}|}{0.5(Emp_{t+1} + Emp_t)} \tag{30}$$

if $Emp_{t+1,i} - Emp_{t,i} < 0$ and 0 otherwise.

Given the emphasis of our work on a labor market segmented by temporary and permanent workers, we use the previous expressions to provide measures of job destruction and creation by the type of contract held. However, we measure creation and destruction of temporary (or permanent) workers relative to the average *total* employment level. In other words, we measure the change in the stock of workers by contract type relative to the stock of total employment. These rates are given on the first two lines of Table 2. The job destruction rates are 6.4% for permanent workers and 6.2% for temporary workers. The creation rates are 8.1% and 5.3%. As the fraction of temporary workers is only 14% of the workforce, these rates point to a much higher degree of turnover for temporary workers.

Notice that the sum of the destruction rates for temporary and permanent workers is not equal to the destruction rate for all workers. The same can be said for the creation rate. The reason is that establishments can change the number of temporary and permanent workers without altering the stock of all workers. If we restrict the sample to those establishments that increase or decrease the stock of both permanent and temporary workers, the rates for all workers are the sum of the rates of the two types of workers. These measures are reported in Table 2 under the "Alternative Definition" label. Turnover decreases under this alternative definition, with creation and destruction rates for all workers that are 2% lower than using the conventional definition. The total job creation rate is 8.2% and the job destruction rate is 7.1%.

Table 2: Job Creation and Job Destruction (%)

Conventional Definition			
	All Workers	Permanent	Temporary
Job Creation	10.2	8.1	5.3
Job Destruction	9.2	6.4	6.2
Alternative Definition			
	All Workers	Permanent	Temporary
Job Creation	8.2	5.1	3.1
Job Destruction	7.1	4.1	3.0

5 Model Estimation

Our goal is to use the theory to understand the relationship between inequality and employment contracts. More specifically, we want to assess how changes in firing policies affect inequality in wages. To this end, the theory needs a careful parameterization. This section describes the mapping between theory and data, goes over some technicalities of this mapping, and shows its results. Obtaining a solution for the model requires specifying parametric distributions for $G(z)$ and $F(y)$.[13] We assume that y is drawn from a normal distribution and z from a uniform distribution. In the model the overall scale of the economy is indeterminate and shifts in the mean of y plus z have no impact. Consequently, we normalize the mean of y plus z to one, reducing the dimension of the parameter vector to estimate. Denote by B the level of matches given vacancies v and searching workers $N^S = \lambda^P n^P + \lambda^T n^T + u$. Recall that the matching function is of the form

$$B(v, N^S) = \xi v^{1-\phi} \left(N^S\right)^{\phi} .$$

This choice of technology for the matching process implies the following job-finding and job-filling rates, where, again we define $\theta = v/N^S$:

$$\alpha^w(\theta) = \xi \theta^{1-\phi},$$

[13]The reader can details about our solution and estimation algorithms in the Appendix.

and

$$\alpha^f(\theta) = \xi\theta^{-\phi}.$$

Having specified parametric forms for G, F, and the matching technology we are now ready to describe our procedure in detail. Let $\gamma = (f, \phi, \xi, k, \mu_y, \sigma_z, \sigma_y, \lambda^P, \lambda^T)$ be the vector of structural parameters we need to estimate where μ_x and σ_x denote the mean and the standard deviation for a random variable x.[14] The literature estimating search models is large. Much of this literature has followed full-information estimation methodologies, maximizing a likelihood function of histories of workers.[15] These workers face exogenous arrival rates of job offers (both on and off-the-job) and choose to accept or reject such offers. Parameters maximize the likelihood of observing workers' histories conditional on the model's decision rules. In this paper, we depart from this literature by choosing a partial information approach to estimating our model. Our reason is twofold. First, our search model is an equilibrium one; the arrival rates of job offers are the result of aggregate behavior from the part of consumers and firms. Second, the lack of a panel dimension of the WES does not allow us to perform a maximum likelihood estimation. For these reasons, we take a partial-information route and estimate the model by combining indirect inference and simulated method of moments.

The first step involves choosing a set of empirical moments; set of dimension at least as large as the parameter vector of interest. We estimate the parameters by minimizing a quadratic function of the deviations of those empirical moments from their model-simulated counterparts. Formally,

$$\hat{\gamma} = \arg\min_{\gamma} M(\gamma, \mathbf{Y}_T)' W(\gamma, \mathbf{Y}_T) M(\gamma, \mathbf{Y}_T) \tag{31}$$

where $\hat{\gamma}$ denotes the point estimate for γ, W is a weighting matrix, and M is a column vector whose k-th element denotes a deviation of an empirical moment and a model-simulated moment. The vector $\mathbf{Y}_T$ describes time series data - of length T - from which we compute the empirical moments. The above expression should be familiar to readers, as it is a standard statistical criterion function in the method-of-moments or GMM literatures. Traditional estimation techniques rely on minimizing the criterion function (31) and using the Hessian matrix evaluated at the min-

[14] Parameters c, β, and μ_z, should in principle be included in the vector γ. We fix β to be 0.96 and c to be 1% of the firing cost f. The standard deviation of z is given by the normalization that $E(y) + E(z) = 1$. Finally, we set b to be 55% of the average permanent worker salary, a number consistent with the average replacement rate in Canada.

[15] The list is far from being exhaustive but it includes Cahuc, Postel-Vinay, and Robin (2006), Flinn and Mabli (2008), Bontemps, Robin, and Berg (1999), Eckstein and Wolpin (1990). The reader is referred to Eckstein and van den Berg (2007) for a survey of the literature that includes many more examples.

imized value to compute standard errors. In many instances equation (31) is non-smooth, locally flat, and have several local minima. For these reasons, we use the quasi-Bayesian Laplace Type Estimator (LTE) proposed by Chernozhukov and Hong (2003). They show that under some technical assumptions, a transformation of (31) is a proper density function (in their language, a *quasi-posterior* density function) As a result, they show how moments of interest can be computed using Markov Chain Monte Carlo (MCMC) techniques by sampling from that quasi-posterior density. We describe our estimation technique in more detail in the technical appendix, but MCMC essentially amounts to constructing a Markov chain that converges to the density function implied by a transformation of (31). Draws from that Markov Chain are draws from the quasi-posterior, and as a result, moments of the parameter vector such as means, standard deviations, or other quantities of interest are readily available. An important aspect of the estimation procedure is the choice of the weighting matrix W. We post-pone a description of how we weight the different moments and we now turn to describe the moments themselves.

Indirect inference involves positing an auxiliary - reduced-form - model which links actual data and model-simulated data. Given our focus on wage inequality, the auxiliary model we choose is a wage regression that links wages, productivity, and the type of contract held. Before being more specific about this regression let us first discuss an identification assumption needed to estimate it. An important element in our model's solution are wages by type of contract which are given by equations (23)-(25). Irrespective of the type of contract wages are always a function of a worker's productivity $y + z$. In the data, such productivity is unobserved; one observes an establishment's total productivity or the productivity for the entire sample. To overcome this difficulty we assume that the time-varying component of productivity y is firm or establishment-specific. Consequently, differences among workers' wages within a firm will be the result of working under a different contract or of having a different match-specific quality. We then posit that the (log) wage of worker i of firm j at time t is given by:

$$log(w_{ijt}) = \beta + \beta_{ALP} log(ALP_{jt}) + \beta_{Type}\chi_{ijt} + \epsilon_{ijt} \tag{32}$$

where ALP_{jt} is an establishment's average labor productivity - output divided by total hours - and χ_{ijt} is an indicator variable describing a worker's temporary status. This is the equation we estimate from the data.[16] A panel of values for ALP_{jt} is easy to obtain, as we have observations on the number of workers and the amount of output per establishment. Note that variations over time in ALP_{jt} arise from changes in the time-varying productivity shock but also from the

[16]We take logarithms for wages and ALP_{jt} as our model is stationary and displays no productivity growth.

matches and separations that occur within an establishment over time. If as a result of turnover within a establishment, the mix of workers changes- there are more temporary workers in some year, for instance- the average worker productivity will change, even without a change in y_{jt}. Let us now describe what the analogous equation to (32) is when we estimate our model-simulated data. Our theory is silent about firms or establishments; there are only matches of which one can reasonably speak. Note, however, that ALP_{jt} is the sum of the time-varying component y_{jt} plus an expectation of the match-specific productivity z at time t - assuming a large number of workers per establishment. Hence, we simulate a large number of values of y, z, and wages by contract type and regress wages on a constant, the sum of y and the mean simulated z and the contract type.[17] Disturbances in this regression will be interpreted as deviations of the match-specific quality for a given match relative to its mean match-specific value (plus some small degree of simulation error).

Our sample of the WES data-set covers the years 2001 to 2006. We estimate equation (32) for each year which yields a series of estimates $(\beta, \beta_{ALP}, \beta_{Type}, \sigma_{\epsilon})$. Returning to our criterion function (31), the first two moments we choose to match are the time-series averages of the coefficients β_{ALP} and β_{Type}. Table 3 summarizes the vector of all moments (a total of 10), which also includes the fraction of temporary workers $(\frac{n^T}{1-u})$, the job-finding probability (α^w), the ratio of wages of permanent workers to those of temporary workers $(\frac{w^P}{w^T})$, the unemployment rate (u), and the average of the fraction of the firing costs relative to the wage of a permanent worker $(\frac{f}{w^P})$.[18] To identify λ^P and λ^T we add two moments. The job-to-job transition rates for permanent (EE^P) and temporary (EE^T) workers. These two moments are calculated from the Survey of Labour and Income Dynamics (SLID). Finally, we include a measure labeled "Turnover", which is the average of the job destruction and job creation rates for permanent workers. The reason to choose that measure is two-fold. First, we assume stationarity in our model. As a result, destruction rates must equal creation rates (for all types of workers). Hence we can't use job destruction and job creation rates separately. Second, we also assume that a temporary worker must be promoted or fired after one period. Under this assumption it is easy to show that the job creation (and hence the job destruction, by stationarity) rates for temporary workers equals the fraction of temporary workers in the economy.

The deviations of the empirical averages from their model counterparts comprise the vector M. Following much of the GMM literature, we weight elements of M according to the inverse

[17]We take the log of wages in the data but keep the model-analog regression in terms of wages because, as we normalize the mean of $y + z$ to be only 1, in principle wages can be negative.

[18]We thank M. Zhang for sharing her data on the Canadian job-finding rate used in Zhang (2008).

Table 3: Statistical Properties: Empirical Moments (2001-2006)

Series	Mean	Standard Deviation
$n^T/(1-u)$	0.140	0.040
α^w	0.919	0.004
f/w^P	0.182	0.002
w^P/w^T	1.140	0.034
u	0.071	0.004
βAPL	0.159	0.013
β_{Type}	0.193	0.019
EE^P	0.097	0.030
EE^T	0.256	0.078
$Turnover$	0.073	0.016

of the covariance matrix of the deviations of the time series shown in Table 3 from their model equivalents.

6 Results

Table 4 shows the estimated parameter values along with their standard errors. The point estimates are the quasi-posterior means and the standard errors are the quasi-posterior standard deviations.[19] We estimate a bargaining power of workers ϕ equal to 0.617. This value is about the same magnitude as those that are calibrated, but larger than previously estimated values such as Cahuc *et al.*'s (2006), which is very close to zero. The estimation yields distributions for y and z whose means are far apart. Recall that $E(y) + E(z) = 1$ but $E(y)$ is larger than 2.

These estimated parameters imply moments that we report on the first column of Table 5.[20] The second column of the table reports the equivalent empirical moments. The fit is satisfactory and most moments are close to the empirical counterparts. The exceptions are *Turnover* and both job-to-job transitions rates (EE^T and EE^P). These are all larger than in the data but the model matches well the unemployment rate and the fraction of temporary workers. The latter,

[19]These results are based on 3,000 draws of the Markov chain.

[20]We performed an alternative estimation restricting our data to firms that were in the sample for the entire time (in other words, a balanced panel of firms). Parameters estimated with this alternative dataset were similar to estimates shown here. These alternative results are available upon request.

Table 4: Posterior Moments

	Mean	Std. Dev
f	0.178	0.002
k	0.033	0.003
b	0.537	0.005
ϕ	0.617	0.010
ξ	1.259	0.006
σ_z	0.063	0.010
μ_y	3.318	0.007
σ_y	0.750	0.020
λ^P	0.084	0.021
λ^T	0.616	0.010

as pointed out above, is equal to the creation rate of temporary jobs.

6.1 Firing Costs and Wage Inequality

We perform the experiment of increasing firing costs by 50% from the estimated value of $f = 0.178$, which results in a value of f equal to 0.267. Table 6 reports the result of this experiment. The first and the last column of that table show the same numbers as Table 5. The middle column shows resulting moments after increasing by 50% the level of firing costs. Increasing f decreases the unemployment rate to about half, increasing the fraction of temporary workers, and decreasing turnover of permanent jobs. Permanent jobs are less attractive and the workforce becomes increasingly employed under fixed-term contracts. The job-to-job transition rates for the two types of workers do not change, because the vacancy-to-searchers ratio (θ) does not change. Consequently, the job-finding probability remains the same.

Increasing the level of f has no discernible effect on the wage premium permanent workers earn. The rise in f, which increases that wage premium, is offset by other factors, such as the drop in the measure of the the set A, which decreases the premium. On net, the ratio of permanent to temporary wages barely increases.

What are the implications of these changes for the shape of the wage distribution? Figure 1 shows the wage distribution for the three cases discussed. The blue (solid) line represents the density function of wages (using standard kernel-smoothing methods) when the parameters are set to their quasi-posterior means. If we increase the level of firing costs by 50%, the result is the

Table 5: Moments: Model vs. Data

	Model	Data
$n^T/(1-u)$	0.123	0.140
α^w	0.918	0.919
f/w^P	0.182	0.182
w^P/w^T	1.108	1.140
u	0.073	0.071
βAPL	0.145	0.159
β_{Type}	0.189	0.193
EE^P	0.077	0.097
EE^T	0.566	0.256
$Turnover$	0.122	0.061

Table 6: Effects of an Increase in Firing Costs (f)

	f=0.178	f=1.5*0.178	Data
$\frac{n^T}{n^T+n^P}$	0.123	0.154	0.140
$\alpha(\theta)$	0.918	0.916	0.919
$\frac{f}{w}$	0.182	0.272	0.182
β_{APL}	0.145	0.144	0.159
β_{Type}	0.189	0.140	0.193
u	0.073	0.059	0.071
$\frac{w^P}{w^T}$	1.108	1.113	1.140
EE^P	0.077	0.076	0.097
EE^T	0.566	0.564	0.256
$Turnover$	0.122	0.105	0.061

red (dashed-dotted) line: lower mean wages, because of the larger fraction of temporary workers, and considerably larger inequality. Inequality measured using the standard deviation rises by 15% and the mean of wages falls by roughly 8%.

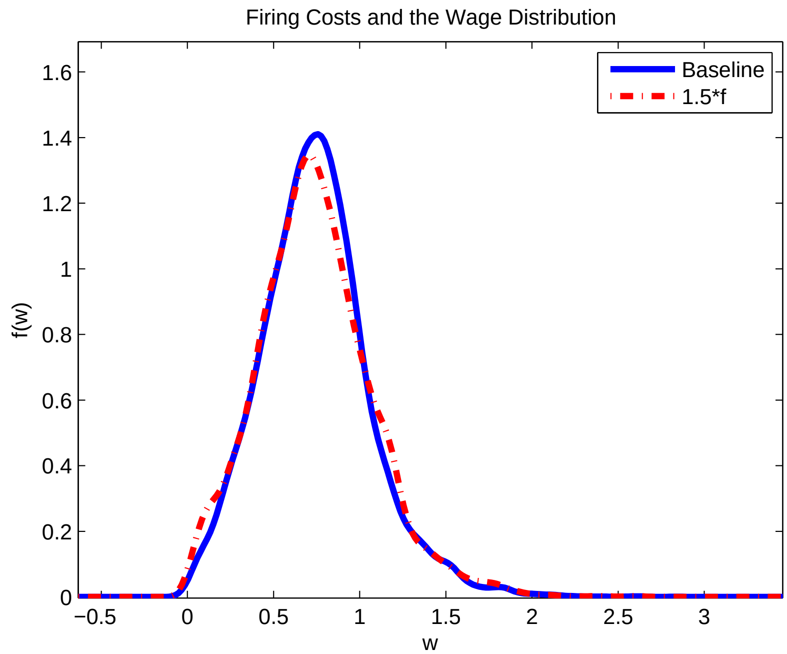

Figure 1: Wage distributions for different levels of firing costs.

6.2 The Welfare Implications of Temporary Contracts

We now provide some calculations of the changes in welfare that result from the introduction of temporary contracts in economies where existing workers are protected by firing costs. We do so by performing the following computational experiment. Given the estimated parameters above (the baseline case), we force $\bar{z}$ to drop to a level in which the fraction of temporary workers is zero. The goal is to compare welfare changes from the baseline economy to this second economy in which the fraction of temporary workers is zero. As a measure of welfare we compute,

$$\mathcal{W} = \frac{1}{1-\beta}\left\{n^T E\left\{(y+z)|z \leqq \bar{z}\right\} + n^P E(y+z) - kv - n^P f \int_{z_{min}}^{z_{max}} F(y^P(z))dG(z)\right\}. \tag{33}$$

Note that in this expression we have equated the aggregate unemployment benefits payment bu to taxes levied τ. Hence, the welfare of unemployed agents does not appear explicitly but it is

Table 7: Temporary Contracts: Welfare Evaluation

Model	u	θ	$\mathcal{W}$
Baseline	0.073	5.64	24.66
No Temp.	0.089	3.52	22.16

taken into account. As the first row, third column, of Table 7 shows, the welfare of the baseline economy of the baseline economy is 24.66. This economy features an unemployment rate of 7.3% and an equilibrium value of θ of 5.64. Without temporary contracts the welfare drops to a value of 22.16, as the second row of the table indicates.[21] This decrease of about 10% results from the higher unemployment rate (8.9% vs.7.3%), which in turn results from the much lower level of vacancies posted by firms. This can be seen from the large drop in θ (from 5.64 to 3.52).

7 Concluding Remarks

This study provides a theory of the co-existence of labor contracts with different firing conditions. Consistent with empirical evidence that points to employers choosing among contracts with different degrees of labor protection, firms here choose to offer *ex-ante* identical workers different contracts, and as a result, different wages. The reason is match-quality that varies across worker-firm pairs and that is revealed at the moment firms and workers meet. Firms offer permanent contracts to "good" matches, as they risk losing the worker should they offer them a temporary contract. This risk results from the different on-the-job search behavior by the two types of workers: in equilibrium temporary workers search while permanent workers do not. Not-so-good matches are given a temporary contract under which they work for a lower wage. After one period, temporary workers have to be dismissed or promoted to permanent status.

The existence of search and matching frictions implies that workers might work temporarily in jobs with an inferior match quality, before transferring to better, and more stable, matches. Our assumption of including a time-varying component in the total productivity of a worker allows our environment to generate endogenous destruction rates that differ by type of contract. Our environment is simple enough to deliver several analytical results regarding cut-off rules for the type of relationship firms and workers begin and when and how they separate. Despite its simplicity, the environment is rich in its implications.

[21] It is important to emphasize that we do not change any of the elements of the vector γ to achieve $\bar{z} = z_{min}$.

One of these implications is that we can examine wage inequality from a different perspective. To what extent do firing costs help shape the wage distribution? We find that a substantial increase in inequality follows an increase in the level of firing costs. This rise in inequality is due entirely to the increase in the fraction of temporary workers, which earn relatively lower wages. It is not due to an increase in the "permanent worker premium", the ratio of the wage a permanent worker earns relative to that a temporary worker.

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A Appendix: Proof of Propositions

Proof of Proposition 1. Equation (13) can be written as

$$\begin{aligned} S^P(y,z) &= y+z-b+\beta\left(1-\lambda^P\alpha^w(\theta)\right)\int_{y^P}^{y_{max}} S^P(x,z)\,dF(x) \\ &\quad +\left[1-\beta\left(1-\lambda^P\alpha^w(\theta)\right)\right]f-\left(1-\lambda^P\right)\frac{\phi\alpha^w(\theta)\left(k+\beta\alpha^f(\theta)\mu_G(A)f\right)}{(1-\phi)\alpha^f(\theta)}. \end{aligned} \tag{34}$$

From the fact that $\partial S^P/\partial y = 1$ and $\partial^2 S^P/\partial y\partial z = 0$, it implies that $S^P(y,z) = y+\varphi(z)$. The integral on the right-hand side of (34) is then

$$\begin{aligned} \int_{y^P}^{y_{max}} S^P(x,z)\,dF(x) &= \int_{y^P}^{y_{max}} x+\varphi(z)\,dF(x), \\ &= (x+\varphi(z))F(x)\,|_{y^P}^{y_{max}} - \int_{y^P}^{y_{max}} F(x)\,dx. \end{aligned}$$

For any $z\in Z$, $S^P\left(y^P,z\right) = 0$ implies $y^P = -\varphi(z)$. Substitute $\varphi(z)$ with $-y^P$, the expression of the integral is

$$\int_{y^P}^{y_{max}} S^P(x,z)\,dF(x) = \int_{y^P}^{y_{max}} [1-F(x)]\,dx. \tag{35}$$

To pin down y^P, we need to solve the equation $S^P(y^p,z)=0$, thus

$$\begin{aligned} & y^P+z+\beta\left(1-\lambda^P\alpha^w(\theta)\right)\int_{y^P}^{y_{max}}[1-F(x)]\,dx \\ &= b-\left[1-\beta\left(1-\lambda^P\alpha^w(\theta)\right)\right]f \\ &+\left(1-\lambda^P\right)\frac{\phi}{1-\phi}\left(\theta k+\beta\alpha^w(\theta)\mu_G(A)f\right) \end{aligned} \tag{36}$$

Denote left-hand side by $\Phi(y|z,\theta)$ and right-hand side by $\Phi(\theta)$. Notice that $\Phi(\theta)$ is increasing in θ plus $\mu_G(A)\in[0,1]$, thus for any $\theta\in[\theta_{min},\theta_{max}]$,

$$\begin{aligned} & b+\frac{\phi}{1-\phi}\theta_{min}k-\left[1-\beta\left(1-\lambda^P\alpha^w(\theta_{max})\right)\right]f < \Phi(\theta) \\ & < b+\frac{\phi}{1-\phi}\left(\theta_{max}k+\beta\alpha^w(\theta_{max})f\right)-(1-\beta)f. \end{aligned}$$

$\Phi(y|z,\theta)$ is increasing in y and z, and decreasing in θ. If inequalities (16) and (17) holds then for given θ and z, we must have

$$\Phi(y_{min}|z,\theta) \le \Phi(y_{min}|z_{max},\theta_{min}) < \Phi(\theta) < \Phi(y_{max}|z_{min},\theta_{max}) \le \Phi(y_{max}|z,\theta) .$$

We can conclude there is a unique solution $y^P(z) \in (y_{min}, y_{max})$ for equation (36) by the intermediate value theorem. That is, $y^P(z)$ exists for any $z \in [z_{min}, z_{max}]$.

Similarly, equation (14) can be rewritten as

$$\begin{aligned} S^R(y,z) &= y + z + \beta\left(1-\lambda^P\alpha^w(\theta)\right)\int_{y^P}^{y_{max}}[1-F(x)]\,dx - c - b \\ &\quad -\beta\left(1-\lambda^P\alpha^w(\theta)\right)f - \left(1-\lambda^P\right)\frac{\phi\alpha^w(\theta)\left(k+\beta\alpha^f(\theta)\mu_G(A)f\right)}{(1-\phi)\alpha^f(\theta)}. \end{aligned} \tag{37}$$

Following the same argument for the condition $S^P\left(y^P,z\right) = 0$, the above equation yields the cut-off value by solving:

$$\begin{aligned} & y^R + z + \beta\left(1-\lambda^P\alpha^w(\theta)\right)\int_{y^P}^{y_{max}}[1-F(x)]\,dx \\ &= b + c + \beta\left(1-\lambda^P\alpha^w(\theta)\right)f \\ &+ \left(1-\lambda^P\right)\frac{\phi\alpha^w(\theta)\left(k+\beta\alpha^f(\theta)\mu_G(A)f\right)}{(1-\phi)\alpha^f(\theta)}. \end{aligned} \tag{38}$$

Comparing equations (36) and (38), we get

$$y^R = y^P + c + f.$$

Then assumption 2 guarantees the existence of $y^P \in (y_{min}, y_{max} - c - f)$ which implies $y^R < y_{max}$ exists as well. ■

Proof of Proposition 2. Step 1. $E_y J^P(y,z)$ and $E_y J^T(y,z)$ are both strictly increasing in z. From the surplus sharing rule, it is sufficient to show that $S^P(y,z)$ and $S^T(y,z)$ are strictly increasing in z. Substitute equation (35) into (34), we obtain

$$S^P(y,z) = y + z - b + \beta\left(1-\lambda^P\alpha^w\right)\int_{y^P(z)}^{y_{max}}[1-F(x)]\,dx + \left[1-\beta\left(1-\lambda^P\alpha^w\right)\right]f - \left(1-\lambda^P\right)\frac{\phi\alpha^w(\theta)\left(k+\beta\alpha^f(\theta)\mu_G(A)f\right)}{(1-\phi)\alpha^f(\theta)}. \tag{39}$$

Take the derivative of S^P with respect to z, we get

$$\frac{\partial S^P(y,z)}{\partial z} = 1-\beta\left(1-\lambda^P\alpha^w\right)\left(1-F\left(y^P(z)\right)\right)y^{P\prime}(z). \tag{40}$$

From equation (36), the implicit function theorem implies that

$$y^{P\prime}(z) = -\frac{1}{1-\beta\left(1-\lambda^P\alpha^w\right)\left(1-F\left(y^P\right)\right)} < 0. \tag{41}$$

Plug (41) into (40), we get $\partial S^P/\partial z > 0$. Similarly, the total surplus of a temporary contract can be rewritten as

$$S^T(y,z) = y + z - b + \beta\left(1-\lambda^T\alpha^w\right)\int_{y^P(z)+c+f}^{y_{max}}[1-F(x)]\,dx \tag{42}$$

$$-\left(1-\lambda^T\right)\frac{\phi\alpha^w(\theta)\left(k+\beta\alpha^f(\theta)\mu_G(A)f\right)}{(1-\phi)\alpha^f(\theta)}. \tag{43}$$

The derivative of S^T with respect to z is given by

$$\frac{\partial S^T(y,z)}{\partial z} = 1-\beta\left(1-\lambda^T\alpha^w\right)\left(1-F\left(y^P(z)\right)\right)y^{P\prime}(z) > 0. \tag{44}$$

Step 2. The difference $E_yJ^P(y,z) - E_yJ^T(y,z)$ is strictly increasing in z. Given the surplus splitting rule (10), it is sufficient to show that $E_y\left(S^P(y,z) - S^T(y,z)\right)$ is increasing in z. From (40) and (44), we have

$$E_y\left[\frac{\partial S^P(y,z)}{\partial z} - \frac{\partial S^T(y,z)}{\partial z}\right] = -\beta\left(\lambda^T-\lambda^P\right)\alpha^w\left(1-F\left(y^P(z)\right)\right)y^{P\prime}(z) > 0,$$

since by assumption $\lambda^T > \lambda^P$.

These two steps guarantee that if $E_yJ^P(y,z) = E_yJ^T(y,z)$ holds, the cut-off value z is unique.

The last step is to verify the single crossing property. That is, if

$$\begin{aligned} E_y J^P(y, z_{min}) &< E_y J^T(y, z_{min}), \\ E_y J^P(y, z_{max}) &> E_y J^T(y, z_{max}) \end{aligned}$$

hold, then the cut-off value $\bar{z}$ exists. Denote

$$\begin{aligned} \Delta_\theta(z) &= \frac{E_y J^P(y,z) - E_y J^T(y,z)}{1-\phi} \\ &= \beta\left(1-\lambda^P \alpha^w(\theta)\right)\int_{y^P}^{y_{max}}[1-F(x)]\,dx - \beta\left(1-\lambda^T\alpha^w(\theta)\right)\int_{y^R}^{y_{max}}[1-F(x)]\,dx \\ &\quad -\left[\frac{1}{1-\phi} - 1 + \beta\left(1-\lambda^P\alpha^w(\theta)\right)\right] f - \frac{\phi\left(\lambda^T-\lambda^P\right)}{(1-\phi)}\left(\theta k + \beta\alpha^w(\theta)\mu_G(A) f\right). \\ &= b - \frac{1}{1-\phi} f - y^P - z - \beta\left(1-\lambda^T\alpha^w(\theta)\right)\int_{y^R(z)}^{y_{max}}[1-F(x)]\,dx \\ &\quad + \left(1-\lambda^T\right)\frac{\phi}{1-\phi}\left(\theta k + \beta\alpha^w(\theta)\mu_G(A) f\right). \end{aligned}$$

The last equality is derived by replacing $\beta\int_{y^P}^{y_{max}}[1-F(x)]\,dx$ with equation (36). Notice that equation (36) defines an implicit function $y^P(z,\theta,\mu_G)$. Totally differentiating (36) yields

$$\begin{aligned} \frac{\partial y^P}{\partial\theta} &= \frac{\phi\left(k + \beta\mu_G f \alpha^{w\prime}(\theta)\right)}{(1-\phi)\left[1-\beta\left(1-\lambda^P\alpha^w(\theta)\right)\left(1-F\left(y^P\right)\right)\right]} > 0, \\ \frac{\partial y^P}{\partial\mu_G} &= \frac{\phi\beta f\alpha^w(\theta)}{(1-\phi)\left[1-\beta\left(1-\lambda^P\alpha^w(\theta)\right)\left(1-F\left(y^P\right)\right)\right]} > 0, \\ \frac{\partial y^P}{\partial d} &= \frac{-1}{\left[1-\beta\left(1-\lambda^P\alpha^w(\theta)\right)\left(1-F\left(y^P\right)\right)\right]} < 0. \end{aligned}$$

Then

$$\Delta_\theta(z_{min}) \le b - \frac{1}{1-\phi} f - y^P(z_{min},\theta_{min},0) - z_{min} + \left(1-\lambda^T\right)\frac{\phi}{1-\phi}\left(\theta_{max}k + \beta\alpha^w(\theta_{max}) f\right), \quad (45)$$

and

$$\begin{aligned} \Delta_\theta(z_{max}) \ \ge\ & b - \frac{1}{1-\phi} f - y^P(z_{max},\theta_{max},1) - z_{max} + \left(1-\lambda^T\right)\frac{\phi}{1-\phi}\theta_{min}k \qquad (46) \\ & -\beta\left(1-\lambda^T\alpha^w(\theta_{min})\right)\int_{y_{min}}^{y_{max}}[1-F(x)]\,dx. \end{aligned}$$

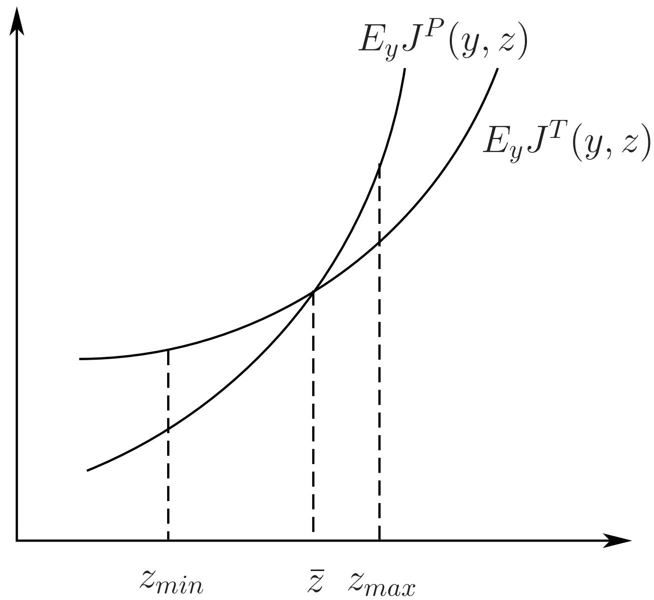

Figure 2: Permanent Contract vs. Temporary Contract

Therefore, if the right hand side of (45) is less than 0 and the right hand of (46) is greater than 0, then $\Delta_\theta(z_{min}) < 0 < \Delta_\theta(z_{min})$ for any $\theta \in [\theta_{min}, \theta_{max}]$. Figure A shows the single crossing property.

■

B Labor Market Institutions in Canada

In this section, we give a brief overview of institutional settings regarding the labor market and employment in Canada. In terms of employment protection, on one hand, Canada ranks in between relatively unregulated countries such as the United States, the United Kingdom or New Zealand and heavily regulated countries such as Italy or Spain. Based on OECD research, Cahuc and Zylberberg (2004) (Table 12.4, p. 736) rank Canada above the US, the UK and New Zealand in the degree of employment protection. On the other hand, the regulation on temporary employment in Canada is the weakest among all OECD countries. As a result, the Canadian labor market features a fraction of temporary workers at 14%, smaller than that of Spain at around 30%, but still sizeable. Mapping the employment protection legislation in Canada to our model encounters two difficulties. The first is that labor legislation varies across provinces and types of workers (federal vs. the rest). The second difficulty is that in Canada, as in virtually all other countries but the United States, termination compensation (or severance pay) takes two forms. First, a monetary compensation set as a multiple of the weekly or daily wage and, second, an advanced notice of termination with the likely output loss for the employer. For simplicity, in our theoretical environment the parameter f encompasses both types of firing costs.

All provinces mandate either a monetary compensation or the advanced notice for all workers except those with a very short tenure (less than 3 months in most provinces, and less than 6 months in new Brunswick, Prince Edward Island and Yukon). In Ontario, in addition to termination notice (or payment), workers with a tenure of 5 years or longer are also entitled to receive monetary severance payments, the amount of which increases with the worker's tenure. As an example, in British Columbia no compensation is required if the employee is dismissed after less than three months on the job[22] but long-tenured workers must be compensated through either advanced notice or severance pay up to a maximum of two months per year worked.[23]

According to Canada Labour Code, federal employers must inform an employee 2 weeks before an employment termination. In lieu of this notice, employers can pay the employee with 2 weeks regular wages. When an employer terminates 50 or more employees within a short period of time, it is required to notice governmental agencies at least 16 weeks before the termination starts. An employee is not required to give an advance notice if she or he terminates the em-

[22] see www.labour.gov.bc.ca/esb/facshts/termination.htm.

[23] Legislation for other provinces shows a similar structure: see Employment Standards Code, section 57, 2010 in www.qp.alberta.ca for legislation in Alberta or http://www.cnt.gouv.qc.ca/en/end-of-employment/notice-of-termination-of-employment/labour-standards/section-83/index.html for legislation in Quebec.

ployment. On severance pay, when an employment is terminated by the employer, the employee receives 2 days regular wages for every complete year of service, but the minimum severance pay for a termination is 5 days regular wages.

One assumption made in our theory is that temporary employment lasts for one period only, after which the contract is rescinded or transformed into a permanent one. In reality, firms have some discretion in renewing fixed-term contracts. However, court decisions have limited this discretion by prohibiting employers from repeatedly renewing temporary contracts. Examples of these decisions include Ceccol v. Ontario Gymnastic Federation, 2001 CanLII 8589, and Monjushko v. Century College Ltd., 2008 BCSC 86 (CanLII). In all these cases, the court ordered that a repeatedly renewed fixed-term contract is considered as a permanent contract entitling the employee to compensation. It is difficult to model the flexibility that firms have in renewing, to some extent, the fixed-term contracts and we assume, for simplicity, that firms can only do so for one period (one year, in the empirical application).

In Canada, the employment insurance (EI) program provides unemployment benefits to unemployed workers and workers who pause their job for other reasons like pregnancy or new-born caring. The EI replacement is 55 percent of the worker's average insurable weekly earnings.[24] The EI regular benefits are paid for a period ranging from 14 to 45 weeks, depending on the unemployment rate in the region where the worker make claims and on the number of hours of insurable employment accumulated during the last 52 weeks before the starting date of EI claims.

C Model Solution and Estimation

We now turn to the description of some technical aspects of the solution and estimation algorithms that produce the results shown in section 6. The model described can be defined as a function $\Xi : \Gamma \to \tilde{Y}$, where $\gamma \in \Gamma \subset R^{n_\gamma}$, and $\tilde{y} \in \tilde{Y} \subset R^{n_M}$. An element in the set $\tilde{Y}$ can be thought of an endogenous variable (e.g. the unemployment rate) that is an outcome of the model. The estimation procedure uses a statistical criterion function that minimizes the deviations of model-implied moments - weighted appropriately - from empirical moments.

Empirical moments are given by the means of time series that have a model-implied moment as a counterpart. Given a vector of time series of length T denoted by $Y_T = \left\{Y_T^1, \ldots, Y_T^{n_M}\right\}$ define the vector $M_{n_M \times 1}$ as having typical element $m_j = (\tilde{y}(\gamma) - \bar{Y}_T^j)$ with $j = 1, \ldots, n_M$ and $\bar{Y}_T^j = (1/T)\sum_{t=1}^{T} y_t$. We construct the statistical criterion function,

[24] As of January 2012, the maximum insurable earnings amount is \$45,900, under which the EI payment is \$485 per week.

$$H(\gamma, Y_T) = M(\gamma, Y_T)'W(\gamma, Y_T)M(\gamma, Y_T) \tag{47}$$

We sensibly choose the matrix $W(\gamma, Y_T)$ to be the inverse of the variance matrix of Y_T. In our application $n_M = 10$ and $n_\gamma = 9$, since the parameter vector of interest is given by $\gamma = (f, \phi, \xi, k, \mu_y, \mu_z, \sigma_y, \lambda^P, \lambda^T)$. In principle one can obtain an estimate of γ by:

$$\hat{\gamma} = \arg\min_{\gamma} H(\gamma, Y_T).$$

Minimizing the function $H(\gamma, Y_T)$ by means of standard minimization routines e.g. any optimizer in the family of Newton-type methods, is seldom an easy task. Problems abound, and they include non-differentiabilities, flat areas, and local minima. To obtain estimates of γ we employ a Markov Chain Monte Carlo method (MCMC) that transforms the function $H(\gamma, Y_T)$ into a proper density function. This transformation is given by:

$$p(\gamma, \mathrm{Y}_T) = \frac{e^{H(\gamma, \mathrm{Y}_T)}}{\int_\Gamma e^{H(\gamma, \mathrm{Y}_T)} d\gamma} \tag{48}$$

where $\pi(\gamma)$ is a prior distribution (or weight function) over the parameter space. This distribution can be uniform which implies a constant $\pi(\gamma)$ and we assume so in the estimation. Chernozhukov and Hong (2003) label $p(\gamma, Y_T)$ a quasi-posterior density because it is not a posterior density function in a true Bayesian sense; there is no updating. It is, however, a proper density function with well-defined moments and as a result we can define, for instance, the quasi-posterior mean as:

$$\hat{\gamma} = \int_\Gamma \gamma p(\gamma, \mathrm{Y}_T) d\gamma \tag{49}$$

In practice, the way we compute the quasi-posterior mean is by a Monte Carlo procedure. Markov Chain Monte Carlo amounts to simulating a Markov Chain that converges to the quasi-posterior distribution. Beginning with an initial guess for the parameter vector γ^0, we iterate on the following algorithm:

1. Draw a candidate vector γ^i from a distribution $q(\gamma^i | \gamma^{i-1})$.
2. Compute $e^{H(\gamma^i, \mathrm{Y}_T)}$.
3. If $p_A = \frac{e^{H(\gamma^i, \mathrm{Y}_T)}}{e^{H(\gamma^{i-1}, \mathrm{Y}_T)}} \geq 1$, accept γ^i.

4. Else, accept γ^i with probability p_A.

5. Set $i \leftarrow i+1$ and return to Step 1.

Repeating these 5 steps and generating a long sequence of draws for γ yields a sample of large size, hopefully drawn from the quasi posterior density $p(\gamma, Y_T)$.[25] Any moment of interest (means, standard deviations, quantiles, etc...) can be readily computed. To evaluate the function $e^H(\gamma, Y_T)$ one needs to solve for the model counterparts of the empirical series in Y_T. For a given γ^i in the sequence of simulated draws, we obtain a model solution using the following steps:

1. We begin with guesses for θ, and $\bar{z}$.[26]

2. Find the surplus functions S^P, S^R and S^T by substituting and combining equations (13), (14), (15), (37), (39), and (42).

3. Update θ using equation (11). Using the functional form for the matching function specified above, θ is given by:

$$\theta = \alpha^{f-1}\left(\frac{\Phi}{k}\right)$$

and

$$\begin{aligned}\Phi &= \int_{z_{min}}^{z_{max}} \left[\mathbb{I}_A E_y S^P(y,z) + (1-\mathbb{I}_A) E_y S^T(y,z)\right] dG(z)\,(1-\phi)\beta \\ &\quad -\beta f \mu_G(A).\end{aligned}$$

There are two important things to consider in this step. First, the initial guess of θ is important. Not all values of θ converge. Second, due to the degree of nonlinearity in our problem, we dampen the speed of updating θ by heavily weighting the previous value. We set the updated value θ_{NEW} to be equal to $\lambda\theta_{OLD} + (1-\lambda)\theta$ where λ is 0.9 (updating is slow).

4. Update $\bar{z}$ by solving the two-equation system defined by

$$E_y J^P\left(y^P(\bar{z}), \bar{z}\right) = E_y J^T\left(y^P(\bar{z}), \bar{z}\right)$$

and $S^P\left(y^P(\bar{z}), \bar{z}\right) = 0$ which solve for $\bar{z}$ and $y^P(\bar{z})$. These two equations take the following

[25] We used 5,000 simulations and discarded the first 1,000.

[26] We hope it is clear to the reader the implicit dependence of these variables on γ^i.

forms

$$\beta\left(1-\lambda^{P}\alpha^{w}(\theta)\right)\int_{\bar{y}^{P}}^{y_{max}}[1-F(x)]\,dx-\beta\left(1-\lambda^{T}\alpha^{w}(\theta)\right)\int_{\bar{y}^{R}}^{y_{max}}[1-F(x)]\,dx$$
$$=\left[\frac{1}{1-\phi}-1+\beta\left(1-\lambda^{P}\alpha^{w}(\theta)\right)\right]f+\frac{\phi\left(\lambda^{T}-\lambda^{P}\right)}{(1-\phi)}\left(\theta k+\beta\alpha^{w}(\theta)\,\mu_{G}(A)\,f\right). \quad (50)$$

$$\bar{y}^{P}+\bar{z}+\beta\left(1-\lambda^{P}\alpha^{w}(\theta)\right)\int_{\bar{y}^{P}}^{y_{max}}(1-F(x))\,dx++\left[1-\beta\left(1-\lambda^{P}\alpha^{w}(\theta)\right)\right]f$$
$$=b+\frac{\phi\left(1-\lambda^{P}\right)\left(\theta k+\beta\alpha^{w}(\theta)\,(1-G(\bar{z}))\,f\right)}{1-\phi}. \quad (51)$$

5. Iterate on the previous two steps until the sequences of θ and $\bar{z}$ have converged.

6. Having obtained $\bar{z}$ and θ we can update the employment measures - both temporary and permanent - using the steady-state versions of equations (27) and (28). These are given by:

$$n^{P}=\frac{\alpha^{w}(\theta)\,\Delta}{\left[1+\left(1-\lambda^{T}\right)\alpha^{w}(\theta)G(\bar{z})\right]\left[1-\left(1-\lambda^{P}\alpha^{w}(\theta)\right)\int_{z_{min}}^{z_{max}}\left[1-F\left(y^{P}(z)\right)\right]dG(z)\right]+\left(1-\lambda^{P}\right)\alpha^{w}(\theta)\,\Delta},$$

where $\Delta=1-G(\bar{z})+\left(1-\lambda^{T}\alpha^{w}(\theta)\right)\int_{z_{min}}^{\bar{z}}\left[1-F\left(y^{R}(z)\right)\right]dG(z)$.

And,

$$n^{T}=\frac{\left[1-(1-\lambda^{P})n^{P}\right]\alpha^{w}(\theta)\,G(\bar{z})}{1+(1-\lambda^{T})\alpha^{w}(\theta)\,G(\bar{z})}.$$

The moments that are the targets of the estimation procedure are not difficult to calculate. The list of 10 moments is:

1. Fraction of temporary workers: $\frac{n^{T}}{n^{P}+n^{T}}$.

2. Job-finding rate: $\alpha^{w}(\theta)$.

3. Unemployment rate: u.

4. Average firing costs: f/w^{P}.

5. Wage premium: w^{P}/w^{T}.

6. β_{ALP}.

7. β_{Type}.

8. Turnover measure for permanent workers: we calculate the turnover measure as the average of job creation (JC_P) and job destruction for permanent workers (JD_P). These are given by,

$$JC_P = \alpha^w(1 - G(\bar{z}))\frac{\lambda^P n^P + \lambda^T n^T + u}{n^P + n^T} + (1 - \lambda^T \alpha^w)\int_{z_{min}}^{\bar{z}} (1 - F(Y^R(z)))dG(z)\frac{n^T}{n^P + n^T}$$

and,

$$JD_P = (1 - \lambda^P \alpha^w(\theta))\int_{z_{min}}^{z_{max}} F(Y^P(z))dG(z)\frac{n^P}{n^P + n^T} + \lambda^P \alpha^w(\theta)\frac{n^P}{n^P + n^T}$$

9. Job-to-job transition rate for permanent workers: $\lambda^P \alpha^w(\theta)$.

10. Job-to-job transition rate for temporary workers: $\lambda^T \alpha^w(\theta)$.