SFB 649 Discussion Paper 2008-021

Preferences for Collective versus Individualised Wage Setting

Tito Boeri*
Michael C. Burda**

* Bocconi University, Italy
** Humboldt-Universität zu Berlin, Germany

This research was supported by the Deutsche Forschungsgemeinschaft through the SFB 649 "Economic Risk".

http://sfb649.wiwi.hu-berlin.de
ISSN 1860-5664

SFB 649, Humboldt-Universität zu Berlin
Spandauer Straße 1, D-10178 Berlin

SFB 649 ECONOMIC RISK BERLIN

Preferences for Collective versus Individualised Wage Setting

Tito Boeri and Michael C. Burda*

February 18, 2008

Abstract

Standard models of equilibrium unemployment assume exogenous labour market institutions and flexible wage determination. This paper models wage rigidity and collective bargaining endogenously, when workers differ by observable skill and may adopt either individualised or collective wage bargaining. In the calibrated model, a substantial fraction of workers and firms as well as the median voter prefer collective bargaining to the decentralised regime. A fundamental distortion of the separation decision represented by employment protection (a firing tax) is necessary for such preferences to emerge. Endogenizing collective bargaining can significantly modify comparative statics effects of policy arising in a single-regime setting.

JEL: J5, J6, D7.

Keywords: Wage rigidity, employment protection, equilibrium unemployment.

*Boeri: Bocconi University IGIER, CEPR and IZA, (tito.boeri@uni-bocconi.it); Burda: Humboldt-Universität zu Berlin, CEPR and IZA (burda@wiwi.hu-berlin.de). We have benefited from comments of Jim Albrecht, Pietro Garibaldi, John Kennan, Marco Leonardi, Chris Pissarides, Etienne Wasmer and two anonymous referees. This research was supported by the EU Commission's SER Project "Dynamic Aspects of the European Unemployment Problem" and the SFBs 373 and 649 (German Science Foundation). We are grateful to Daniel Neuhoff for programming and the Netherlands Institute for Advanced Studies and the European Central Bank for providing highly productive environments for this research.

1 Introduction

Despite the received wisdom among economists that labour market rigidities reduces efficiency and welfare, a broad majority of industrial democracies continue to retain and even foster institutions which set wages without reference to local productivity and labour market conditions. Especially in Europe, the coverage of collectively bargained wage agreements generally exceeds the presence of organised labour at the workplace, often significantly.[1] Surveys show that political support for these arrangements is robust; according to the 2001 Eurobarometer, 65% of EU citizens agree with the statement that "workers need strong unions to protect their interests". An on-line survey of perceptions of institutions conducted by the McKinsey Company revealed that 60% of Germans consider labour unions to be important for society - compared with 66% for Greenpeace and 46% for ADAC, an automobile club. Similarly, a 2004 survey conducted by the Fondazione Rodolfo Debenedetti found that 40% of Italians consider unions to best represent their interests, compared with 14% for the current government, 12% for the opposition and 4% for Confindustria, the employers association. Even in the United Kingdom, where unions have lost considerable influence over the past three decades, two-thirds of respondents to the Eurobarometer survey expressed the view that unions were important or very important for society.

A number of economists, most notably Saint-Paul (2000), have shown how majorities can arise for institutional arrangements which obstruct employment adjustment such as employment protection. This paper contributes to that literature by investigating interactions between employment protection, labour market frictions, and wage rigidity. The framework for analysis is the equilibrium search and matching model of Mortensen and Pissarides (1994, 1999a,b) (henceforth MP). We compare the outcome of flexible wage setting in a decentralised competitive search market with a rigid-wage labour market in which pay is determined without reference to individual match productivity. The form of the wage rigidity arises endogenously as the outcome of Nash bargaining between a labour union and an employer's association. Thus, both the union's pay scale and its membership are endogenous.

The endogenous emergence of collective bargaining is due to deviations from idealized conditions in search-matching economies. There is, first of all,

[1] In France, the land of the general strike, "excess coverage" is almost 70 per cent of the workforce. See Boeri, et al. (2001), Ebbinghaus and Visser (2000) and Visser (2006) for more details on excess coverage.

a firing tax - a deadweight loss to a worker-firm match incurred upon dissolution. While the impact of firing taxes has been studied extensively, their interaction with other labour market institutions is less well-understood.[2] In presence of a firing tax, there is a potential divergence from the optimality condition identified by Hosios (1990) in models of equilibrium unemployment. Moreover, a social minimum or norm may restrict pay schedules available to the parties of collective bargaining. These deviations open up potential for improvement in the context of a collective bargain. At the same time, wages in a collective bargain are set independently of idiosyncratic productivity levels and local labour market conditions, and take account only of observable worker skill levels. This reduces the cross-sectional variation of wages with respect to the case in which wages are set according to an individualised bargaining process. As a result, some labour markets are "closed" in that the highest match surplus attainable in these local labour markets is lower than the reservation utility of the worker. Individuals having skills corresponding to closed labour markets are involuntarily non-employed as they are not searching for jobs. This involuntary non-employment occurs endogenously as a function of the assumed rigidities, and collective bargaining takes these effects on non-employment into account. labour markets which do not adopt the collective agreement do not close, but rather revert to decentralised wage setting; equilibrium in our economy is a hybrid mix of rigid and flexible labour markets.

To examine the quantitative implications of our model, we calibrate it to the Italian labour market. For our preferred calibration, significant fractions of workers and firms evince a preference for collectively bargained wages. In addition, the model predicts that support for the rigid-wage regime is stronger at intermediate rather than low skills levels, contrary to conventional wisdom. This is because rigid wages tend to increase job destruction and reduce job creation for the least skilled. Furthermore, in presence of employment protection, higher incidence of idiosyncratic shocks strengthens this underlying support.

Another set of findings concern the local comparative static effects of exogenous variation in institutional parameters and their dependence on skill. These can vary substantially from those that obtain when collective bar-

[2] See Ljungqvist (2002) for a recent survey of theoretical work on the frequently ambiguous effects of severance regulation. Ljungqvist and Sargent (2002) have studied interactions between firing taxes and unemployment benefits. Similar interactions in a different model setting have been studied by Coe and Snower (1997).

gaining and real wage rigidity is held constant. Firing taxes are essential for inducing preferences for rigid wages, and interact with the frequency of idiosyncratic shocks to productivity as well as startup costs to increase the attractiveness of the rigid wage regime. This complementarity can therefore account for the "clusters of institutional rigidities" observed in OECD countries (Saint-Paul 2004). Finally, preferences for the rigid wage regime are stronger, notably at the upper end of the skill distribution, and increase in the rate of incidence of shocks in the labour market.

In the next section, we contrast behaviour of the benchmark model of equilibrium unemployment with an alternative in which wages depend only on systematic productivity (skill). We then endogenize the determination of this wage schedule as the outcome of a Nash bargaining between an union and an employers' association. The equilibrium of this economy is such that no workers or firms have an interest in changing their wage-setting regime. Section 3 considers preferences of workers and firms for the two regimes in the context of a calibrated version of the model. Section 4 evaluates how rigidities and preferences for them vary in response to changes in underlying institutions. Section 5 concludes.

2 Flexible versus Rigid Wage Determination in Equilibrium Unemployment

2.1 Model framework

The building blocks of our model are standard and can be found in Pissarides (2000) or Mortensen/Pissarides (1999) We consider a continuum of labour markets indexed by $s \in (0, 1]$ where s stands for a deterministic and observable component of worker productivity. Workers cannot change their skill level and supply their labour inelastically; they are either unemployed or employed. Firms either produce with one worker, or search with an open vacancy. They can enter freely and search in any labour market at zero cost, but must pay a periodic startup or recruitment cost of sk per unit period. Firms can work with all types of workers but only one at any given point in time, and cannot search while employing a worker. In a given labour market of skill s, the probability of matching depends on labour market tightness, for which the ratio of vacancies v to unemployment u, given by $\theta \equiv v/u$ is a sufficient statistic. This matching or contact probability derives from a constant returns matching function $m = m(u,v)$; the unconditional probability of a vacancy to match with an unemployed worker is $q = \frac{m(u,v)}{v} = m(\theta, 1)$, with $q'(\theta) < 0, q''(\theta) > 0$, and $\lim_{\theta \longrightarrow 0} q(\theta) = \infty$; the probability of an unemployed worker meeting a vacancy is thus $\frac{m(u,v)}{u} = \frac{\theta m(u,v)}{v} = \theta q(\theta)$.

For production to occur, a worker must be matched with a job. When matched, a firm and a worker generate periodic productivity sx, where $x \in (0, 1]$ is a match-specific component referred to as a "shock." All newly-formed matches (i.e. filled jobs) begin at the highest possible value of x ($x = 1$). Immediately thereafter, match productivity can change at Poisson frequency λ, in which case it is a random draw with a fixed, known cumulative distribution $F(x)$.

In both flexible and rigid-wage regimes, an exogenous firing tax sT is levied on termination of job-worker matches, with $T < \frac{1}{r+\lambda}$. This firing tax is a measure of "job protection" and is pure deadweight loss paid to a third party or simply dissipated resources associated with government regulation. It should be distinguished from severance compensation (a lump-sum transfer from employer to employee upon severance), which in principle can be offset by a compensating wage adjustment (see Lazear 1990, Burda 1992).

2.2 Equilibrium in a Labour Market of Skill Level s

Flexible wage regime We first evaluate the steady-state, equilibrium valuations of states in a labour market for arbitrary skill s, when wages are perfectly flexible, and use the superscript f to denote variables specific to flexible-wage markets.[3] Given our assumptions, the continuation valuation by workers of unemployment (U^f), and employment ($W^f(x)$), and by firms of an open vacancy (V^f) versus a job ($J^f(x)$) must solve the following four functional equations:

$$rU^f = b + \theta^f q\left(\theta^f\right)\left[W^f(1) - U^f\right] \quad (1)$$

$$rV^f = -sk + q\left(\theta^f\right)\left[J^f(1) - V^f\right] \quad (2)$$

$$rW^f(x) = w^f(x) + \lambda \int_{R^f}^{1} (W^f(z) - W^f(x))dF(z) + \lambda F(R^f)(U^f - W^f(x)) \quad (3)$$

[3]Where it is understood to hold for any arbitrary skill group, the subscript for s is suppressed for notational convenience.

$$rJ^f(x) = sx - w^f(x) + \lambda \int_{R^f}^{1} ((J^f(z) - J^f(x))dF(z) + \lambda F(R^f)(V^f - sT - J^f(x)). \quad (4)$$

Equations (1) through (4) equate normal returns on capitalized valuations of labour market states to their expected periodic payouts. In equation (1), the flow yield from the valuation of the state of unemployment U^f at interest rate r is equated to income in unemployment or the valuation of leisure b, which is assumed to exceed rT, plus an expected "capital gain" stemming from finding new employment at $x = 1$.

Equation (2) governs the valuation of an unfilled vacancy. All filled vacancies begin at a common productivity, so all vacancies must be identical *ex-ante*; like U^f, V^f is constant for a given skill level. The function $W^f(x)$ in (3) returns the value of employment in a job-worker match with current productivity x. The implicit rate of return on the asset of working in a job at productivity x is equal to the current wage $w^f(x)$ plus the expected capital gain on the employment relationship. The lower bound of the definite integral, R^f, is the cutoff or threshold value of match productivity, determined endogenously in the model. If idiosyncratic productivity x falls below R^f, the match is no longer profitable and the job/worker pair is destroyed. A similar arbitrage argument determines the valuation to a firm of a filled job in (4), given the current realization of x and for a worker of skill level s.

Rigid wage regime In the rigid wage labour market, labour compensation is independent of local or idiosyncratic influences; i.e. match productivity or market tightness in the particular skill category. It can, however, depend on observable skill s. Denote this rigid-wage as $w^r(s)$. At the moment, this wage is given to the labour market; it will later be derived as the outcome of a collective agreement involving a union and an employers' association. By assumption, the equilibrium state valuations by workers U^r and W^r in a labour market of skill s in the rigid wage regime (denoted by superscript r) are independent of idiosyncratic productivity x. This will not, however, hold for the firm's valuation of a filled job. The functional equations governing the valuation of the four states are given by

$$rU^r = b + \theta^r q(\theta^r) [W^r - U^r] \quad (5)$$

$$rV^r = -sk + q(\theta^r) [J^r(1) - V^r] \quad (6)$$

$$rW^r = w^r(s) + \lambda F(R^r)(U^r - W^r) \quad (7)$$

$$rJ^r(x) = sx - w^r(s) + \lambda \int_{R^r}^{1} ((J^r(z) - J^r(x))dF(z) + \lambda F(R^r)(V^r - J^r(x) - sT) \tag{8}$$

The interpretation of equations (5) through (8) is similar to those of the previous section. The reservation productivity R^r derives from the employer's perspective; a job is destroyed for realizations of x lower than R^r. As in the flexible wage case, R^r will depend on the skill level of the segment, s, as well as on w^r, T and other parameters. At this point, it is natural to impose a participation constraint on employment $W^r \geq U^r$, where U^r denotes the value of unemployment for a worker in the rigid wage segment. Since we restrict attention to steady states, this implies that for all s, $w^r(s) > b$.

Valuation of vacancies in equilibrium There are no restrictions on the entry of firms in any skill segment. Hence, in both regimes the equilibrium value of vacant jobs will satisfy the free entry condition $V^f = V^r = 0$. In the flexible wage regime, (2) becomes

$$J^f(1) = \frac{sk}{q\left(\theta^f\right)}, \tag{9}$$

and in the rigid-wage regime

$$J^r(1) = \frac{sk}{q\left(\theta^r\right)}. \tag{10}$$

2.3 Wage Determination

Flexible wage regime In the individualised wage setting regime, workers' remuneration is determined by a Nash sharing rule.[4] For an existing match in the competitive labour market, the Nash-bargained wage is given by

$$w^f(x) = \arg\max_{w^f} [W^f(x) - U]^{\beta} [J(x) + sT - V]^{1-\beta}$$

yielding the first order condition

$$W(x) - U = \beta \left[J(x) + W(x) + sT - V - U \right]. \tag{11}$$

[4] Here we follow MP (1999a,b) and Pissarides (2000); for details see the Appendix. Detailed derivations of these and other results in this paper are available in a longer Appendix which can be obtained from the authors upon request.

Combining (9), $V^f = 0$ and (11) evaluated at $x = 1$ yields a value of U^f, which can be used in turn to obtain the equilibrium wage rule in the flexible regime, which corresponds to Mortensen and Pissarides (1999):

$$w^f(x) = (1-\beta)b + \beta s \left(k\theta^f + x + rT\right). \tag{12}$$

Given values of β, s and k, the flexible wage is linear in θ^f, a sufficient statistic for tightness in labour markets, and in the idiosyncratic productivity x. The greater the bargaining power of employers, the more closely the wage tracks the monetary value of unemployment. On the other hand, more bargaining power on the side of workers will link wages more tightly with idiosyncratic match productivity, local market conditions, the cost of an unfilled vacancy, as well as the lock-in effect of the firing tax and the interest rate.

Rigid wage regime Wages in the rigid wage regime depend solely on observable productivity s, so $w^r = w^r(s)$ with $\frac{\partial w^r}{\partial s} > 0$. This dependence is parametrized as

$$w^r = \overline{w} + \phi(s - \overline{w}) \tag{13}$$

where $\overline{w} \geq 0$ is a contractual minimum below which union wages cannot fall. While the participation constraint requires $w^r \geq b$, we also assume that a fairness norm or a social minimum requires that $\overline{w} \geq b$. In words, union contracts would never stipulate a wage below the "social minimum" b, even if $s > b$. The parameter ϕ, which lies on the interval $[0, 1]$, reflects the dependence of compensation on skill or systematic productivity; low values of ϕ generate more "egalitarian" wage structures. The linear form is rationalized by both equation (12) as well as the linearity of w^r in s under flexible wage-setting in equilibrium, as is shown below.[5]

[5] Furthermore, the linear form is a relatively stringent parametrization which imposes discipline on the calibration exercise presented below.

2.4 Job Creation, Destruction and Equilibrium

2.4.1 Job Creation

Flexible wage regime The *job creation condition* in the flexible regime is as in Pissarides (2000) by

$$(1-\beta)\frac{1-R^f}{r+\lambda}-T=\frac{k}{q\left(\theta^f\right)} \tag{14}$$

and is represented in (θ^f, R^f) space as the JC-curve in the left panel of Figure 1. The JC curve is downward-sloping because an increase in labour market tightness reduces wages and increases profitability; to restore the zero profit condition associated with vacancies, the threshhold level associated with termination of a match must be lower.[6] Notice that skill level s itself does not affect the position of the JC curve, because startup costs are proportional to skill. Hence, there is no bias with respect to the job creation margin in favour of a particular skill level.

Rigid wage regime The job creation condition in the rigid wage labour market is not familiar, but can be derived in the same way as (14) and is derived in the Appendix as

$$\frac{1-R^r}{r+\lambda}-T=\frac{k}{q\left(\theta^r\right)}. \tag{15}$$

The JC curve in the rigid labour market is plotted in the right panel of Figure 1. It remains strictly downward sloping in (θ^r, R^r)-space, since $q' < 0$, and lies everywhere above its counterpart in a decentralised labour market (14). It is also independent of skill level s .

2.4.2 Job Destruction

Flexible wage regime As in the MP model, jobs are destroyed when productivity falls below its corresponding reservation or threshold level. In the individual-bargaining regime, R^f is defined for each skill level s by the condition:

[6] Implicit differentiation of (14) gives $\frac{dR}{d\theta}=\frac{(r+\lambda)kq'}{(1-\beta)q^2}$, where f is the density associated with F. Since $q'(\theta)<0$, it follows that $\frac{dR}{d\theta}<0$ unambiguously.

$$J(R^f) = -sT. \tag{16}$$

At the same time, Nash bargaining also implies that R^f satisfies the zero match-surplus condition:

$$J(R^f) + sT - V^f + W(R^f) - U^f = 0. \tag{17}$$

The free entry condition implies $V^f = 0$, so as in the MP model, $W(R^f) = U^f$. Separations are consensual and privately efficient; they need not be socially efficient in the sense of Hosios (1990).

The reservation productivity level for the competitive search market, R^f is determined by

$$sR^f + \frac{s\lambda}{r+\lambda}\int_{R^f}^{1}(z - R^f)dF(z) + rsT = b + \frac{\beta s k \theta^f}{1-\beta}. \tag{18}$$

The left-hand side is the flow benefit of a continuing match at productivity R^f; this is the current flow product plus the option value of possible future improvements over the following time interval. The right-hand side represents the (opportunity) costs of maintaining the match at the threshold value of idiosyncratic productivity. This *job destruction condition* (Mortensen and Pissarides 1994, 1999a,b) determines the upward-sloping JD curve in (θ^f, R^f) space displayed in the left panel of Figure 1.[7] Intuitively, a higher level of labour market tightness raises the individually bargained wage and, for given s, R^f the critical value of idiosyncratic productivity that justifies the match's continuation.

Rigid wage regime The hallmark of the rigid wage regime is that the value of a job to the employee is independent of idiosyncratic match productivity. For this reason, employer and employee can disagree about the desirabilility of continuing a match. As the wage is not the outcome of individual level bargaining, surplus division obeys a rule of the residual claimant type. Let $S^r(x)$ be the total surplus resulting from a match for an arbitrary skill class s, so for any $x \in [R^r, 1]$ we have:

$$J^r(x) = \max(-sT, S^r(x) - (W^r - U^r)). \tag{19}$$

[7] To confirm that the JD curve is upward-sloping, differentiate (18) and solve to obtain $\frac{dR^f}{d\theta^f} = \frac{\frac{\beta k}{1-\beta}}{s\left[1 - \frac{\lambda}{r+\lambda}(1-F)\right]} > 0$.

The firm captures all surplus exceeding $W^r - U^r$. The maximum operator applies since the firm can always close operation, here at cost sT.

Unlike the decentralised, individual-wage labour market, the decision to destroy a job is taken by employers unilaterally whenever $J^r < -sT$ in a labour market for skill s. A crucial point to stress here is that under the assumed conditions, $W^r > U^r$ always.[8] Hence, the set of idiosyncratic productivities for which the job is destroyed by the employer will not coincide with those for which the job has zero value to the worker at the assumed rigid wage. To the contrary, in a rigid-wage labour market, the "consensual" dissolution of an employment relationship no longer applies, and there are always too many separations from the workers' perspective. Separations are inefficient in the sense that for some range of productivities workers will be fired, but at the given wage, they would prefer to continue working. *Except on a set of measure zero, there are only involuntary layoffs in the rigid wage regime.* In contrast, quits and layoffs are indistinguishable in search labour markets with decentralised wage setting.[9]

In the Appendix, we show that the reservation productivity R^r for a match for skill level s when wages are rigid is given by

$$sR^r + \frac{\lambda s}{r+\lambda}\int_{R^r}^{1}(x - R^r)dF(x) = \overline{w} + \phi(s - \overline{w}) - rsT \qquad (21)$$

The JD-curve, plotted in (θ^r, R^r) space in the panel B) of Figure 1, is horizontal, reflects the independence of R^r of local labour market conditions. By inspection, the firing tax T reduces the job destruction threshold and raises the average duration of a job. In contrast to (18), neither labour market tightness (θ^r) nor individual worker bargaining strength (β) appear in the job destruction condition. The rigid wage influences the outcome via R^r, which for given model parameters is determined for each value of s as the solution to (21).

---

[8] Combining (7) and (5) yields

$$[r + \lambda F(R^r) + \theta^r q(\theta^r)](W^r - U^r) = w^r(s) - b, \qquad (20)$$

so $W^r - U^r > 0$ if and only if $w^r(s) > b$. On the other hand, firms shut down whenever x falls below the threshold defined by (21). By inspection, whenever $J^r(R^r) = -sT$, it follows that $w^r(s) > b$ as long as $b > rsT$. Since $s \in [0, 1]$, a sufficient condition for all skill classes is $b > rT$, which was assumed.

[9] Quits by workers cannot result in material gains in the MP model because on-the-job search is ruled out.

2.4.3 Equilibrium

Flexible wage regime. The intersection of (18) with the job creation condition (14) defines a labour market equilibrium for submarket with skill s. The result is depicted as the point of intersection in the left panel of Figure 1, a unique reservation productivity and labour tightness pair (R^{f*},θ^{f*}) which characterizes labour market equilibrium. We will denote this equilibrium by $R^{f*} = R^{f*}(s, \lambda, \beta, k, b, T)$ and $\theta^{f*} = \theta^{f*}(s, \lambda, \beta, k, b, T)$, which are implicit functions of skill s, the Poisson arrival rate λ, worker bargaining power β, startup costs k, firing tax T and income-equivalent in unemployment b.

Given the equilibrium values R^{f*} and θ^{f*}, the unemployment rate in the labour market for skill level s follows from the familiar flow condition for constant unemployment:

$$u^{f*} \equiv u^{f*}(s, \lambda, \beta, k, b, T) = \frac{\lambda F(R^{f*})}{\lambda F(R^{f*}) + \theta^{f*} q(\theta^{f*})}. \tag{22}$$

Rigid wage regime. The intersection of the JD and the JC curves in the right panel of Figure 1 yields unique equilibrium values of the reservation productivity and market tightness for the labour market under the rigid wage regime, which we denote as $R^{r*} = R^{r*}(s, \lambda, k, \overline{w}, \phi, b, T)$ and $\theta^{r*} = \theta^{r}(s, \lambda, k, \overline{w}, \phi, b, T)$ respectively. Analogous to (22), the equilibrium unemployment rate u^r in a rigid-wage labour market with skill level s is given by .

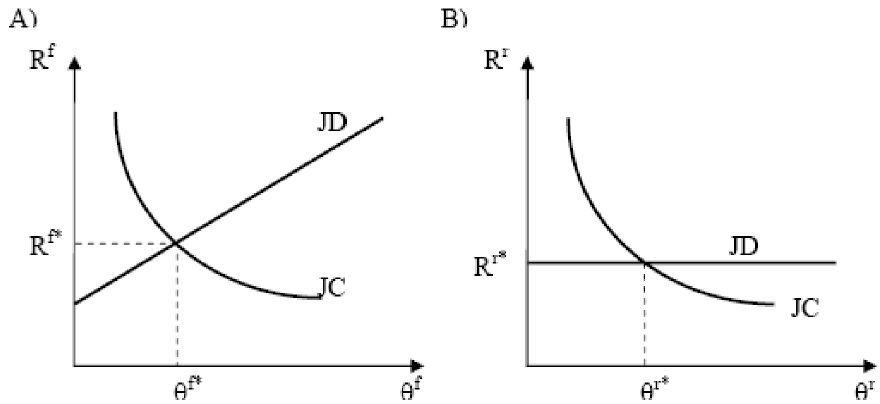
$$u^{r*} = \frac{\lambda F(R^{r*})}{\lambda F(R^{r*}) + \theta^{r*} q(\theta^{r*})} \equiv u^{r}(s, \lambda, k, \overline{w}, \phi, b, T). \tag{23}$$

2.4.4 Closed Labour Markets

A market for labour will not exist in equilibrium for every skill level. We define a labour market of skill level s to be *closed* if no vacancies are posted in equilibrium; in this case the unemployment (or nonemployment) rate is 100%.[10] Alternatively, a labour market is closed if for all $x \in (0, 1]$ match surplus is negative; under these conditions no vacancies will be posted and

[10] Since there is no gain from keeping a worker with a productivity which does not cover the opportunities costs of both parties, no worker should ever be observed working at a wage lower than b.

Figure 1: Equilibrium in Labour Markets of Arbitrary Skills with A) Decentralised and B) Collectively Bargained Wages



the unemployment rate is 100%. Define $\underline{s}$ as the minimal skill class for which the labour market is open ($\theta > 0$). The value taken by $\underline{s}$ will depend on the wage setting regime. Our model thus captures explicitly both the *extensive* margin of labour utilization (the least productive skill level) as well as the *intensive* margin (the unemployment rate).

In the case of individualised, flexible wage-setting, as $\theta^{f*} \rightarrow 0$, the JC condition (14) implies that R^{f*} is bounded from above by $1 - \frac{r+\lambda}{1-\beta}T$; labour markets are closed for $R^{f*} \in [1 - \frac{r+\lambda}{1-\beta}T, 1]$. Similarly, the JC condition for the rigid wage regime implies closed labour markets for $R^{r*} \in [1 - (r + \lambda)\, T, 1]$.

It is possible to derive analytic expressions for $\underline{s}^f$ and $\underline{s}^r$. For the former, solve the job creation condition (14) for q, invert it, substitute the resulting expression for θ in the job destruction condition (18), consider the limit of s as R approaches $1 - \frac{r+\lambda}{1-\beta}T$ from below:

$$\underline{s}^f = \frac{b}{1 - \frac{r\beta}{1-\beta}T - \frac{\lambda}{r+\lambda}\int_{1-\frac{r+\lambda}{1-\beta}T}^{1} F(x)dx} \tag{24}$$

When $T = 0$, b is the limiting match productivity for open labour markets; at the outset, match productivity simply must exceed the flow benefit from leisure. When $T > 0$, labour markets can be closed for workers with productivity strictly greater than b and who are willing to work for $w > b$. The firing tax thus destroys jobs unambiguously at the extensive margin, shutting down low productivity labour markets by rendering them unprofitable. Surprisingly, this dimension has been largely neglected by the literature on employment protection.[11]

We can also derive minimum productivity level for which the rigid segment is open as R^f approaches $1-(r+\lambda)T$ from below:

$$\underline{s}^r = \frac{\overline{w}}{1 - \frac{\lambda}{(1-\phi)(r+\lambda)}\int_{1-(r+\lambda)T}^{1} F(x)dx} \tag{25}$$

It can be seen that labour markets are closed not only by the direct effect of the minimum wage $\overline{w}$ exceeding maximal match productivity, but also by ϕ and T, which create ranges of skill levels which exceed $\overline{w}$, yet in which workers cannot be productively employed, so labour markets are closed. As T approaches zero, both $\underline{s}^f$ and $\underline{s}^r$ approach $\overline{w}$. However, for any positive value of T, $\underline{s}^r - \underline{s}^f$ has ambiguous sign.

2.4.5 Analytic Comparative Statics

We now restrict attention to markets for which $s > \underline{s}^f$ and $s > \underline{s}^r$, respectively. The dependence of the endogenous variables on the model parameters in the two regimes is described in the table below.

TABLE 1. ANALYTIC COMPARATIVE STATICS RESULTS BY WAGE-SETTING REGIME

Effect of $\Longrightarrow$		s	λ	b	β	T	$\overline{w}$	ϕ
	....on $\Downarrow$							
Flexible wage regime	R^{f*}	$-$	$+$	$+$	$+$	$-$	■	■
	θ^{f*}	$+$	$+$	$-$	$-$	$-$	■	■
	u^{f*}	$-$	$+$	$+$	$+$	?	■	■
Rigid wage regime	R^{r*}	$-$	$+$	$+$	■	$-$	$+$	$+$
	θ^{r*}	$+$	$+$	$-$	■	$-$	$-$	$-$
	u^{r*}	$-$	$+$	$+$	■	?	$+$	$+$

[11] A common theoretical prediction is that employment protection in the form of a firing tax has ambiguous effects on employment/unemployment (Bentolila and Bertola, 1990, but see also Hopenhayn and Rogerson 1993). Recent empirical evidence at the macro level is less ambiguous (DiTella and McCulloch, 2005).

An increase in s - an exogenous increase of skill - shifts the JD curve downwards and the JC curve outwards from the origin; in both regimes the labour market tightens unambiguously and the firing threshold declines. An increase in the frequency of productivity shocks and the flow value of non-employment unambiguously increases unemployment in the flexible labour markets via their effects on wages. To the extent that a rigid wage does not depend on b and λ (and $\overline{w}+\phi(s-\overline{w})>b$), job creation and destruction margins (hence unemployment) are unaffected by changes in these parameters. As noted above, increases in the contractual minimum and in the slope of the wage-skill profile in the rigid segment have unambiguous effects on job duration (negative), market tightness (negative) and unemployment (positive). Finally the firing tax reduces both job creation and destruction while its effect on unemployment is ambiguous in an open labour market.

2.5 Rigid Wages as Collective Choice

Up to this point, the rigid wage policy was taken as given to derive the valuations of labour market states by workers and employers. In this section we endogenize the wage rule in the rigid regime to reflect the outcome of a *collective* bargaining process between a single union and a single employers' association, with the objective of improving welfare of workers and firms over levels attainable under decentralised bargaining. We continue to restrict the choice of the collective wage schedules to the set of linear functions defined by equation (13), consistently with the observation of linear profit sharing and performance-related pay arrangements sponsored by unions.[12] In our calibrations, the decentralised wage schedule implied by decentralised equilibrium is also linear in s.

Denote by Ω the set of those skill levels s for which $W^r(s)-W(s)$ and $J^r(s)-J(s)$ are both positive, and let N be the mass of those labour markets. Clearly, both Ω and N are functions of the collective wage agreement $\{\overline{w},\ \phi\}$, which solves the following Nash bargaining problem:

$$\max_{\overline{w},\phi}\,[\mathbf{W^r}]^{\gamma}\,[\mathbf{J^r}]^{1-\gamma} \tag{26}$$

where

[12] In addition, simple compensation schedules are more likely to be understood by union members. See Marsden et al. (2005) on the first European Structure of Earning Survey conducted by Eurostat in 1995.

$\mathbf{W^r} \equiv \int_\Omega \max\left(W^r(s) - W^f(s), 0\right) dG(s)$

$\mathbf{J^r} \equiv \int_\Omega \max\left(J^r(s) - J^f(s), 0\right) dH(s)$

where $\Omega = \{s : \left(W^r(s) - W^f(s) > 0\right) \wedge \left(J^r(s) - J^f(s) > 0\right)\}$ is the set of labour markets over which wages are collectively bargained, and $N = \int_\Omega dG(s)$. $\mathbf{W^r}$ and $\mathbf{J^r}$ represent the surpluses deriving from a bargain which accrue to a single "labour union" and "employers' association," given a collective agreement $\{\overline{w}, \phi\}$, and $G(s)$ and $H(s)$ are weighting functions giving the contribution of skill segment s to the overall surplus of the collective agreement.[13] Bargaining surplus cumulates conditional on being positive to both parties, and bargaining parties take values available under individual decentralised bargaining (i.e. the MP model), $W(s)$ and $J(s)$, as given. The parameter γ stands for the relative bargaining power of the collective organisation of workers vis-a-vis the employers association, with $0 < \gamma < 1$.[14]

3 Worker and Firm Preferences for Labour Market Regimes: Calibration Results

3.1 Model Specification and Functional Forms

We now investigate and evaluate the properties of a calibrated version of our model. In particular, we are interested in studying the preferences of workers and firms across skill classes for the two different wage setting regimes. Following Millard and Mortensen (1997) and Mortensen and Pissarides (1999), we focus on the effects of a subset of labour market institutions

[13] As an extension, one could parameterize "solidarity" among members - or a preference for diversity/variety in skill across the membership:

$$\mathbf{W^r} \equiv \int_\Omega \frac{\left[\max\left(W^r(s) - W(s), 0\right)\right]^\eta - 1}{\eta} dG(s)$$

with $\eta \leq 1$.

[14] We distinguish this bargaining power from that of each individual worker vis-a-vis the employer, β. As with individual-level bargaining strength, γ could stand for risk aversion and degree of time impatience in the spirit of the strategic approach to bargaining theory; see for example Binmore et al. (1986).

which differ across countries, holding other aspects of labour markets constant. Matching probabilities are given by the functional form $q(\theta) = A\theta^{-\alpha}$ with $0 < \alpha < 1$ and $A > 0$. Idiosyncratic match productivity x is assumed to be uniformly distributed over the interval $(0, 1]$. The job creation condition for market of skill s in the flexible search labour market becomes:

$$\theta^f = \left[\frac{A}{k}\left((1-\beta)\frac{1-R^f}{r+\lambda} - T\right)\right]^{1/\alpha} \tag{27}$$

while in the rigid search market it is:

$$\theta^r = \left[\frac{A}{k}\left(\frac{1-R^r}{r+\lambda} - T\right)\right]^{1/\alpha}. \tag{28}$$

The job destruction conditions are given by

$$sR^f + \frac{\lambda s}{2\,(r+\lambda)}(1-R^f)^2 = b + \frac{\beta s k \theta^f}{1-\beta} - rsT \tag{29}$$

and

$$sR^r + \frac{\lambda s}{2\,(r+\lambda)}(1-R^r)^2 = \overline{w} + \phi\,(s-\overline{w}) - rsT \tag{30}$$

respectively. Markets are open when $R \in (0, 1]$ and $\theta > 0$. Under these conditions, one can solve analytically for the skill threshold for open labour markets

$$\underline{s}^f = \frac{b}{1-\left(1-\frac{\lambda(r+\lambda)T}{2(1-\beta)(\lambda+r\beta)}\right)\frac{(\lambda+r\beta)T}{1-\beta}}$$

in the flexible economy, and

$$\underline{s}^r = \frac{\overline{w}}{1-\left(1-\frac{(r+\lambda)T}{2}\right)\frac{\lambda T}{1-\phi}}$$

in the rigid wage economy. As before, as T approaches zero and $\overline{w}$ approaches b, $\underline{s}^r$ approaches $\underline{s}^f$. The firing tax interacts with other labour market institutions - individual bargaining power under individualised wage setting and the productivity parameter under rigid wages - to shut down labour markets at the lower end of the productivity distribution. In the rigid wage regime both parameters of the collective agreement $\overline{w}$ and ϕ increase $\underline{s}^r$, and reinforce each other as long as $T > 0$. This is first direct evidence of policy complementarity as discussed by, e.g. Coe and Snower (1997). Below, we will support this point with numerical comparative statics evidence.

3.2 A First Calibration Exercise: Italy 1990-2000

3.2.1 Parametrisation

A quarterly version of the model was calibrated to match characteristics of the Italian labour market during the 1990s, which in terms of union coverage and labour market rigidities is fairly representative of continental ("Old") Europe. Many parameter values are standard in the literature. We set the elasticity of the matching function α to 0.5, the consensus of empirical work on matching functions (Blanchard and Diamond, 1989; Petrongolo and Pissarides, 2000). The bargaining power of workers β in a decentralised setting is set equal to the elasticity of the matching function.[15] Collective bargaining has a natural *raison d'etre*: to correct deviations from the ideal decentralised model of equilibrium unemployment (Pissarides 2000). The power of labour in the collective bargaining vis-a-vis the employers' representative γ is set to 0.5, which is consistent with the observation in Italy of broadly the same coverage of workers in firms represented by Confindustria, the employers' association, and of unions in the form of membership rates. By imposing $\beta = \gamma$, we do not assign a stronger bargaining power to collective organisation vis-a-vis the individuals.

The real interest rate (r) is set at $(1 + .05)^{\frac{1}{4}} - 1$. Startup and firing costs are expressed as fractions of a quarterly level of output at $x = 1$. The value of the firing tax ($T = 1$) is set at three months of output or roughly 4-5 months of pay. This corresponds to the levels of the pure tax component of employment protection legislation estimated by Garibaldi and Violante (2006) for Italy. Skill classes are defined in the range $(0, 1.0]$ at intervals of 0.01, and the skill distribution is based on Italy's 1998 IALS (International Adult Literacy Survey) scores (http://www.statcan.ca) and is a truncated normal with mean 0.5 and a standard deviation of 0.12; furthermore, we assume $G(z) = H(z) = \Phi(z)$, the cumulative normal distribution.[16] The quarterly frequency of idiosyncratic shock incidence λ is set to 0.10, the

[15] Hosios (1990) showed that the equality of the elasticity of the matching technology and the share of the match surplus accuring to workers is a condition for efficiency in search and matching models *in the absence of a firing tax.* Moene (1997) has shown that under certain conditions, competitive search models can attain this condition endogenously.

[16] Our parameterization of the skill distribution comes from Italian 2006 International Adult Literacy Survey (IALS), for which the density passes tests of normality at conventional significance levels with a mean score of 253 and a standard deviation of 60. This corresponds to a standard deviation of roughly 0.12 around the centered mean of 0.5.

value used by Yashiv (2000) in his calibration of the Mortensen-Pissarides model to Israeli data. For the parameter k we chose $k = 0.15$, which reflects estimates of total startup costs as a percentage of income per capita by Djankov et al. (2001) and Fonseca et al. (2001), converted to a fraction of labour productivity using the average 1990s employment rate.

3.2.2 Calibration

Given these choices, the two remaining free parameters are the efficiency of the matching function, A and the flow monetary value of non-employment, b. These were chosen to minimize the unweighted sum of the squared percentage deviations of the model economy's steady state from average values for Italy during the 1990s of the OECD standardized unemployment rate (10.7%) and of average measured (uncompleted) unemployment duration (5 quarters). For A the search was confined to values less than 1.2; for b we considered the range $[0, .55]$ to rule out cases where markets for more than 55% of the skill classes are closed.

The equilibrium of the aggregate economy can be summarized as a union pay scale $\{\overline{w}, \phi\}$ and a minimum open labour market $\underline{s} = \min(s^f, s^r)$. It is thus a hybrid mix of the two regimes. Adherence of a particular skill segment to the single collective agreement presumes gains to both worker and firms. If either the union or the employers' association derives negative surplus in a skill segment, collective bargaining fails and the labour market adopts the flexible regime (i.e. the decentralised MP wage determination). A labour market in segment s is closed if neither collective bargaining nor decentralised wage-setting regimes generate a positive employment rate $(u^{f*}(s) = 1) \vee (u^{r*}(s) = 1)$. Denote by $u^*(s)$ and $\theta^*(s)$ the equilibrium values of u and θ in skill segment s irrespective of the wage regime. The model's aggregate equilibrium unemployment rate is computed as $\int_{\min(s^f,s^r)}^1 u^*(s)dG(s)$; the non-employment rate due to closed markets as $\int_0^{\min(s^f,s^r)} dG(s)$, and duration as $A^{-1}\int_{\min(s^f,s^r)}^1 (\theta^*(s))^{\alpha-1} dG(s)$. At each stage of the moment matching procedure, the union wage scale parameters $\{\overline{w}, \phi\}$ are endogenous and optimally chosen; that is, they are the solution of (26), given the model's other parameters, especially A and b. Table 2 displays the parameter values selected for the Italian case as well as the optimised wage schedule resulting from collective bargaining. The latter is given by $\overline{w} = .373$, $\phi = .55$, implying wage compression vis-a-vis the flexible regime, in which dw/ds is greater than 1 in the open labour markets. The contractual minimum is aligned with the value of leisure.

Table 2. Parameter Values for Baseline Calibration, Italy

α (elasticity of $q(\theta)$, the job finding rate)	0.50
γ (union bargaining power in collective agreements)	0.50
β (bargaining power of individual workers)	0.50
r (real interest rate per quarter)	0.0125
T (firing tax, proportional to productivity)	1.00
λ (frequency of the match-specific shock)	0.10
k (startup costs, proportional to productivity)	0.15
A (efficiency parameter of the matching function, *matched)*	*0.53*
b (income in unemployment/value of leisure, *matched)*	*0.373*
$\overline{w}$ (contractual minimal pay at lowest skill level, *optimised*)	*0.373*
ϕ (contractual dependence of pay on skill, *optimised*)	*0.550*

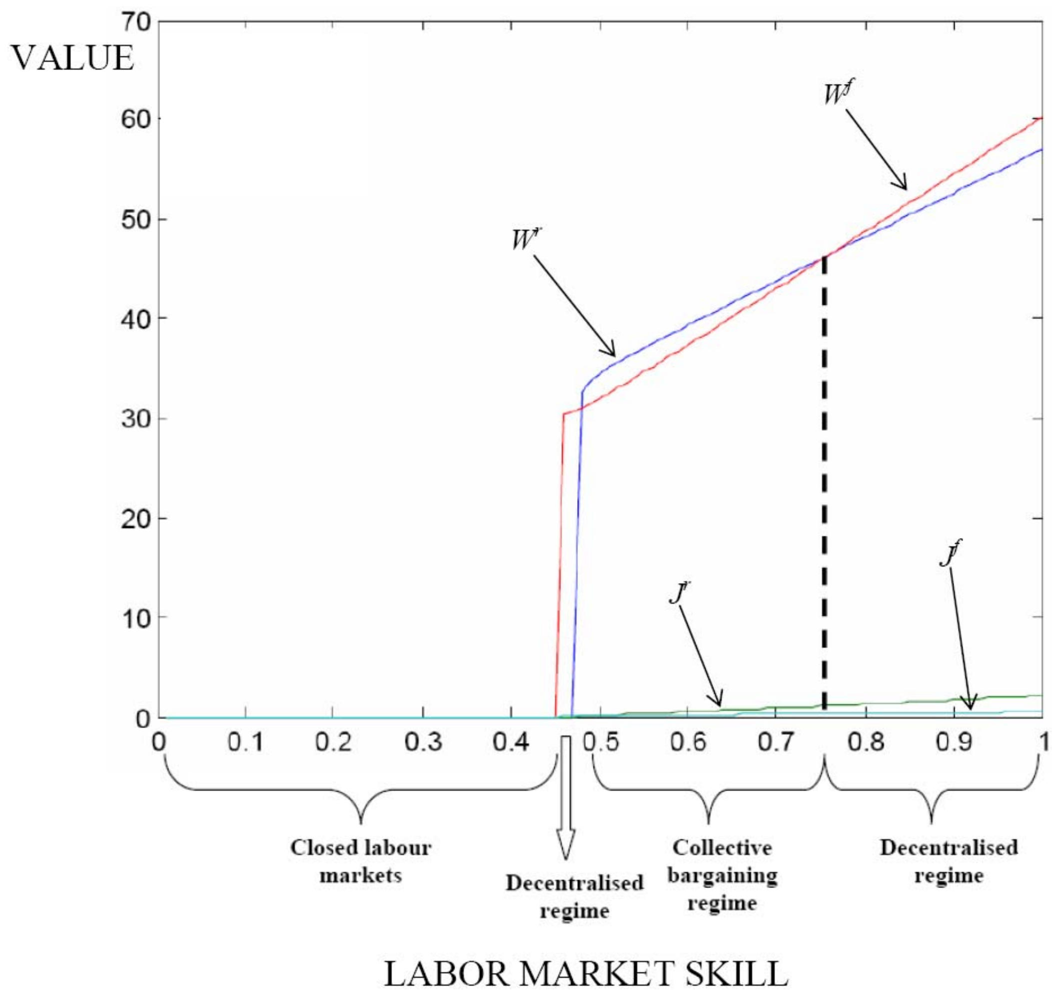
3.2.3 Characteristics of the equilibrium in the calibrated model economy

In Figure 2, the steady state valuations of employment from the worker's and firm's perspective for both flexible and rigid-wage regimes are plotted by skill level s for the above calibration. In both regimes, the labour market is closed for the lowest skill levels. The optimised union wage policy shuts down the lowest skill labour markets.that are open in the flexible regime. For intermediate skill levels with the mass of workers, the valuation of employment is higher under the rigid wage regime. At high skill levels, workers prefer to have their wages set under competitive conditions. From the employer's perspective, rigid wages are preferable in the upper skill distribution, but not so in general in the low productivity regions of the distribution, where skill density is highest.

Table 3 summarizes the characteristics of the baseline calibration in more detail. The equilibrium in aggregate economy has a mean unemployment rate of 12% with a mean completed steady state unemployment duration of 4.6 quarters.[17] Roughly one fifth of the potential labour force is inactive

[17]Note that the unemployment rate is the average rate of unemployment of those labor markets which are operating, so in the rigid wage regime, the unemployment rate will significantly understate the *nonemployment* rate, which includes closed markets.

Figure 2: Equilibrium State Valuations, Benchmark Calibration. Italy



because the labour market for their skill group is shut down. About 85 per cent of the labour force (68 per cent out of 79.8 in open markets) is covered by collective agreements. Both the worker of median skill in the economy as well as the worker of median skill who is employed supports the collective agreement. Of all the markets, about three fourths has an advocate at least from one side of the bargaining table.

TABLE 3. .CHARACTERISTICS OF THE CALIBRATED ECONOMY, ITALY

Variable	*Value*
Economy-wide unemployment rate (ILO)	12.0
Average duration of unemployment (quarters)	4.6
Lowest skill level employed under decentralised wage setting	0.45
Lowest skill level employed under collective bargaining	0.48
Mass of union support (%)	74.7
Mass of collective bargaining coverage (%)	68.0
Mass of open markets (%)	79.8

3.3 Calibration for Sweden 1990-2000

Given the highly distorted Italian case, it is natural to ask whether the model is robust enough to account for the average behavior of other economies with significant union presence. In Table 4, we display a calibration of our model to Sweden, allowing only the startup cost (k), matching efficiency (A), and pecuniary value of unemployment (b) to vary. We set $k = .10$, reflecting a more liberal product market regulatory environment, while A and b were selected using the same matching procedure described in the previous section. Compared with Italy, Sweden has open labour markets for a wider range of skills: the lowest skill level in the decentralised regime is .36 (compared with .45 in Italy), while the rigid regime shuts down markets for skill lower than .42 (.48 in Italy). In Sweden, the income equivalent of unemployment and the contractual minimum are lower and the wage-skill link higher than in Italy; collective bargaining is closer to the individualised wage setting mechanism. Almost 90 per cent of the labour force has skills corresponding to open labour markets and 9 of these workers out of ten (79.8/87.8) are covered by collective wage agreements, a result closely in line with estimates by Visser (2006). Naturally, one cannot expect a model of this degree of abstraction to capture all differences between the two economies; yet the model does strikingly well on the basis of only unemployment income, matching efficiency, and startup/search costs.

TABLE 4. .CHARACTERISTICS OF THE CALIBRATED ECONOMY, SWEDEN

Variable	*Value*
Economy-wide unemployment rate (ILO) ($\overline{u}$)(%)	7.2
Average Duration of Unemployment in quarters	1.9
Lowest skill level employed under decentralised wage setting	0.36
Lowest skill level employed under collective bargaining	0.42
Optimally chosen contractual minimum ($\overline{w}$)	0.30
Optimally chosen wage-skill link (ϕ)	0.63
Mass of union support (%)	79.8
Mass of collective bargaining coverage (%)	79.8
Mass of open markets (%)	87.8
Memo: *Different from Italian calibration*	
k (startup costs, proportional to productivity)	0.10
A (matching function efficiency, *matched)*	0.600
b (income in unemployment/value of leisure, *matched)*	0.300

4 Interactions between Labour Market Institutions and Endogenous Collective Bargaining

4.1 Trading Places: Counterfactual Comparative Statics

In order to better characterise what makes Sweden so different from Italy, we use the model calibrations to carry out a number of policy experiments, exchanging policy settings and institutional features between the two otherwise identical European economies. For example, we ask: what would be the effect on unemployment if Sweden adopted, ceteris paribus, the monetary equivalent of the value of non-employment in Italy? And how high would Italian unemployment be if the matching process in this country were as efficient as in Sweden? The results of these "counterfactual comparative statics exercises" are presented in Table 5.

The results strongly suggest that the flow value of unemployment b and entry costs k best account for unemployment differentials between Italy and Sweden. Imposing Swedish values of these parameters on Italy would reduce unemployment rate by 5.5 points. Exporting Italian b and k to Sweden, in contrast, would increase Swedish unemployment by 4.2 points. It is important to note that b acts more on participation margins, affecting the skill range of open markets, while entry costs affect the duration of unemployment in open labour markets. It is striking that introducing Swedish parameters in Italy reduces the egalitarianism of pay in the collective agreement (i.e., ϕ increases). However, the experiment also implies a broadening of the coverage of collective bargaining; imposing Swedish labour market institutions on Italy results in *more* wage dispersion across skills, but *less* wage dispersion within the open labour markets.

TABLE 5. COUNTERFACTUAL EXPERIMENTS
A) ITALY WITH SWEDISH PARAMETERS

	Orig.	*Abs. change resulting from Swedish:*					
Italian outcome	*Value*	b	A	k	b, A	b, k	A, k
Unemployment rate $\overline{u}$*:(%)*	12.0	-3.8	-1.1	-2.0	-4.8	-5.5	-3.1
Avg unempl.. duration (qtrs)	4.7	-2.4	-0.9	-1.5	-2.8	-3.1	-2.1
Optimal wage-skill link ϕ	0.55	0.08	0.02	0.02	0.09	0.09	0.03
Mass of union support (%)	74.7	14.7	0.0	0.0	14.7	15.5	-2.7
Mass of coll.barg. cov.(%)	68.0	15.3	-1.6	-2.2	15.5	14.7	-2.2
Mass of open markets :(%)	79.8	14.6	0.0	0.0	14.6	14.6	0.0

B) SWEDEN WITH ITALIAN PARAMETERS

	Orig.	*Abs. change resulting from Italian:*					
Swedish outcome	*Value*	b	A	k	b, A	b, k	A, k
Unemployment rate $\overline{u}$*:(%)*	7.2	2.0	0.8	1.7	2.7	4.2	3.1
Avg unempl. duration (qtrs)	1.9	0.1	0.5	0.9	0.0	2.7	1.6
Optimal wage-skill link ϕ	0.63	-0.26	-0.02	-0.01	-0.27	-0.25	-0.01
Mass of union support :(%)	74.0	-7.7	2.3	0.0	-7.7	-7.7	0.0
Mass of coll.barg. cov. (%)	79.8	-34.7	1.1	0.3	-34.7	-31.7	1.1
Mass of open markets (%)	87.8	-15.8	0.0	0.0	-15.8	-15.8	0.0

4.2 Turbulence, Firing Taxes, and Startup Costs

Ljungqvist and Sargent (1998, 2002) have stressed the role of turbulence in the rise of European unemployment. In their analysis, generous benefits and severance regulation increase unemployment duration and rates of human capital loss during periods of structural change and upheaval. Another interpretation of turbulence is simply an increased rate of shock incidence λ.interacting with labour market policies - unemployment benefits and/or severance regulation - have led to lower turnover and increased unemployment durations. The empirical stylized fact which motivates this literature is an increasing fraction of earnings variance in the United States which cannot be accounted for by observable factors. Our model should have something to say about these issues, in particular: under what conditions could turbulence - the rate at which jobs are subjected to productivity changes - induce workers and firms to prefer rigid to individualised Nash-bargained wages?

To address this question, we consider the regime valuations of workers and firms for different combinations of shock incidence parameter λ while maintaining otherwise model parameter settings at benchmark values for the Italian calibration. In addition, we consider variation of λ juxtaposed against variation in the firing tax (T). A distinguishing feature of our approach is that workers and firms are sorted into different wage setting regimes, depending on their preferences for wage variation in response to idiosyncratic productivity shocks. The results of these experiments are summarised in Table 6.

The top panel shows that support for collectively bargained wages is increasing in λ, *provided that the firing tax is positive.* When $T = 0$, the mass of workers covered by collective agreements collapses to zero, regardless of the rate of shock incidence. The firing tax is thus a necessary condition for increasing turbulence to translate into increasing support for wage rigidity. At the same time, the dependence of optimal ϕ is not monotonic either with respect to T or λ. This underlines the complex dependencies and complementarities between between different policies and driving forces, as well as the endogenous response of collective bargaining institutions. Our results here complement the growing theoretical and empirical work showing that policy interventions are complementary in their effects.

Another key parameter in the MP model is k, the cost of posting and maintaining a vacancy while searching for a worker. Broadly interpreted, k is a stand-in for all startup costs related to a firm's entering a market and are often linked to product market regulation, which has gained prominence in discussions of European unemployment as well as the determinants of economic backwardness and development.According to the World Bank (Djankov, et al. (2002)) large differences can be observed product market regulation across European economies. For example, it is estimated that the number of days required to start a company varies in the European Union from 4 days in Denmark, 11 days in the Netherlands and 18 days in the United Kingdom, to 45, 49, and 56 days in Germany, France and Belgium respectively.

Table 6. Interactions of Job Protection, Turbulence, and Startup costs: Italian calibration (Absolute Change Relative to Baseline Calibration)

	Parameter configuration					
	$T = 0$		$T = 0.5$		$T = 1$	
Effect of turbulence on:	$\lambda = .10$	$\lambda = .12$	$\lambda = .10$	$\lambda = .12$	$\lambda = .10$	$\lambda = .12$
Unemployment rate $\overline{u}$:(%)	1.4	3.8	0.05	2.2	0.0	2.0
Avg unempl. duration (qtrs)	-2.9	-2.9	-2.8	-2.7	0.0	-1.2
Optimal wage-skill link ϕ	-0.05	-0.05	0.14	0.09	0.0	-0.05
Mass of union support (%)	18.6	18.6	7.3	5.0	0.0	0.0
Mass of coll.barg. cov. (%)	-68.0	-68.0	0.0	0.7	0.0	1.2
Mass of open markets :(%)	13.5	13.5	9.7	8.1	0.0	-2.4
Effect of startup costs on:	$k = .10$	$k = .15$	$k = .10$	$k = .15$	$k = .10$	$k = .15$
Unemployment rate $\overline{u}$ (%)	-0.9	1.4	-2.0	0.0	-2.0	0.0
Avg unempl.duration (qtrs)	-3.3	-2.9	-3.2	-2.8	-1.5	0.0
Optimal wage-skill link ϕ	-0.05	-0.05	0.17	0.14	0.02	0.0
Mass of union support (%)	18.6	18.6	5.0	7.3	0.0	0.0
Mass of coll.barg. cov.(%)	-68.0	-68.0	-1.1	0.0	-2.2	0.0
Mass of closed markets (%)	13.5	13.5	9.7	9.7	0.0	0.0

In the lower panel of Table 6 we display the effects of different levels of k on the benchmark Italian scenario at different levels of the firing tax T. Again, when $T = 0$, workers never prefer rigid over individually bargained wages, regardless of the value of k. When $T > 0$, skill segments exist which prefer rigid wages, and their mass is increasing with k, evidence of complementarity between the two parameters. The collective wage profile is steeper when entry costs are lower. Evidently, a significant part of the effect of reduced

k on unemployment comes from the reaction of collective bargaining to the altered environment. This institutional endogeneity is the subject of next section and will be examined in more detail.

4.3 Endogenous collective bargaining and the effects of labour market policies

As highlighted by the discussion of the counterfactuals above, the wage scale chosen in collective bargaining responds to changes in institutional or policy parameters parameters, such as the monetary value of leisure (non-employment benefits), startup costs and the firing tax. It does this to satisfy the objective of the Nash bargaining problem: to maximize the joint surplus accruing to the signatories of the wage agreement. This surplus has both an intensive and an extensive margin. The endogenous response of collective bargaining may might significantly alter the net effect of reforms when compared with a scenario in which collective bargaining does not react at all to these policy changes.

Table 7 evaluates the effects on unemployment resulting from marginal changes in the exogenous variables *without* (second row) and *with* (third row) endogenous reaction of the rigid wage scale. As suggested by the table, holding ϕ (and $\bar{w}$) constant, reductions in firing taxes have relative large effects on unemployment. When instead collective bargaining adjusts to changes in T , the decline in unemployment is milder. The fourth column of Table 7 helps explaining why this is the case: when T declines, collective bargaining reacts by reducing across skill wage compression, and this in turn prevents reductions in employment from having large effects on the coverage of collective bargaining.

In some cases, the endogeneity of collective bargaining can reverse the qualitative direction of the effect of institutional changes that are predicted by simple comparative statics analysis. For instance, a reduction in the bargaining power of individual workers (holding union bargaining power constant) induces a decline in unemployment when collective bargaining does not react, while it involves an *increase* in unemployment otherwise, as more workers are covered by collective wage bargaining than in the baseline. In other cases, policy actions, such as a decrease in startup costs or a cut in unemployment benefits, may lead to even steeper reactions in unemployment than those predicted by an unreactive wage bargaining structure.

Table 7. Numerical comparative statics analysis: Response of unemployment to exogenous parameters, with and without Endogenous Collective Bargaining, Italian Baseline Calibration

	Parameter					
Effects on unemployment (% changes)	T	b	k	β	A	λ
Holding ϕ constant	-0.9	-3.4	-0.1	-0.2	1.2	-1.7
Allowing ϕ to react	-0.3	-4.0	-0.4	0.6	0.9	-0.8
% change in ϕ	0.5	-1.5	0.1	1.3	-0.1	0.6

Effects of a one percent decline of each exogenous parameter on the unemployment rate at unchanged rigid wage scale and allowing ϕ to react

4.4 The role of fundamental distortions

In Section 4.2 it was shown that preferences for collective bargaining collapse when the firing tax is zero. Since the model actually contains three distortions - firing tax, a pay norm in work irrespective of productivity, and a potential deviation from the Hosios condition - it is natural to ask which of the three, if any, are necessary for the emergence of preferences for collective bargaining. Figure 3 depicts how preferences for collective bargaining and rigidities arise from interactions between labour market institutions and these fundamental distortions of the prototypical MP model. The first frame A) displays the baseline Italian calibration for reference. The second frame B) is the same calibration with $\beta = .7$; the bargaining power of individual workers in decentralized setting now exceeds the elasticity of matches with respect to their presence in the unemployment pool ($\alpha = .5$). In the third frame C) we maintain $\beta > \alpha$ as in the second case, while removing the restriction on the contractual wage at zero productivity $\overline{w} > b$. In all three cases, a significant fraction of the labour force enjoys a higher surplus in employment under rigid wages.

In the last three panels the firing tax is set to zero. In panel D), the binding minimum is $\overline{w} > b$ is restored but the set of skill levels in collecting bargaining is empty. This is not changed significantly by raising β to 0.7, depicted in E). Finally, the case of no distortions at all is shown in F): $T = 0$, $\beta = \alpha$, and $\overline{w}$ unrestricted. Under these idealized conditions, collective bargaining simply replicates the Mortensen-Pissarides decentralised outcome.

Evidently, the firing tax is central to inducing worker preferences.

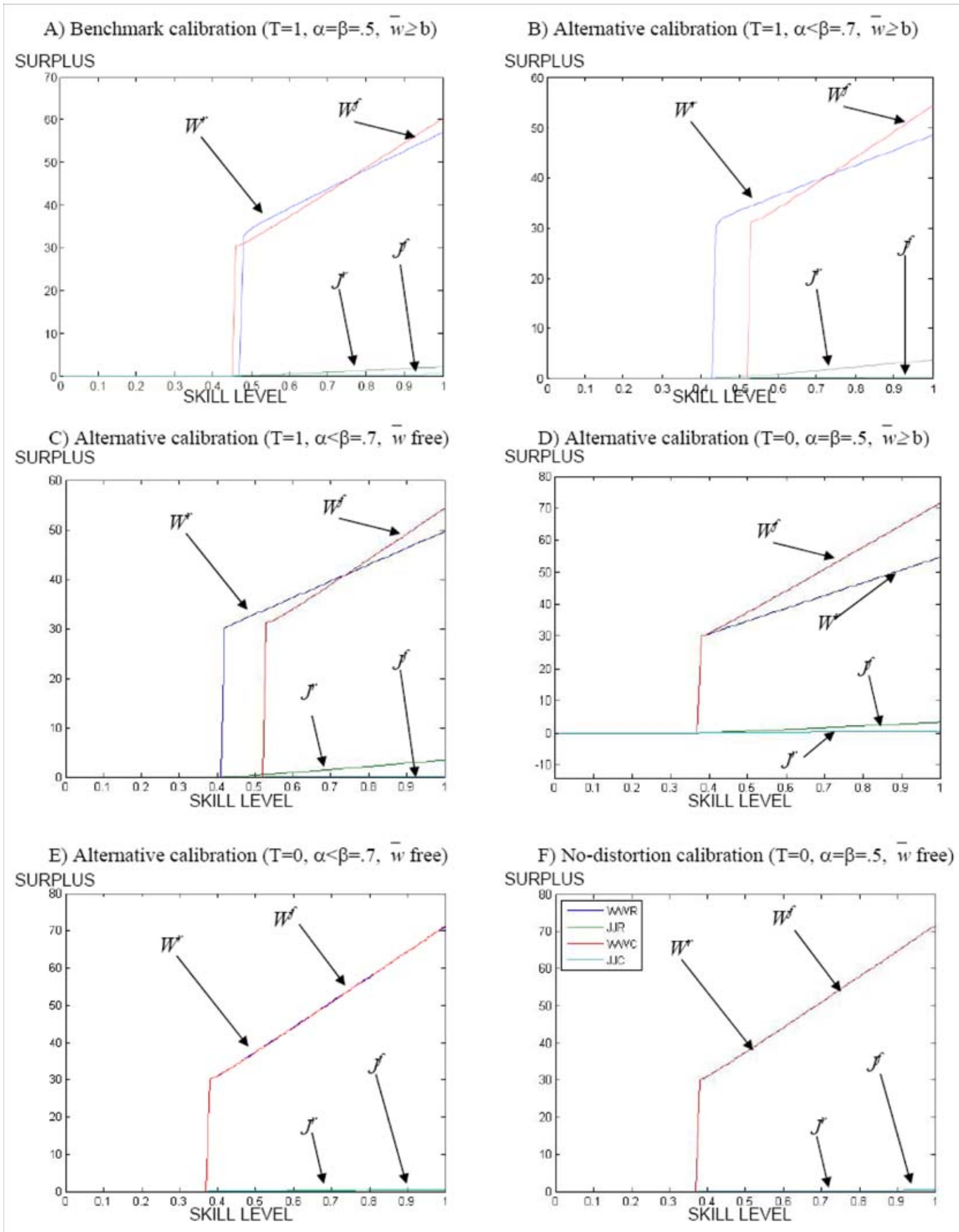
5 Conclusions

Deviations from the standard model of equilibrium unemployment can induce worker and firm preferences for rigid wages over those set in individualised Nash bargaining. We show this in a model of equilibrium unemployment which allows labour market segments for different skill levels to select their own mode of wage determination. We thus move beyond Mortensen and Pissarides (1994,1999) and Pissarides (2000), who assumed individualised.wage determination with no role for collective bargaining, and provide a justification for wage rigidity sought by Hall (2005) and Shimer (2005) in a somewhat different context. In presence of a distortion of the separation decision - a firing tax - collective bargaining is preferred by workers and employers to decentralised bargaining for a wide range of skill levels. Rigid wages can be thought of as a commitment device which supresses holdup under decentralised wage bargaining in presence of employment protection. Collective bargaining also internalize congestion-search externalities compared with decentralised wage determination, adjusting wage scales to the efficiency of the matching function, although it does not take into account of the specific conditions of each skill-local labour market.

Our model highlights the effect of employment protection on the extensive margin of employment by reducing the range of skills for which labour markets are open. There is no ambiguity in our model as to the effects of firing taxes on employment although, within each open skill segment, employment protection has an ambiguous effect on skill-specific employment-unemployment. Insofar as our model predicts that some positive share of firms-workers will be under the collectively negotiated, rigid wages, it reduces the cross-sectional variation and the volatility of wages in response to idiosyncratic productivity shocks vis-a-vis the standard MP model, making it correspond more closely to the data.

While our calibration results are specific to the two countries considered, Italy and Sweden, some results have a more general, qualitative character. We have shown that collective bargaining interacts with other adjustment mechanisms inducing political economic complementarities. One of the key findings of our counterfactual experiments is that higher shock incidence

Figure 3: Effect of Variation of Fundamental Distortions on Equilibrium valuations, Benchmark Calibration. Italy



λ increases the coverage of collective wage agreements even if it appears to increase unemployment. Our results point to complementarity between various types of labour market rigidities, a theme that has been studied elsewhere.[18]. In the class of models we consider,[19] employment protection or a firing tax is a necessary condition for support for collectively bargained wages to arise in equilibrium. Startup costs also make a rigid wage regime more attractive, notably when there is higher turbulence. Severance protection, in the form of a deadweight firing tax, increases the relative popularity of rigid wage policies, because it further increases utility of rigid wage workers who keep their jobs, relative to the decentralised MP equilibrium. Although severance taxation is a deadweight loss for the labour market, it can increase the relative appeal of rigid wage policies for the segment of low-skill workers for which a rigid labour market exists. Perhaps not surprisingly, support for rigid wages coming from firms is significant, especially in higher skill labour segments.

Lastly, our results suggest that policy evaluation should not ignore the feedback effects of endogenous adjustment of the collectively negotiated wage schedule to institutional reforms. These feedback effects are important and may lead to unintended effects of reforms.

6 References

Bentolila, S. and G.Bertola (1990) "Firing Costs and Labour Demand: How Bad is Eurosclerosis?", *Review of Economic Studies*, 57:381-402

Binmore, K., A. Rubinstein, and A.Wolinsky (1986), "The Nash Bargaining Solution in Economic Modelling," *Rand Journal of Economics*, 17:176-188.

Boeri, T., A. Brugiavini and L. Calmfors (2001) (eds.) *The Role of Unions in the Twenty-First Century* Oxford: Oxford University Press, 2001.

Booth, A. (1995) *The Economics of the Trade Unions*, Cambridge: Cambridge University Press.

[18]Coe and Snower (1997) emphasize policy complementarities. Saint Paul (2004) has argued that the most successful reforms in Europe were made by changing several policies simultaneously.

[19]In an earlier version of this paper, we also considered the effect of a non-negotiable renogotiation or recontracting cost. Surprisingly, this feature turns out to be inessential for a rigid wage regime to be attractive to a nontrivial segment of the working population.

Blanchard, O. and P. Diamond (1989), The Beveridge Curve, *Brookings Paper on Economic Activity*, 0:1-60.

Brügemann, J. (2004) Does Employment Protection Create its Own Political Support?, mimeo, MIT.

Burda, M. (1992) "A Note on Firing Costs and Severance Benefits in Equilibrium Unemployment," *Scandinavian Journal of Economics* 94:479-489.

Coe, D. and D.Snower (1997): "Policy Complementarities: The Case for Fundamental Labour Market Reform," *IMF Staff Papers* 44:1-35.

DiTella, R. and R.McCulloch (2005) "The Consequences of Labor Market Flexibility: Panel Evidence based on Survey Data", *European Economic Review*, 49:1225-1259.

Djankov, S. R. LaPorta, F. Lopez-de-Silanes, and A.Shleifer (2002) "The Regulation of Entry" *Quarterly Journal of Economics,* 117: 1-37.

Ebbinghaus, B. and J.Visser (2000). *Trade Unions in Western Europe since 1945.* London: McMillan.

Fonseca, R., P. Lopez-Garcia and C.Pissarides (2001), Entrepreneurship, Start-up Costs, and Employment, *European Economic Review*, 45:692-705.

Garibaldi, P. and G. Violante (2006) "The Employment Effects of Severance Payments with Wage Rigidities" *Economic Journal,*.115:799-832.

Hall, R. (2005) "Employment Fluctuations with Equilibrium Wage Stickiness," *American Economic Review* 95: 50-65.

Hopenhayn, H. and R.Rogerson (1993) "Job Turnover and Policy Evaluation: A General Equilibrium Analysis", *Journal of Political Economy*, 101: 915-938.

Hosios, A.J., (1990) "On the Efficiency of Matching and Related Models of Search and Unemployment," *Review of Economic Studies*, 57: 279-298.

Lazear, E. (1990) "Job Security Provisions and Unemployment", *Quarterly Journal of Economics,* 105: 699-726.

Ljungqvist, L. (2002) "How Do Layoff Costs Affect Employment?", *Economic Journal*, 112: 829-853.

Ljungqvist, L. and T. Sargent (1998) "The European Unemployment Dilemma" *Journal of Political Economy* 106: 514-550.

Ljungqvist, L. and T. Sargent (2004) "European Unemployment and Turbulence Revisited in a Matching Model," *Journal of the European Economic Association*, 2: 456-468.

Marsden, D. (2005), The 5th framework project 'Pay Inequalities and Economic Performance': Main results based on the European Structure of

Earnings Statistics, paper presented at the conference on "Employment, productivity and wage structures in Europe: New evidence from linked employer-employee data", European Commission, Brussels, 7/8 April 2005.

Millard, S. and D. Mortensen (1997) "The Unemployment and Welfare Effects of Labour Market Policy: a Comparison of the USA and the UK", in: Snower and de la Dehesa, eds., *Unemployment Policy: Government Options for the Labour Market* Cambridge: Cambridge University Press.

Moene, E. (1997), "Competitive Search Equilibrium", *Journal of Political Economy*, 105: 385-411.

Mortensen, D. and C.Pissarides (1994) "Job Creation and Job Destruction in the Theory of Equilibrium Unemployment", *Review of Economic Studies* 61:397-415.

Mortensen, D. and Pissarides, C. (1999a) "Unemployment Responses to 'Skill-biased' Technology Shocks: The Role of Labour Market Policy," *The Economic Journal* 109: 242-265.

Mortensen, D. and Pissarides, C. (1999b) New Developments in Models of Search in the Labour Market, in Ashenfelter and Card (eds.) *Handbook of Labour Economics*, North Holland, Amsterdam (2589-2601).

Petrongolo, B. and Pissarides, C. (2001) "Looking into the Black Box: a Survey of the Matching Function," *Journal of Economic Literature,* 39:390-431.

Pissarides, C. (2000) *Equilibrium Unemployment Theory,* Cambridge USA: MIT Press.

Saint-Paul, G. (2000) *The Political Economy of Labour Market Institutions* Oxford: Oxford University Press.

Saint-Paul, G. (2005) "Are European labour markets becoming more competitive? Evidence from estimated worker rents," in Restrepo, J. and A. Tokman (eds.), Labour Markets and Institutions, Santiago: Central Bank of Chile 2005; 281-300.

Shimer, R. (2005) "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *American Economic Review* 95:25–49.

Visser, J. (2006) "Union Membership Statistics in 24 Countries", *Monthly Labor Review*, x:38-49.

Yashiv, E. (2000) "The Determinants of Equilibrium Unemployment" *American Economic Review* 90: 1297-1322.

7 Appendix

7.1 Derivation of the job creation condition in the rigid wage regime

Use the equilibrium valuation equation (8) to value a job under the rigid wage regime at $x = R^r$, imposing $V^r = 0$ and the fact that at the destruction margin by definition $J^r(R^r) + sT = 0$, to solve for $\lambda \int_{R^r}^1 J^r(z)dF(z)$:

$$\lambda \int_{R^r}^{1} J^r(z)dF(z) = w^r - sR^r - [r + \lambda(1 - F(R^r))]\, sT$$

Substitute this into (8) with $V^r = 0$ and obtain

$$(r + \lambda)\, J^r(x) = s\,(x - R^r) - (r + \lambda)\, sT$$

Now set $x = 1$ and use the zero profit condition in the rigid wage regime (10) to obtain the JC-condition:

$$\begin{aligned} (r + \lambda)\, J^r(1) &= s\,(1 - R^r - (r + \lambda)T) = (r + \lambda)\left[\frac{sk}{q\,(\theta^r)}\right] \\ &\Rightarrow \frac{(1 - R^r)}{(r + \lambda)} - T = \frac{k}{q\,(\theta^r)} \end{aligned} \tag{31}$$

7.2 Derivation of the job destruction condition in the rigid wage regime

Rewrite the job valuation equation (8) and impose $V^r = 0$ to obtain

$$(r + \lambda)\, J^r(x) = sx - w^r + \lambda \int_{R^r}^{1} J^r(z)dF(z) - \lambda F(R^r)sT. \tag{32}$$

Substitute $J^r(z) = \frac{s(z - R^r)}{(r+\lambda)} - sT$ in the integral on the right hand side:

$$\begin{aligned} (r + \lambda)\, J^r(x) &= sx - w^r + \lambda \int_{R^r}^{1} \frac{s\,(z - R^r)}{r + \lambda} dF(z) \\ &\quad -\lambda\,[1 - F(R^r)]\, sT - \lambda F(R^r)sT \\ &= sx - w^r + \frac{\lambda s}{r + \lambda} \int_{R^r}^{1} (z - R^r)\, dF(z) - \lambda sT. \end{aligned} \tag{33}$$

Imposing $x = R^r$ and $J^r(R^r) = -sT$ yields the condition for job destruction:

$$w^r = sR^r + \frac{\lambda s}{(r+\lambda)} \int_{R^r}^{1} (z - R^r)\, dF(z) + rsT$$

SFB 649 Discussion Paper Series 2008

For a complete list of Discussion Papers published by the SFB 649, please visit http://sfb649.wiwi.hu-berlin.de.

001 "Testing Monotonicity of Pricing Kernels" by Yuri Golubev, Wolfgang Härdle and Roman Timonfeev, January 2008.
002 "Adaptive pointwise estimation in time-inhomogeneous time-series models" by Pavel Cizek, Wolfgang Härdle and Vladimir Spokoiny, January 2008.
003 "The Bayesian Additive Classification Tree Applied to Credit Risk Modelling" by Junni L. Zhang and Wolfgang Härdle, January 2008.
004 "Independent Component Analysis Via Copula Techniques" by Ray-Bing Chen, Meihui Guo, Wolfgang Härdle and Shih-Feng Huang, January 2008.
005 "The Default Risk of Firms Examined with Smooth Support Vector Machines" by Wolfgang Härdle, Yuh-Jye Lee, Dorothea Schäfer and Yi-Ren Yeh, January 2008.
006 "Value-at-Risk and Expected Shortfall when there is long range dependence" by Wolfgang Härdle and Julius Mungo, Januray 2008.
007 "A Consistent Nonparametric Test for Causality in Quantile" by Kiho Jeong and Wolfgang Härdle, January 2008.
008 "Do Legal Standards Affect Ethical Concerns of Consumers?" by Dirk Engelmann and Dorothea Kübler, January 2008.
009 "Recursive Portfolio Selection with Decision Trees" by Anton Andriyashin, Wolfgang Härdle and Roman Timofeev, January 2008.
010 "Do Public Banks have a Competitive Advantage?" by Astrid Matthey, January 2008.
011 "Don't aim too high: the potential costs of high aspirations" by Astrid Matthey and Nadja Dwenger, January 2008.
012 "Visualizing exploratory factor analysis models" by Sigbert Klinke and Cornelia Wagner, January 2008.
013 "House Prices and Replacement Cost: A Micro-Level Analysis" by Rainer Schulz and Axel Werwatz, January 2008.
014 "Support Vector Regression Based GARCH Model with Application to Forecasting Volatility of Financial Returns" by Shiyi Chen, Kiho Jeong and Wolfgang Härdle, January 2008.
015 "Structural Constant Conditional Correlation" by Enzo Weber, January 2008.
016 "Estimating Investment Equations in Imperfect Capital Markets" by Silke Hüttel, Oliver Mußhoff, Martin Odening and Nataliya Zinych, January 2008.
017 "Adaptive Forecasting of the EURIBOR Swap Term Structure" by Oliver Blaskowitz and Helmut Herwatz, January 2008.
018 "Solving, Estimating and Selecting Nonlinear Dynamic Models without the Curse of Dimensionality" by Viktor Winschel and Markus Krätzig, February 2008.
019 "The Accuracy of Long-term Real Estate Valuations" by Rainer Schulz, Markus Staiber, Martin Wersing and Axel Werwatz, February 2008.
020 "The Impact of International Outsourcing on Labour Market Dynamics in Germany" by Ronald Bachmann and Sebastian Braun, February 2008.
021 "Preferences for Collective versus Individualised Wage Setting" by Tito Boeri and Michael C. Burda, February 2008.

SFB 649, Spandauer Straße 1, D-10178 Berlin
http://sfb649.wiwi.hu-berlin.de

This research was supported by the Deutsche Forschungsgemeinschaft through the SFB 649 "Economic Risk".