UNIVERSITA' CATTOLICA DEL SACRO CUORE

WORKING PAPER

DISCE

Dipartimenti e Istituti di Scienze Economiche

Job protection, industrial relations and employment

Giulio Piccirilli

IEIL0050 - October - 2007

UNIVERSITA' CATTOLICA DEL SACRO CUORE
- Milano -

QUADERNI DELL'ISTITUTO DI
ECONOMIA DELL'IMPRESA E DEL LAVORO

Job protection, industrial relations and employment

Giulio Piccirilli

n. 50 – ottobre 2007

QUADERNI DELL'ISTITUTO DI
ECONOMIA DELL'IMPRESA E DEL LAVORO

Istituto di Economia dell'Impresa e del Lavoro
Facoltà di Economia
Università Cattolica del Sacro Cuore
Largo Gemelli, 1 - 20123 Milano

* I quaderni sono disponibili on-line all'indirizzo dell'Istituto
http://www.unicatt.it/istituti/ EconomiaImpresaLavoro

* Esemplare fuori commercio per il deposito legale agli effetti della Legge n. 106 del 15 aprile 2004.

* La Redazione ottempera agli obblighi previsti dalla Legge n. 106 del 15.04.2006, Decreto del Presidente della Repubblica del 03.05.2006 n. 252 pubblicato nella G.U. del 18.08.2006 n. 191.

Job protection, industrial relations and employment

Giulio Piccirilli

Istituto di Economia dell'Impresa e del Lavoro, Università Cattolica
giulio.piccirilli@unicatt.it

October 2007

Abstract

In a dynamic stochastic monopoly union model we show that firing costs have a small and ambiguous impact on the level of employment if the union precommits to future wages. Further, in comparison with the commitment equilibrium and for very general union preferences, the no-commitment equilibrium exhibits higher wages and a lower employment level.

Since commitment-like equilibria are more likely in cooperative bargain environments, these results suggest that, coeteris paribus, the interaction between employment protection and the quality of industrial relations reduces unemployment. We provide evidence on OECD countries which is consistent with this predictions.

Keywords: Firing Costs, Unemployment, Industrial Relations

Jel-Code: J23, J51, J63

1 Introduction

In spite of the large amount of research devoted to the consequences of employment protection, the issue still draws the attention of the economic profession. Some results are by now conclusive. There are no doubts, for instance, that employment protection compresses job market flows and increases long term unemployment. Other results, however, are controversial. Notably, theoretical as well as empirical works do not seem to offer a clear perspective on the relationship between protection and the rate of aggregate unemployment.

In this paper we attempt to shed some light on the unemployment impact of protection by means of a theoretical and empirical investigation which emphasises the roles of wage bargaining and industrial relations.

The idea that the impact of protection in wage bargaining is essential to understand the impact on unemployment arises from the literature.

In a famous early paper, Lazear (1990) clarifies that what matters for severance payments to affect employment is whether they increase the overall cost of labour. It follows that these transfers reduce employment only to the extent they are not undone through lower bargained wages at entry.

In contrast with Lazear, Lindbek and Snower (1988) and Bertola and Bentolila (1990) focus on those components of protection that can be described as pure firing taxes. In spite of this difference, however, the impact of firing provisions in wage bargaining continues to be crucial. In Lindbeck and Snower, firing taxes contribute to the bargaining strength of insiders in wage negotiations and, as a consequence, firm hire less workers. In Bertola and Bentolila, instead, firing taxes are not allowed to affect wages. As a result, firing provisions compress job creation and destruction but the net impact on average employment is inherently uncertain.

Liumqvist (2002) clarifies that the nexus between wage bargaining and the employment impact of firing taxes carries over to general equilibrium models with search and matching. In these models, whether firing taxes increase equilibrium unemployment depends crucially on whether they affect the split of match surplus. If firing taxes are allowed to change the split of match surplus in favour of workers, which is akin to assume that taxes contribute to their bargaining strength, unemployment unambiguously increases (Saint-Paul, 1995). By contrast, if firing taxes are not allowed to affect the split of match surplus, which is akin to assuming no impact in wage bargaining, unemployment does not display any predictable variation following an increase in protection. More precisely, the sign of the variation depends on non-core elements of the model such as the assumptions regarding the dynamics of match productivity (Mortensen and Pissarides, 1999, and Burda,1992)[1].

Given that wages represent the main channel that conveys the link between employment protection and unemployment, a natural question to ask is under what conditions higher firing costs lead to higher bargained wages. In this paper, we take the view that the relationship between firing costs and wages depends on whether wage setters can enter long-term commitments or, more concretely, on whether the industrial relations environment favours long-term cooperative interactions between workers and firms. The reason lies in a classical hold-up problem. Firing costs strengthen the bargain power of employed workers and allow rent extraction in the form of higher wages. Firms, in turn, anticipate the opportunistic behaviour of workers and reduce labour demand during business expansions. It follows that workers can boost the number of recruits during business expansions only if they are able to commit ex-ante to future wage moderation. Within this perspective, cooperative industrial relations are expected to offer an environment which permits long term commitments through informal agreements. Enforcement of these agreements is provided by the costs associated to interrupting the cooperation. By contrast, adversarial relationships represent the natural backstage for the opportunistic behaviour which lies at the core of the hold-up problem. Thus, in our view, the quality of industrial relations plays a role in determining the overall wage and employment impact of firing restrictions.

The model at the core of the paper borrows from the setting of Bertola (1990) but substitutes exogenously fixed wages with endogenous wage-setting operated by a union in an industry with atomistic firms. The assumption of a monopolistic union facing many competitive firms simplifies the analysis and, for this reason, is also common to many previous contributions[2]. Nevertheless, in the real world unions do not possess unlimited

[1] Of course, the contributions that have been cited represent only a small part of a large body of literature. A non-exaustive list would also include Hopenhayn and Rogerson (1993), Bentolila and Saint-Paul (1994), Millard and Mortensen (1994), Bertola and Rogerson (1997), Pissarides (2000).

[2] If one browse within the set of papers cited in this introduction, the monopoly union assumption has

bargaining power in wage negotiations so that the assumption should be used only in contexts where results do not hinge on the degree of union power. We believe that this is the case in the present study. After all, what is relevant for the substantive implications of the model is the fact that the union possesses *some* power in wage negotiation and that firing taxes interact with this power by offering a support for rent extraction.

In addition to endogenous wages, the model exhibits two other distinctive features, a stochastic dynamic environment and firing taxes that are proportional to the number of layoffs. We believe that these ingredients are useful to capture the essential traits of regulated labour markets. The reasons are the following. First, firing restrictions are commonly regarded in the world of businesses to be detrimental to the ability of firms to cope with unforeseen contingencies. This view suggests the use of a stochastic dynamic environment as a natural setting for the investigation. Second, in almost all countries, employment protection legislation (EPL) commands per-worker provisions (Emerson, 1988; OECD, 1999). This fact obviously translates into taxes that are proportional to the size of workforce adjustments. Furthermore, the empirical literature based on micro-level data appears to be supportive of linear specifications as opposed to convex specifications. Workforce adjustments of single firms are discrete and infrequent instead of being small and continuous (Hamermesh,1989; Burda, 1991).

We analyse this setting both under union commitment and no-commitment on future wages and find results that can be summarised as follows. First, in the equilibrium under commitment, firing restrictions reduce workforce turnover but the impact on employment and wages turns out to be ambiguous. Second, in the equilibrium under no-commitment, firing restrictions exert an additional positive impact on wages that is absent under commitment, this impact relates to the hold-up problem outlined above. Furthermore, the impact depends on the curvature of the union objective function in the sense that it is stronger if workers become more averse to variations in the wage flow. Thus, in comparison with the commitment case and for a reasonable degree of risk aversion, firing restrictions lead to higher wages and lower employment levels.

Using the conjecture that long-term commitments overlap with the notion of coopera-

been used by Kennan (1988) , Modesto and Thomas (2001) and Garibaldi and Violante (2005).

tive industrial relations, we test these results by means of OECD data for unemployment and a set of unemployment determinants together with World Economic Forum (WEF) information on the quality of industrial relations in different countries. Results turn out to be in line with theoretical predictions. More specifically, we find that EPL reduces unemployment in countries featuring cooperative industrial relations but turns out to be neutral in adversarial contexts.

Related literature

Close to the present paper are the works of Kennan (1988) and Modesto and Thomas (2001). Both contributions exhibit endogenous wage setting, a monopoly union and a sector of many competitive firms subject to workforce adjustment costs. These papers, however, depart from the linear cost tradition and build on the analytically friendly but unrealistic assumption of quadratic symmetric costs. Their main concern is to study connections between the characteristics of the wage bargaining process and the speed of adjustment of employment to its long run equilibrium level. The model in Modesto and Thomas is also non-stochastic so that adjustments are interpreted as following from a once-and-for-all perturbation. Finally, in Modesto and Thomas the equilibrium under commitment coincides with the one under no-commitment if firing costs are linear proving that the quadratic cost assumption is crucial for their results.

Since we focus on an interaction between Epl and the institutional environment of wage bargaining a contribution which we regard close in spirit to the present work is the paper by Garibaldi and Violante (2005). These show that a further relevant interaction is the one between Epl and the degree of centralisation in wage bargaining. In their setting, firing costs are modeled as transfers so that centralisation matters in that it prevents full undoing of these transfers. In spite of the difference between the two settings, however, their point is similar to the one made in the present paper. To understand the employment impact of Epl one needs to uncover the interplay between firing provisions and the characteristics of the bargaining environment.

The plan of the paper is as follows. In section 2 we present the theoretical environment. In sections 3 and 4 the firms-union interaction is studied respectively with and without a commitment on wages. In section 5 we analyse the interaction between firing costs and the ability to commit while in section 6 we check whether theoretical results are empirically consistent. Section 7 contains some concluding remarks.

2 Model

2.1 Assumptions

A single wage-setting union and a unit mass of identical competitive firms operate in the same industry. Business conditions, i.e. demand and productivity conditions, are common to all firms and are subject to stochastic changes. Firms maximise the discounted cash flow by adapting their workforce to changing business and wage conditions. In making these decisions, however, they are obliged to pay to a third party a firing cost for any dismissed worker. Production is realised through a labour-only technology, the current cash flow cf is given by the difference between current revenues and labour costs:

$$cf(\alpha_t, w_t, l_{t-1}, l_t) = (\alpha_t - \frac{d}{2}l_t)l_t - w_t l_t - I_{l_t \leq l_{t-1}} F\,(l_{t-1} - l_t)$$

Revenues $(\alpha_t - \frac{d}{2}l_t)l_t$ depend on the level of firm's employment l_t and on the shifter α_t which indexes business conditions during period t. The value of the shifter may change from period t to period $t+1$. We assume that the motion is governed by a two-states Markov process, α cycles between an high value α_g and a low value α_b $(< \alpha_g)$ with a constant per-period transition probability q (< 1). Labour costs are given by the wage bill $w_t l_t$ plus total firing costs. F represents the firing cost for a single dismissed worker while $I_{l_t \leq l_{t-1}}\,(l_{t-1} - l_t)$ gives the total mass of dismissed workers. The dummy $I_{l_t \leq l_{t-1}}$ switches from 1 to 0 if current employment becomes higher than past employment.

The union maximizes a discounted utility flow by adopting an optimal wage policy (monopoly union), per-period utility $U(w_t, L_t)$ depends on the wage level w_t and on aggregate employment L_t.

We assume that the union is utilitarian:[3]

$$U(w_t, L_t) = L_t v(w_t) + (m - L_t) v(\widetilde{w}) \tag{1}$$

In this expression, m represents union membership, which we assume to be fixed, and $(m - L_t)$ the number of unemployed members. The utility of each member v depends on the union wage w_t for those who happen to be employed and on the "alternative" exogenous wage $\widetilde{w}$ for the unemployed. We assume that v belongs to the CARA or DARA families, i.e. the coefficient of absolute risk aversion $-v''/v'$ is either constant or decreasing with respect to the wage. We exclude functions displaying increasing absolute risk aversion (IARA) on the basis of the argument that they imply implausible risk behaviour.[4] Belonging to the CARA or DARA families also implies that v is concave with a positive third derivative.

2.2 The employment policy

In any period firms choose the level of employment after having observed the current state of business conditions and the current wage. Both variables are regarded to be exogenous by any (small) firm. The optimal employment sequence or, equivalently, the optimal hiring and firing sequence, solves the Bellman problem

$$V(\alpha_t, w_t, l_{t-1}) = \max_{l_t} cf(\alpha_t, w_t, l_{t-1}, l_t) + \tfrac{1}{1+r}\ E_t\left[V(\alpha_{t+1}, w_{t+1}, l_t)\right]$$

The value of the firm is given by the current cash flow plus the expected discounted continuation value. In addition to current wages and business conditions the value also depends on lagged employment due to the presence of firing costs.

To characterise the employment policy we introduce the notion of the shadow value of labour. We define the shadow value $S(\alpha_t, w_t, l_t)$ as the value accruing to the firm from a worker permanently added to its workforce. This value is computed along the optimal policy. Thus, the shadow value corresponds to the increase in V due to a marginal upward

[3]The utilitarian objective function has been widely used in the union literature. The obvious reference is Oswald (1985).

[4]With IARA preferences, low wage individuals are less averse to absolute risk than high wage individuals.

shift in the employment path $\{l_{-1}, l_t.....\}$:

$$S(\alpha_t, w_t, l_t) = \alpha_t - d\ l_t - w_t + \frac{1}{1+r} E_t\left[S(\alpha_{t+1}, w_{t+1}, l_{t+1})\right] \tag{2}$$

The shadow value is given by a recursive relationship since it equals the current net marginal revenue of labour plus the expected discounted next period shadow value. Due to the linearity of firing costs, for a given current employment l_t, $S(\alpha_t, w_t, l_t)$ is unrelated to lagged employment l_{t-1}. In this sense S is a pure forward looking variable corresponding to the expected discounted sum of net marginal labour products:

$$S(\alpha_t, w_t, l_t) = \sum_j \left(\frac{1}{1+r}\right)^j E_t\left(\alpha_{t+j} - d\ l_{t+j} - w_{t+j}\right) \tag{3}$$

Equation 3 has been obtained by running forward the recursive expression in 2 and by conjecturing asymptotic boundedness for the shadow value. This conjecture turns out to be correct along the optimal employment path.

Since laying off a single worker costs F while a recruit costs nothing, firms choose inaction when the shadow value *under inaction* - *i.e.* $S(\alpha_t, w_t, l_{t-1})$ - lies within the interval $[-F, 0]$. In this case, in fact, neither hiring nor firing yield a net positive reward. Workforce adjustments occur only when $S(\alpha_t, w_t, l_{t-1})$ falls outside the inaction interval $[-F, 0]$. If $S(\alpha_t, w_t, l_{t-1}) > 0$ optimality requires recruiting new workers. Further, hiring must take place up to the point the marginal recruit becomes valueless or, more formally, up to the point the shadow value is brought to the upper boundary of the inaction interval, i.e. $S(\alpha_t, w_t, l_t) = 0$ if $l_t > l_{t-1}$. On the other hand, if $S(\alpha_t, w_t, l_{t-1}) < -F$ optimality requires a reduction in workforce. In particular, this reduction must be such that firing an extra worker entails no net positive value, this happens when the shadow value is brought to the lower boundary of the inaction interval, i.e. $S(\alpha_t, w_t, l_t) = -F$ if $l_t < l_{t-1}$. This confirms the conjecture that the shadow value is bounded along the optimal policy.

We conclude this section with a formal description of the optimal employment policy which will turn useful when we analyse union behaviour. For this purpose, we define two threshold levels for w_t which serve to specify whether the current wage triggers hiring, firing or inaction. Thus, let $\overline{w}(\alpha_t, l_{t-1})$ and $\underline{w}(\alpha_t, l_{t-1})$ represent respectively the *maximum* and the *minimum* wage consistent with inaction, these thresholds are defined as follows:

$$\overline{w}(\alpha_t, l_{t-1}) = \alpha_t - d\ l_{t-1} + \frac{1}{1+r} E_t \left[S(\alpha_{t+1}, w_{t+1}, l_{t+1}) \right] + F \tag{4}$$

$$\underline{w}(\alpha_t, l_{t-1}) \equiv \overline{w}(\alpha_t, l_{t-1}) - F \tag{5}$$

These equations imply that if the current wage w_t is equal to $\overline{w}$ then the shadow value under inaction $S(\alpha_t, w_t, l_{t-1})$ is equal to $-F$ whereas if the current wage is equal to $\overline{w}$ the shadow value is nil. Thus, if the current wage lies inside the interval $[\underline{w}, \overline{w}]$ firms choose inaction. Notice also that the thresholds depend upon the expected next period shadow value and, through this channel, upon expected future wage rates. This means that higher future wages reduce both $\underline{w}$ and $\overline{w}$ and make firing a more likely occurrence for any given current wage w_t. Reversing the perspective, lower expected future wages allow the union to charge higher current wages without incurring into a reduction in the number of employed workers.

Using the wage thresholds we can express the optimal employment policy as follows:

$$I_{w_t \leq \underline{w}(\alpha_t, l_{t-1})} S(\alpha_t, w_t, l_t) = 0 \tag{6}$$

$$I_{w_t \geq \overline{w}(\alpha_t, l_{t-1})} \left[S(\alpha_t, w_t, l_t) + F \right] = 0 \tag{7}$$

$$I_{\underline{w}(\alpha_t, l_{t-1}) \leq w_t \leq \overline{w}(\alpha_t, l_{t-1})} (l_{t-1} - l_t) = 0 \tag{8}$$

In these equations, the dummy $I_{()}$ is equal to 1 when the attached condition is true and to 0 otherwise. The first equation describes firm behaviour when the current wage is set equal or below $\underline{w}$. If $w_t = \underline{w}$ the shadow value S is equal to zero by definition whereas, if $w_t < \underline{w}$, firms increase employment so as to reset S to zero. The second and the third equations have similar interpretations.

2.3 The wage policy

In the first part of this section we analyse the strategy of the union under the assumption that it can precommit to a particular wage policy. At the end of the section we deal with the no-commitment case.

2.3.1 The wage policy under commitment

Let $h_t = (\alpha_0, \alpha_1, ...\alpha_t)$ represent the history of exogenous business conditions from period 0 up to period t and H_t the set of all possible vectors h_t, we assume that the union commits by announcing a sequence of history contingent wages $w_t(h_t)$, $t = 0, 1..$, for all $h_t \in H_t$. The announcement is made at the beginning of period 0 and, therefore, is conditioned on the observation of current business conditions α_0 and lagged aggregate employment L_{-1}. The union chooses the wage sequence so as to maximise the discounted utility flow under the constraints posed by the employment decisions of firms. Formally, this amounts to state that the union is faced with solving the Lagrangian problem

$$\mathcal{L} = E_0 \left\{ \sum_t \left(\frac{1}{1+r} \right)^t \left[U(w_t, L_t) + \sigma_t I_t^H S_t + \lambda_t I_t^F (S_t + F) + \gamma_t I_t^I (L_{t-1} - L_t) \right] \right\} \tag{9}$$

Multipliers $[\sigma_t, \lambda_t, \gamma_t]$ have been used to embed into the program the constraints 6-8 that follow from the employment policy of firms. For ease of notation, $S(\alpha_t, w_t, L_t)$ has been substituted with S_t while the dummies in constraints 6-8 have been substituted respectively with I_t^H, I_t^F and I_t^I [*H: hiring, F: firing, I: inaction*]. Since the mass of firms has a unit measure, aggregation implies $l_t = L_t$. Thus, l_t needs to be substituted with L_t when one refers to the constraints arising from the aggregate employment policy.

The problem in 9 can not be solved through dynamic programming since the shadow value S_t and the vector $\left[I_t^H,\ I_t^F,\ I_t^I \right]$ depend upon (the expected value of) future wages. Equation 3 illustrates the forward nature of S_t while equations 4 and 5 illustrate the forward nature of the wage thresholds $\overline{w}$ and $\underline{w}$ which, in turn, determine the dummy vector. Intuitively, future wages affect the current union welfare by determining the current value for firms of an extra worker added to the workforce. This, in turn, determines whether firms fire, hire or stay inactive at current time and, in the first two cases, how many workers are involved in the adjustment.

The fact that future wages affect current employment decisions causes the optimal policy to be time inconsistent. The union has an incentive to announce low future wages and then to renege on the announcement. On technical grounds, program 9 is non-recursive and can not be solved with the Bellman format. For this reason, we transform the program and make it recursive by adopting the method of Marcet and Marimon (1992). This method consists of introducing fictitious state variables - Abel-variables in the words of Liumqvist and Sargent (2004, chap 15) - which force the planner to implement the ex-ante optimal policy while behaving in time consistent fashion.

Let Σ represent the Abel-variable associated to S in constraint 6 and Λ the one associated to S in constraint 7, the definition of these variables is as follows[5]:

$$\Sigma_t = \Sigma_{t-1} + \sigma_t I_t^H \qquad \Lambda_t = \Lambda_{t-1} + \lambda_t I_t^F \qquad \Sigma_0 = \Lambda_0 = 0 \tag{10}$$

Let $Y_t = (\alpha_t, L_{t-1}, \Sigma_{t-1}, \Lambda_{t-1})$ represent the vector of state variables at time t and $W(Y_t)$ the discounted payoff flow along the optimal policy. Further, conjecture that the dummies $\left[I_t^H,\, I_t^F,\, I_t^I\right]$ are a function only of the current state Y_t. Under this conjecture, the law of motion in 10 implies that $W(Y_t)$ follows the Bellman recursion

$$\begin{aligned} W(Y_t) \;=\; & \max_{\{w_t,\, L_t,\, \sigma_t,\, \lambda_t,\, \gamma_t\}} U(w_t, L_t) + (\Sigma_t + \Lambda_t)(\alpha_t - dL_t - w_t) + \\ & + \lambda_t I_t^F F + \gamma_t I_t^I (L_{t-1} - L_t) + \frac{1}{1+r} E_t W(Y_{t+1}) \end{aligned} \tag{11}$$

As a result of recursivity, the solution of the program is represented by a set of *time*

[5] Note that S is not the only forward looking variable in the program. As observed in the text, the dummies also depend on the expectation over future wage and employment levels. However, when evaluating alternative wage policies, changes in these dummies do not affect the discounted welfare of the union. The reason is straightforward. Whenever a dummy is "active" the attached multiplier is nil since it represents the relevant first order condition for firms. Thus, if a dummy moves between zero and one as a consequence of a small change in the wage policy there in no impact on the discounted summation in 9.

invariant functions of Y_t:

$$f_t = f(Y_t) \qquad\qquad f = w, L, \sigma, \lambda, \gamma \tag{12}$$

For given initial conditions $Y_0 = [\alpha_o,\, L_{t-1},\, 0,\, 0]$, the evolution of the state vector Y_t is governed by these policy functions and by the stochastic exogenous motion of business conditions α. This implies that for any history $h_t = (\alpha_0, \alpha_1, ...\alpha_t)$ one can compute the corresponding state vector Y_t by applying functions $f(.)$ recursively. More formally, these policy functions introduce a correspondence from the set of history vectors H_t to the set of state vectors $\{Y_t\}$. Thus, for any given history h_t the optimal wage under commitment $w_t(h_t)$ is equal to the time invariant function $w(.)$ computed for the corresponding state vector Y_t.

Time invariance of policy functions also validates the conjecture for the vector $\left[I_t^H,\, I_t^F,\, I_t^I\right]$ being only dependent on the current state Y_t. In fact, given the current state Y_t, policy functions $f(.)$ map probabilities over the future evolution of the business index α_t into probabilities over future states Y_t. This means that Y_t is the only determinant of expectations concerning future wage and employment levels. Thus, Y_t is the only determinant of current wage thresholds, $\overline{w}_t$ and $\underline{w}_t$, and of the current dummies.

2.3.2 The wage policy under no-commitment

In the absence of a commitment wages are chosen period by period. This prevents the union from implementing the policy that is optimal as of the beginning of the game. Technically, behaving in a time-consistent not optimal fashion amounts to setting Σ_{t-1} and Λ_{t-1} equal to zero at the beginning of any period t so that the state vector collapses from $(\alpha_t, L_{t-1}, \Sigma_{t-1}, \Lambda_{t-1})$ to (α_t, L_{t-1}). For this reason, the wage and employment policies can be summarised as follows:

$$w_t \;=\; w(\alpha_t, L_{t-1}, 0, 0) \equiv \widetilde{w}(\alpha_t, L_{t-1}) \tag{13}$$

$$L_t \;=\; L(\alpha_t, L_{t-1}, 0, 0) \equiv \widetilde{L}(\alpha_t, L_{t-1}) \tag{14}$$

3 Wages and employment under commitment

3.1 The equilibrium under commitment

In this section we define the equilibrium under commitment and characterise the wage and the employment paths along such an equilibrium. The treatment is quite general as it does not relate to the particular law of motion which governs the exogenous dynamics of α. In the next subsection, we show how employment and wages evolve if α follows the two-states Markov process of good and bad business conditions.

Definition A commitment equilibrium is defined as follows:

i) *Optimal firm behaviour*: any firm sets employment l_t period by period according to equations 6-8;

ii) *Optimal union behaviour*: the union sets wages by precommitting at time 0 to the sequence $w_t(h_t) = w(Y_t)$, where Y_t is the state vector corresponding to h_t;

iii) *Aggregation*: aggregate employment is the sum of employment in all firms: $l_t = L_t$.

On the basis of this definition, it is straightforward to see that the equilibrium path for wages and employment results from functions $w_t = w(Y_t)$ and $L_t = L(Y_t)$. These, in fact, can be interpreted as mutual best responses since $w(Y_t)$ is, by construction, the optimal commitment policy face to firms employment decisions whereas $L(Y_t)$ derives from a program which is constrained by the optimal conditions 6-8.

In the appendix, we solve the program 11 and provide some formal statements which serve to characterise the $w(Y_t)$ and $L(Y_t)$ sequences. We reach two main results:

Result 1: Under commitment, if employment is constant from one period to the other, wages are also constant (lemma 1).

Result 2: Under commitment, if business conditions do not change from one period to the other - i.e. $\alpha_t = \alpha_{t-1}$ - then employment and, by result 1, wages do not change. (proposition A1).

Result 1 is explained as follows. The objective function of the union is concave with respect to the wage. Thus, if employment is constant along a portion of the equilibrium path, the union strictly prefers to commit to a sequence of constant wages along this portion rather than to equivalent sequences with changing wages. For equivalent sequences we mean wage sequences with the same expected discounted value and that bring forth, as a consequence, the same employment level.

Result 2 is due to the fact that the cost of adjusting employment is linear not convex. Therefore, *providing* firms decide to adapt employment to new business and wage conditions, there is no gain for them to delay the adjustment or spread the adjustment over many periods. Thus, considering that wages change only if employment does (result 1), employment and wages change only at business turns - if they change at all - but not within a spell of constant business conditions.

3.2 Wages and employment

While the analysis conducted so far holds for any process driving business conditions in this section we restrict our attention to the simple stochastic cycle of good and bad conditions. Recall that results 1 and 2 imply that employment and wages can only change at business turns but not within a spell of constant business conditions. Furthermore, it is also possible that employment and wage do not change at all as a consequence of firing costs that are prohibitively large. However, we regard this case as implausible from an empirical point of view. After all, even in countries with very strict employment protection workforce responds to idiosyncratic firms conditions (OECD, 1994). Thus, in the remainder of this section we focus on an equilibrium which exhibits hiring at the beginning of good spells and firing at the beginning of bad spells[6]. We first show how to compute wage and employment levels along such an equilibrium and then study under what parameter restrictions positive workforce adjustments take place. Towards the end of the section we discuss the employment impact of firing costs.

Let us define with L_g^c and w_g^c [c: *committment*] the employment and wage levels along a good spell and with L_b^c and w_b^c the corresponding values along a bad spell. Despite the vector $[L_g^c,\ L_b^c,\ w_g^c,\ w_b^c]$ can be formally computed from program 11 we opt for a more intuitive derivation by noticing that positive workforce adjustments imply that the program of the union is separable across good and bad spells. In other words, when

[6] Hiring at the beginning of bad spells (as a consequence of very low wages) and firing at the beginning of good spells (as a consequence of very high wages) can not be part of an equilibrium. Wages and employment are normal goods for the union (see the discussion below), thus the two variables increase (decrease) jointly when demand conditions improve (deteriorate).

choosing w_g^c at the beginning of a good spell, the union knows that L_g^c has no impact on its own returns once business conditions turn bad. This is because linear adjustment costs and positive firing imply that the subsequent choice on L_b^c by the firm sector only depends upon w_b^c but not on L_g^c.[7] For analogous reasons, when choosing w_b^c at the beginning of a bad spell the union knows that L_b^c has no impact on the continuation value in case business conditions turn good.

Since current employment does not affect returns in subsequent spells, the union sets the wage so as to maximise the discounted utility flow only over the current spell. Furthermore, as employment and wages are constant within spells, this boils down to solving a couple of static programs:

$$\max_{w_g^c} U(w_g^c, L_g^c) \tag{15}$$

$$L_g^c = \frac{1}{d}\left[\alpha_g - \frac{q}{1+r}F - w_g^c\right] \tag{16}$$

$$\max_{w_b^c} U(w_b^c, L_b^c) \tag{17}$$

$$L_b^c = \frac{1}{d}\left[\alpha_b + \frac{r+q}{1+r}F - w_b^c\right] \tag{18}$$

In these programs, labour demands 16 and 18 have been obtained from equation 2 after substituting the relevant values of S. Constant employment and wages within spells lead to constant values of S. Thus, S is equal to 0 at all times within good spells and to $-F$ at all times within bad spells.[8]

Labour demands 16 and 18 clarify under what conditions positive hiring and firing arise

[7] Of course, L_g^c has no impact on union returns but has an impact on firms returns if business conditions turn bad since an higher level L_g^c means more dismissals and higher dismissal costs.

[8] According to these programs, the dynamic equilibrium under commitment results from a simple collection of purely static equilibria. The similarity with the static case, however, should not be interpreted literally. For, in a static context, the position of labour demand is exhogenous whereas, in the present setting, the position of labour demand is endogenously determined by the wage policy to which the union has committed.

in equilibrium. Due to the strict convexity of indifference curves generated by $U(w, L)$ and the linearity of labour demands, wages and employment are "normal goods" for the union. Thus, since positive adjustments require $L_g^c > L_b^c$, a necessary and sufficient condition for positive adjustments (and for $w_g^c > w_b^c$) is that labour demand in good times lies above labour demand in bad times. By inspecting demand schedules this amounts to impose the following restriction on parameters:

$$\alpha_g - \alpha_b > \frac{r + 2q}{1 + r} F \tag{19}$$

Intuitively, positive adjustments arise if firing costs are sufficiently low and/or the change in business conditions sufficiently large. Further, notice that firing costs enter the inequality in combination with the transition rate q. An higher transition probability makes business spells less durable and, as a consequence, reduces incentives to workforce adjustments. Thus, for given firing costs, positive adjustments tend to arise when q is small.

Having characterised the determination of employment and wages we now focus on the impact of firing costs on these variables.

We begin with the impact of firing costs on workforce turnover and wage fluctuations.[9] Observe that firing costs shift labour demand up in bad times and down in good times. The first effect is straightforward as it relates to the protection role of firing costs. The second is more subtle; for a given wage level, higher firing costs reduce incentives to hiring in good times as firms expect a reversal in business conditions in the future. Thus, more recruits in good times mean more dismissals - and higher dismissal costs - when bad conditions return. The consequences of these demand shifts in terms of employment and wage levels are straightforward. Since employment and wages are normal goods for the union, a lower labour demand in good times leads to lower levels of both variables. By contrast, an higher labour demand in bad times leads to higher employment and wage levels. The upshot of these effects is that firing costs tend to dampen wage and employment fluctuations that

[9]The impact of firing costs on turnover has been firstly analysed by Bertola (1990) and Bentolila and Bertola (1990) in models with exhogenous wages.

take place at business turns.

Smaller employment fluctuations, however, are not accompanied by clear-cut changes in their average level. These changes, in fact, depend on a “discounting effect”, governed by r, and on a “curvature effect” which is governed by the shape of union indifference curves.

Discounting makes firing costs more relevant for firing decisions than for hiring decisions. Formally, the multiplier of F in equation 16 is smaller in absolute size than the one in equation 18 by an amount which increases with respect to r. As a consequence, the upward shift of the schedule in bad times is more pronounced in comparison to the downward shift in good times. This effect - taken alone - obviously leads to an increase in average employment following an increase in firing costs.

In contrast with the *positive* discounting effect the curvature effect is *negative*, at least under standard specifications of the utility function of workers. The curvature effect is related to the shape of union indifference curves. In a stochastic cycle of low and high demand schedules the shape of these curves clearly matters in determining average employment. Setting aside the discounting effect ($r = 0$), the position of labour demand is determined by the "adjusted" business index $\alpha_g - qF$ in the good state and by $\alpha_b + qF$ in the bad state. Thus, higher firing costs reduce the volatility of labour demand by reducing the fluctuations of the adjusted index while preserving the average value. It follows that if union wages are concave with respect to the index, higher firing costs tend to increase the average wage and to decrease average employment. By contrast, if wages are convex with respect to the index, higher firing costs decrease the average wage and increase employment.

The set of functions $v(w)$ in use in this paper (DARA and CARA) is too general to establish whether wages are convex or concave with respect to the adjusted index. However, when we focus on the subset of DARA and CARA functions that are commonly used in the union literature (exponential, isoelastic and logaritmic), we find that wages are concave so that, through the curvature effect, firing costs exert a *negative* impact on employment. The details of this result are spelled out in the appendix (proposition A2).

Summing up, under commitment the impact of firing costs on average employment is of uncertain sign. Firing costs increase employment through the discounting effect but decrease employment, under standard preferences, through the curvature effect.

4 Wages and employment under no-commitment

4.1 The equilibrium under no-commitment

In this subsection we define the equilibrium under no commitment and characterise the wage and employment sequence for any stochastic process governing the evolution of business conditions. In the next subsection we focus on the Markov cycle of good and bad states.

Definition A no-commitment equilibrium is defined as follows:

i) *Optimal firm behaviour*: any firm sets employment l_t period by period according to equations 6-8;

ii) *Optimal union behaviour*: the union sets wages period by period by using the wage setting function $w_t = \widetilde{w}(\alpha_t, L_{t-1})$ (see equation 13).

iii) *Aggregation*: aggregate employment is the sum of employment in all firms: $l_t = L_t$.

As for the commitment case, it is straightforward to see that, under no-commitment, the equilibrium sequences of wages and employment are described by $\widetilde{w}(\alpha_t, L_{t-1})$ and $\widetilde{L}(\alpha_t, L_{t-1})$. By construction, these functions represent mutual best responses in a game where the current state encapsulates all relevant information for predicting future variables. The ensuing equilibrium can thus be termed as Markov subgame perfect (Maskin and Tirole, 1988). In the appendix we formally study the characteristic of this equilibrium, below we report the main results from this analysis.

Result 3: Under no-commitment, the union sets $w_t = \overline{w}_t$ - i.e. the maximum wage consistent with employment inaction - if inaction prevails at time t (lemma 4).

Result 4: Under no-commitment, employment *may* change only at business turns but not within a spell of constant business conditions (proposition A3).

Result 5: Under no-commitment, the wage is constant along spells that start with dismissals. By contrast, along spells that start with recruits, the wage increases by F

from the first to the second period of the spell and remains at the higher level until the end of the spell. (lemma 7).

Result 3 is crucial to understand the characteristics of the equilibrium. Intuitively, the union does not possess the technology to commit to future low wages and, through this way, to sustain current labour demand. As a consequence, firms expect that if there are margins to increase wages in some future state without affecting employment in that state, then the union will fully exploit these margins. Indeed, in equilibrium, the union does not gain from contradicting this expectation. There is no gain from not increasing the wage up to $\overline{w}$ if this does not harm current employment nor the continuation value of the game.

The motivation of employment inaction within spells (result 4) is similar to the one given for the commitment equilibrium. With linear adjustment costs there is no reason for firms not to adjust immediately to new business and wage conditions.

Finally, result 5 is closely related to the fact that the union pushes firms onto the firing barrier in all states where inaction prevails (result 3) and to the fact that inaction prevails for sure within a spell of constant business conditions (result 4). This means that the union sets wages so as to push firms onto the firing barrier at all times during a spell that starts with dismissals. Thus, along these spells the wage is constant. By contrast, for spells that start with recruits, the shadow value lies, by definition, on the hiring barrier in the first period and on the firing barrier thereafter. This shift in the shadow value is only possible if the union increases the wage by F from the second period onwards. Intuitively, after firms have recruited new workers, the union fully exploits the margins for a wage increase that are guaranteed by firing costs.

4.2 Wages and employment

Results 3-5 do not require any restriction on the stochastic process that drives exogenous business conditions. In this section we return to the cycle of good and bad conditions and analyse what are the implications of these results in such a simplified setting.

Result 4 suggests that in the two-states cycle the equilibrium may either exhibits employment inaction at all times or positive employment adjustments but only at the beginning of business spells. Similar to the commitment case, whether inaction prevails at all times depends on the size of firing costs and on how large are the swings of business condition. With reasonable firing costs and/or sufficiently large swings workforce adjusts at positive rates. In this case, employment fluctuates between an high level L_g^{nc} (nc : *non committment*) and a low level L_b^{nc}. Furthermore, wages are set so as to keep the shadow value on the firing barrier at all times with the exception of the first period of a good spell. In particular, the wage is constant at level w_b^{nc} along bad spells whereas, along good spell, it is set at the level w_g^{nc} in the first period and at level $w_g^{nc} + F$ in the following periods (result 5).

Similar to the commitment case, with positive adjustments the union program is separable across good and bad spells. This means that the union sets the wage in the first period of any spell so as to maximise the discounted per-period utility flow only over the spell. Employment and wages can thus be thought of as being determined through the following programs:

$$\max_{w_g^{nc}} \frac{r+q}{1+r} U(w_g^{nc}, L_g^{nc}) + \frac{1-q}{1+r} U(w_g^{nc} + F, L_g^{nc}) \tag{20}$$

$$L_g^{nc} = \frac{1}{d}\left[\alpha_g - \frac{F}{1+r} - w_g^{nc}\right] \tag{21}$$

$$\max_{w_b^{nc}} U(w_b^{nc}, L_b^{nc}) \tag{22}$$

$$L_b^{nc} = \frac{1}{d}\left[\alpha_b + \frac{r+q}{1+r} F - w_b^{nc}\right] \tag{23}$$

Labour demands 21 and 23 derive from equation 2 after substituting the relevant values for the shadow value of labour. Observe that labour demand in bad spells is the same in both equilibria. This is due to the fact that in both cases the shadow value S lies on the firing barrier at all times. Since the objective function of the union is also equal one may conclude that, along bad spells, the two equilibria are similar. Intuitively, the inability of enter a wage commitment is irrelevant when workers opportunism is not an issue, i.e. after workforce dismissals.

By contrast, the two equilibria differ when it comes to good spells. First, labour demand under no-commitment is lower than that under commitment. Firms anticipate the wage increase in the second period and, as a consequence, are more reluctant to hire for any given first period wage. Second, the F-shift of wages along good spells modifies the objective function of the union which, under no-commitment, turns out to be a weighted sum of the utility in the first and in all subsequent periods. The main implication of this change is the fact that the union is more willing to trade off a lower (first period) wage against higher employment.[10]

How large need to be F to prevent positive adjustments under no-commitment? Since the union is more willing to exchange lower wages for higher employment, a *sufficient condition* for $L_g^{nc} > L_b^{nc}$ is that labour demand 21 does not lie below labour demand 23:

$$\alpha_g - \alpha_b \geq \frac{1+q+r}{1+r}F \tag{24}$$

Similar to equation 19, this inequality requires F not to be too large with respect to the change in marginal productivity. Further, despite the condition appears to be more stringent than that arising under commitment one can not conclude that positive adjustments are less likely under no-commitment. Strictly speaking, the two conditions are not comparable since the restriction in 19 is necessary and sufficient while the restriction in 24 is only sufficient.

The impact of firing costs on employment and wage fluctuations is qualitatively similar to what we have seen under commitment. An increase in firing costs dampens the swings in labour demand and reduces fluctuations. By contrast, the impact of firing costs on employment and wage levels may be very different when one compares the two equilibria. We deal with this issue in the next section.

[10] To see this, assume $w_g^{nc} = w_g^c$ and $L_g^{nc} = L_g^c$ and compute the marginal rate of substitution for the two objective functions in 15 and 20.

5 Comparing equilibria

The no-commitment equilibrium exhibits many elements that trace back to the classic insider-outsider theory (Lindbeck and Snower, 1988). The union increases the wage by the whole amount of firing costs after new workers have been hired. Firms, in turn, anticipate the wage increase and recruit less workers for given "entry" wages. Obviously, the union is harmed by firms reluctance to hire and, if possible, it would promise not to exploit the margins guaranteed by firing costs. Yet, in the absence of a commitment device, subgame perfection rules out any promise that does not result to be credible. Indeed, promising wage moderation is not credible. After new workers have been hired, the union can safely increase the wage by the amount F without paying any cost in terms of dismissed workers and in terms of a deterioration in the continuation value.

However, in spite of the similarities with the insider-outsider theory, one can not immediately conclude that the insider-outsider mechanism leads to a lower employment level under no-commitment. For, in this case, firing costs not only move labour demand downwards but also bend the shape of union indifference curves in the w_g^{nc}-L_g^{nc} space (equation 20). In particular, F reduces the union marginal return from w_g^{nc} and increases that from L_g^{nc} leading to an incentive to exchange lower wages for higher employment. This induces the union to counteract the negative impact of firing costs on labour demand through low wages. Thus, if firing costs exert under no-commitment an extra negative employment effect which adds to the discounting and curvature effects is ex-ante undetermined. To establish whether the union fully neutralises the reluctance of firms to hiring through low entry wages one needs to study the determination of L_g^{nc} and L_g^c in some more detail.

Solving for L_g^{nc} and L_g^c requires to compute the first order condition from the corresponding programs and to combine these conditions with labour demand. Below, we present the expressions that result from these manipulations where, for the sake of simplicity, we have made two substitutions, $a = \frac{r+q}{1+r}$ and $R = \alpha_g - dL$:

$$\alpha_g - R = \frac{v\left[a\left(-\frac{1}{1+r}F + R\right) + (1-a)\left(\frac{r}{1+r}F + R\right)\right] - v(\overline{w})}{v'\left[a\left(-\frac{1}{1+r}F + R\right) + (1-a)\left(\frac{r}{1+r}F + R\right)\right]} \qquad (L_g^c)$$

$$\alpha_g - R = \frac{a\ v\left(-\frac{1}{1+r}F + R\right) + (1-a)\ v\left(\frac{r}{1+r}F + R\right) - v(\overline{w})}{\left[a\ v'\left(-\frac{1}{1+r}F + R\right) + (1-a)\ v'\left(\frac{r}{1+r}F + R\right)\right]} \qquad (L_g^{nc})$$

Observe first that if v were linear $[v'' = 0]$, the two conditions would coincide and the employment level would be the same no matter whether the union is able to commit or not. This result stands in sharp contrast with the insider-outsider contention that the opportunistic behaviour of workers always reduces the level of employment. Intuitively, when the utility function is linear, the union is not concerned with the actual path of wages but only with the discounted value from the whole wage flow. Thus, the union does not find it costly to charge a particularly low wage in the first period that completely counteracts the reluctance of firms to hiring. The commitment outcome can be replicated at no cost through a mechanism which is equivalent to paying in advance a bond which equals the discounted flow of rents that will accrue in future bargaining.

The class of functions in use, however, imply that v is concave with a positive third derivative. In this case, by the Jensen's inequality, the numerator on the RHS of the first expression is higher than the numerator of the second. By contrast, the denominator is lower. This means that the RHS of the first expression is always higher than that of the second. Further, if one regards the RHSs of the two expressions as functions of R, straightforward differentiation shows that the two RHSs increase and become closer as R increases. In figure 2 we depict the RHS and the LHS of the two expressions as functions of R.

Notice that, in equilibrium, the marginal revenue R is lower under commitment. Thus, we conclude that the employment level is higher under commitment, a result which is consistent with the insider-outsider theory. By the same argument, since firms equate the discounted flow of marginal revenues to the discounted flow of wages plus adjustment costs, wages are on average lower under commitment.

What happens when the utility function is concave? Concavity implies aversion towards anticipated sharp changes in the wage profile of the type that take place in the no-commitment case. Workers are harmed in that a flat wage profile with equal dis-

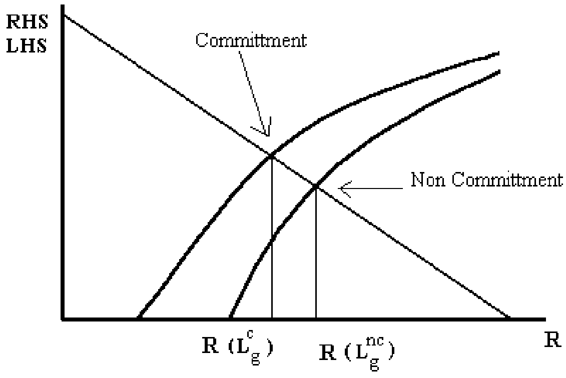

Figure 1: Commitment vs. No-commitment

counted value is strictly preferred to the actual one, which presents an increase of size F from the second period onwards.

This fact does not explain by itself the reasons for the union to choose a lower employment level, and higher wages, in the no-commitment case. It is not difficult to see, however, how this outcome results both from a lower return for the union from the employment level as well as from an higher return from the wage level. The wage shift of size F from the first to the second period reduces the utility of each single employed worker and, henceforth, reduces the gain from being employed as opposed to being unemployed. This means that the union faces a lower benefit from having a large number of employed workers. This effect is captured by the numerators of the expressions above. On the other hand, since the shift is fixed in size it becomes relatively less harmful in terms of utility if wages are particularly high. It follows that the union faces an higher return from a wage increase. This effect is captured by the denominator. Thus, both channels explain why concavity leads to higher wages and lower employment levels in the no-commitment case.[11]

In Table 1 we compute the employment effect from an increase in firing costs when the utility function is isoelastic: $v(w) = \frac{w^{1-\gamma}}{1-\gamma}$, $0 < \gamma < 1$. As γ increases utility becomes

[11]Modesto and Thomas (2001) show that the no-commitment equilibrium exhibits a lower employment level even if they assume $v'' = 0$. Their result, however, is driven by a different mechanism deeply rooted in the assumption of quadratic adjustment costs.

In contrast with linear costs, quadratic costs reduce the elasticity of labour demand in the short run but not that in the long run. As a consequence, the union charges higher wages when it deals with the short run labour demand, i.e. in the no-commitment case.

Curvature	$\gamma = 0.1$	$\gamma = 0.5$	$\gamma = 0.7$
Committtment	0.01	0	0
Non-Committtment	0.01	-3.8	-6

Table 1: Change in average employment (percent) if firing costs increase from F=1 to F=5. Parameters: $\alpha_g = 10$, $\alpha_b = 6$, $q = 0.3$, $r = 0.02$, $d = 2$, $\overline{w} = 4$

more concave, i.e. individuals suffer more for given expected jumps in the wage path. In the table we compute the proportional change in average employment $L_i = 0.5L_g^i + 0.5L_b^i$ $i = c, nc$ due to an increase in firing cost from $F = 1$ to $F = 5$.[12]

Observe that when the utility function is almost linear [$\gamma = 0.1$] the two equilibria present the same variation in average employment. In spite of the absence of a commitment, the union is capable of replicating (almost) the same employment outcome arising under commitment. In addition, the overall employment effect is positive but very small. When the curvature increases, the insider-outsider mechanism becomes more effective. We notice that average employment decreases by 3.8% in the no-commitment equilibrium if $\gamma = 0.5$ and by 6% if $\gamma = 0.7$. No employment reduction takes place in the commitment equilibrium.

6 Empirical analysis

A summary of theoretical results

The model predicts that firing costs exert an additional effect on employment - of negative sign - when one compares the equilibrium under no-commitment with the one under commitment. The reason is a classic hold up problem. Firing costs offer workers the opportunity of extracting high rents once they have been hired. Firms anticipate the opportunistic behaviour of workers and refrain from hiring too much during an upturn. Ex post, workers have no better choice than that of validating firms expectations.

In principle, firm reluctance to hiring could be overcome by particularly low entry wages. Low entry wages, however, may turn out to be very costly in utility terms if workers dislike sharp wage changes. That is, if they are risk averse and credit constrained.

[12]With $F = 5$, firing costs are slightly lower than the average wage arising in the no-commitment equilibrium (with $\gamma = 0.7$). In high employment protection countries the amount of firing costs is estimated to be almost equal to the annual wage bill (OECD, 1994).

Thus, in a world with risk aversion, credit market imperfections and with no-commitment, firing costs feed into wages and decrease employment below the level that would arise under commitment.

This insider-outsider effect adds to the employment impact of firing cost under commitment. The latter, however, is not clear-cut since it results from the combination of two countervailing effects, the discounting and the curvature effect. Thus, the model does not offer any prediction on the *overall* employment impact of firing costs but only on the *differential* impact between commitment and no-commitment equilibria.

Empirical Implications

How do these results translate into empirically testable predictions? A major difficulty in testing the model relates to finding information on long-term wage commitments. Explicit wage contracts are clearly short termed as these contracts usually span two or three years for most bargain contexts and across all the economies. Relying on explicit contacts, however, would be too restrictive since commitment-like equilibra can be also supported by implicit contracts or through long term relationships based on trust.

Contrary to explicit contracts, implicit contracts cannot be enforced by third parties, such as courts. Only the parties involved in the contract can determine whether the agreement has been violated and, eventually, decide for actions intended to punish deviations. Enforcement then typically involves the threat of interrupting cooperative relationships. In the context of the present analysis, firms and workers could agree for a plan of actions that replicate the commitment equilibrium with the understanding that firms revert to the non-commitment strategies if workers should ever defect. Indeed, it is straightforward to show that if the discount rate is sufficiently small the union will never defect.

Agreements that are governed by implicit contracts are self-enforcing. By contrast, relationships supported by trust are not self-enforcing since the party that trusts is, by definition, vulnerable to opportunism but expects that the other party will not exploit this vulnerability (James, 2002). Or, more in line with the theory of incentives, the party that trusts is confident that the other party will not exploit vulnerability due to the penalties that would otherwise be inflicted in some other dimension of social interactions (Spagnolo, 1999). In our context, trust means that firms expect that workers do not exploit the protection guaranteed by firing costs after they have been hired.

In the real world, the notions of trust and implicit contracts overlap with that of cooperation. Indeed, James (2002) explains that implicit contracts and trust represent two ways to obtain a pareto-efficient cooperative solution in a prisoner dilemma context. Thus, from the perspective of our model, we conjecture that an equilibrium similar to the one under commitment tends to overlap with cooperative industrial relations whereas no-commitment equilibria tend to be associated with adversarial relations. As a consequence, we expect that *coeteris paribus, the impact of firing costs on employment is less negative - or more positive - in contexts featuring more cooperative industrial relations.* For this reason, in the empirical analysis below we mainly focus on the interaction between employment protection and cooperation in industrial relations as a determinant of aggregate unemployment.

Data

We test this prediction by exploiting time-series and cross-country variability in unemployment, employment protection and quality of industrial relations. We use a panel that includes 20 OECD countries observed for 15 years, from 1990 to 2004; annual data, however, have been averaged over 5-years periods in order to clear for short run movements[13].

Information regarding the rate of unemployment and its determinants - inflation, unemployment benefits, labour taxation, employment protection, bargain institutions - is the one provided by the OECD and largely used in the macro-labour empirical literature (Nuziata 2003, for instance). Thus, given widespread use in former works, we do not give any detail here and invite the interested reader to look at the data appendix for the exact definition of variables and their source.

The OECD, however, does not provide systematic information on the climate of industrial relations for member countries. To fill the gap we have resorted to the index of "perceived" cooperation in industrial relations computed by the World Economic Forum (WEF). This index is constructed by asking a panel of qualified operators to quantify over a given scale the degree of cooperation in their country. For instance, in 1997 respondents were asked to express their opinion on the sentence "Labor-employer relations are

[13]This is the strategy adopted, among several others, by Nickell (1998), Belot and VanOurs (2004) and Garibaldi and Violante (2005).

Dependend variable: unemployment				
Model	I	II	III	IV
Inflation(t) - Inflation(t-1)	-.996*	-.992	-1.001*	-.990
	(0.551)	(0619)	(0.552)	(0.610)
Replacement Rate	-.045*	-.048	-.047*	-.047*
	(0.026)	(0.029)	(0.024)	(0.026)
Labour Taxation	.128**	.118**	.130**	.118**
	(0.041)	(0.049)	(0.041)	(0.049)
Centralisation	.751**	.820**	.768**	.813**
	(0.343)	(0.356)	(0.331)	(0.343)
Epl	.096	.262	0.192	.225
	(0.779)	(0.841)	(0.553)	(0.584)
Coop	-.218	.083		
	(0.751)	(0.886)		
Inter. Epl-Coop	-.680*	-.646*	-.772**	-.730**
	(0.397)	(0.423)	(0.148)	(0.149)
Union controls	No	Yes	No	Yes
Rsq.	0.56	.56	.56	.56
Nr. Obs.	60	60	60	60

Table 2: Robust standard errors in parentesis; ** 5% significance, * 10% significance.

generally cooperative" (answers: 1=strongly disagree, 7=strongly agree).

Due to the subjective nature of these answers doubts may arise regarding the reliability of the index. This issue, however, has been already addressed by Blanchard and Philippon (2004), who conclude that the index is a good approximation for an ideal objective measure in light of the high correlation with lagged measures of strike activity. The WEF index is available annually for a large number of countries since 1985. However, the wording of the question asked by the interviewers has changed over time, especially in early years. Thus, to preserve a certain degree of uniformity, we have decided to drop observations for years 1985-1989. This explains the reason for our dataset to begin with the year 1990.

Finally, for the purpose of estimation, a weakness of the WEF indicator is the small degree of variability. To get around this problem we have re-scaled the index over a 4-points array (0,1,2,3) by using quartile thresholds.

Estimation

Empirical findings are summarised in table 2. In model I we regress unemployment on a traditional "Phillips curve" set of regressors plus regressors that represent our focus variables: the EPL index, the WEF index of cooperation (Coop) and their interaction. In model II we add a set of union controls: coverage, density and coordination. Observe that most coefficients are of expected sign. Unemployment decreases with respect to the acceleration in inflation and increases with respect to labour taxation and the degree of centralisation in wage bargaining. Contrary to expectations, the impact from unemployment benefits (replacement rate) is negative (but not in model II). More importantly, the strictness of employment protection and the degree of cooperation in industrial relations do not affect unemployment but the interaction between them *reduces* unemployment, albeit only at a 10% significance level. Since the cooperation index is not significant nor it plays any autonomous role in the theoretical model, we exclude it in specifications III and IV. These represent our preferred estimations since the exclusion increases the significance of the negative interaction coefficient.

Although we have not dealt with issues of endogeneity, we believe that these results are consistent with the view that the employment effect of worker protection is determined by the industrial relations environment. Taken at their face value, point estimates imply that a unit increase in the EPL index reduces unemployment by $(0.75 \cdot Coop)$ percentage points. This means that in countries with adversarial relations ($Coop = 0$) EPL does not exert any appreciable impact on unemployment whereas, in countries with highly cooperative relations ($Coop = 3$), a point increase in EPL reduces unemployment by more than 2%.

7 Concluding remarks

In spite of the large attention over the last two decades, there is still a lack of consensus regarding the employment impact of mandated job protection. In models of dynamic labour demand with fixed wages - Bertola and Bentolila (1990), for instance - firing costs reduce workforce turnover but have an ambiguous impact on the level of employment. By contrast, the traditional insider-outsider theory - Lindbeck and Snower (1988) - suggests that wages represent an important channel for the overall employment impact of Epl. In particular, high firing costs strengthen the bargaining position of insiders and lead, as a consequence, to higher wages and lower employment. General equilibrium extensions confirm that the reaction of wages to firing costs is crucial for the overall employment effect of these costs. Empirical findings are also controversial. In the works of Lazear (1990) and Djankov *et al.* (2003), for instance, dismissal regulations increase unemployment. By contrast, Bertola (1990), the OECD (1999) and others find that aggregate employment levels are not affected by the stringency of legal provisions.

In this paper we offer new theoretical insights on the issue and show that the relationship between firing costs and employment is crucially influenced by the existence of a commitment on future wages. Under commitment, the relationship can have either sign depending on the discount rate, on the volatility of business conditions and on worker preferences over different wage and employment bundles. Under no commitment, firing costs add an extra effect of negative sign due to higher wages.

These results suggest that previous theoretical work has disregarded a potentially relevant interaction between Epl and those features of the wage bargaining process that determine whether workers can commit over future wages. A major implication is that employment protection combines with the quality of industrial relation in determining the rate of unemployment. Following an increase in Epl, unemployment tends to increase less (or decrease more) in contexts characterised by more cooperative industrial relations.

This prediction proves to be consistent with the evidence from 20 OECD countries observed over the 1990-2004 period. The interaction term between Epl and the index of cooperation turns out to affect unemployment with a negative sign implying that Epl is neutral for unemployment in adversarial contexts but decreases unemployment with cooperation.

A further implication of the model that has not been explored in this paper concerns the interaction between employment protection and the efficiency of credit markets. Well functioning credit markets favour consumption smoothing. In turn, improved smoothing translates, in reduced form, into a less concave worker utility. Finally, lower concavity implies that the equilibrium under no-commitment tends to replicate the employment sequences that obtains under commitment. An empirical test of this prediction is left to future research.

References

Belot M. and Van Ours J.C. (2004), Does the Recent Success of some OECD Countries in Lowering their Unemployment Rate Lie in the Clever design of their Labour Market Reforms?, Oxford Economic Papers, 56, 621-42;

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

Bentolila S. and Saint-Paul G. (1994), A Model with Labor Demand with Linear Adjustment Costs, Labour Economics, 1, 303-26;

Bertola G. (1990), Job Security, Employment and Wages, European Economic Review, 34, 851-886;

Bertola G. and Rogerson R. (1997), Institution and Labor Reallocation, European Economic Review, 41(6), 1147-71;

Blanchard O. and Philippon T. (2004), The Quality of Labor Relations and Unemployment, NBER working paper n. 10590;

Burda M. (1991), Monopolistic Competition, Costs of Adjustment, and the Behavior of European Manufacturing Employment, European Economic Review, vol. 35(1), pp. 61-79;

Burda M. (1992), A Note on Firing Costs and Severance Payments in Equilibrium Unemployment, Scandinavian Journal of Economics, 93(4), 479-89;

Djankov S., La Porta R., Lopez-de-Silane F., Shleifer A. and Botero J. (2003), The Regulation of Labor, NBER Working Papers n. 9756;

Emerson M. (1988), Regulation or Deregulation of the Labour Market: Policy Regimes for the Recruitment and Dismissal of Employees in the Industrialised Countries, European Economic Review vol.32 pp.775-817;

Garibaldi P. and Violante G.L. (2005), The Employment Effects of Severance Payments with Wage Rigidities, Economic Journal, 115, 799-832;

Hamermesh D. (1989), Labour Demand and the Structure of Adjustment Costs, American Economic Review, 74, 674-689;

Hopenhayn H. and Rogerson R. (1993), Job Turnover and Policy Evaluation: a General Equilibrium Analysis, Journal of Political Economy, 101, 915-38;

James H.S. Jr. (2002), The Trust Paradox: a Survey of Economic Enquires into the Nature of Trust and Trustworthiness, Journal of Economic Behaviour and Organisation, 47, 291-307;

Kennan J. (1988), Equilibrium Interpretations of Employment and Wage Fluctuations, NBER Macroeconomics Annual, 157-205;

Lazear E.(1990), Job Security Provisions and Employment, The Quarterly Journal of Economics, 105, 699-726;

Lindbeck A. and Snower D.J. (1988), The Insider-Outsider Theory of Employment and Unemployment, MIT Press;

Ljungqvist L. (2004), How Do Layoff Costs Affect Employment?, Economic Journal, 112, 829-53;

Ljungqvist L. and Sargent T.J. (2004), Recursive Macroeconomic Theory, MIT Press;

Marcet A. and Marimon R. (1992), Communication, Commitment, and Growth, Journal of Economic Theory, 58, 219-249;

Maskin E. and Tirole J. (1988), A Theory of Dynamic Oligopoly I. Overview and Quantity Competition with Large Fixed Costs, Econometrica, 56, 549-69;

Millard S. and Mortensen D. T. (1994), The Unemployment and Welfare Effects of Labour Market Policy: a Comparison of the U.S. and the U.K., in (D.J. Snower and G. de la Dehesa eds.) Unemployment Policy: How Government Should Respond to Unemployment?, Cambridge University Press;

Modesto L. and Thomas J. (2001), An Analysis of Labor Adjustment Costs in Unionized Economies, Labor Economics, 8,475-502;

Mortensen D.T. and Pissarides C.A. (1999), New Developments in Models of Search in the Labor Market, in (O. Ashenfelter and D. Cards, eds.) Handbook of Labor Economics, Amsterdam, North Holland

Nickell S. (1986), Dynamic Models of Labour Demand, in Handbook of labor economics. Vol. 1, 473-522;

Nickell S. (1998), Unemployment: Questions and some Answers, Economic Journal, 108, 802-16;

Nuziata L. (2003), Labour Market Institutions and the Cyclical Dynamics of Employment, Labour Economics, 10, 31-53;

OECD (1994), Employment Outlook 1994;

OECD (2005), Taxing Wages 2004/2005;

OECD (1999), Employment Outlook 1999;

OECD (1999), Economic Outlook 1999;

OECD (2000), Economic Outlook 2000;

OECD (2004), Economic Outlook 2004;

OECD (2005), Economic Outlook 2005;

OECD (2005), Taxing Wages 2004/2005;

OECD (2006), Economic Outlook 2006;

Oswald A. (1985), The Economic Theory of Trade Unions: an Introductory Survey, Scandinavian Journal of Economics, 87, 160-193;

Pissarides C. (2000), Equilibrium Unemployment Theory, MIT Press;

Spagnolo G. (1999), Social Relations and Cooperation in Organizations, Journal of Economic Behaviour and Organization, 38(1), 1-25;

Saint-Paul G. (1995), The High Unemployment Trap, Quarterly Journal of Economics, 110(2), 527-50;

WEF (World Economic Forum) (1996), The Global Competitiveness Report 1996, Geneva, WEF;

WEF (1997), The Global Competitiveness Report 1997, Geneva, WEF;

WEF (1998), The Global Competitiveness Report 1998, Geneva, WEF;

WEF (1999), The Global Competitiveness Report 1999, Oxford, Oxford University Press;

WEF (2000), The Global Competitiveness Report 2000, Oxford, Oxford University Press;

WEF (2002), The Global Competitiveness Report 2001-2002, Oxford, Oxford University Press;

WEF (2003), The Global Competitiveness Report 2002-2003, Oxford, Oxford University Press;

WEF (2004), The Global Competitiveness Report 2003-2004, Oxford, Oxford University Press;

WEF (2005), The Global Competitiveness Report 2004-2005, Oxford, Oxford University Press;

WEF (1996), The Global Competitiveness Report 1996, Geneva, World Economic Forum;

WEF and IMD (Institute for Management Development) (1990), The World Competitiveness Report 1990, Geneva WEF and Lausanne IMD;

WEF and IMD (1991), The World Competitiveness Report 1991, Geneva WEF and Lausanne IMD;

WEF and IMD (1992), The World Competitiveness Report 1992, Geneva WEF and Lausanne IMD;

WEF and IMD (1993), The World Competitiveness Report 1993, Geneva WEF and Lausanne IMD;

WEF and IMD (1994), The World Competitiveness Report 1994, Geneva WEF and Lausanne IMD;

WEF and IMD (1995), The World Competitiveness Report 1995, Geneva WEF and Lausanne IMD;

Technical Appendix

The union program

The first order conditions for problem 10-11 are:

$$w_t: \qquad -(\Sigma_t + \Lambda_t) + U_w(w_t, L_t) = 0 \tag{A1}$$

$$L_t: \qquad -d(\Sigma_t + \Lambda_t) + U_L(w_t, L_t) - \gamma_t I_t^I + \frac{1}{1+r} E_t W_L(Y_{t+1}) = 0 \tag{A2}$$

$$\sigma_t: \qquad I_t^H \left[\alpha_t - d\ L_t - w_t + \frac{1}{1+r} E_t W_\Sigma(Y_{t+1})\right] = 0 \tag{A3}$$

$$\lambda_t: \qquad I_t^F \left[\alpha_t - d\ L_t - w_t + F + \frac{1}{1+r} E_t W_\Lambda(Y_{t+1})\right] = 0 \tag{A4}$$

$$\gamma_t: \qquad I_t^I\ (L_t - L_{t-1}) = 0 \tag{A5}$$

The Euler conditions are:

$$\Sigma_{t-1} \quad : \qquad W_\Sigma(Y_t) = \alpha_t - d\ L_t - w_t + E_t \frac{1}{1+r} W_\Sigma(Y_{t+1}) \tag{A6}$$

$$\Lambda_{t-1} \quad : \qquad W_\Lambda(Y_t) = \alpha_t - d\ L_t - w_t + E_t \frac{1}{1+r} W_\Lambda(Y_{t+1}) \tag{A7}$$

$$L_{t-1} \quad : \qquad W_L(Y_t) = \gamma_t I_t^I \tag{A8}$$

To obtains the constraints 6 and 7 which arise under positive firing and hiring, run forward equations $A6$ and $A7$, impose asymptotic convergence and substitute respectively in $A3$ and $A4$. Equation $A5$ gives the constraint 8. Thus, equations $A3$-$A7$ reproduce the program constraints.

Equation $A1$ governs the dynamics of wages while equations $A2$ and $A8$ regulate the dynamics of employment. Notice that by combining $A2$ and $A8$ one obtains a stochastic dynamic equation:

$$\gamma_t I_t^I = [U_L(w_t, L_t) - dU_w(w_t, L_t)] + \frac{1}{1+r} E_t \left[\gamma_{t+1} I_{t+1}^I\right] \tag{A9}$$

The equilibrium under commitment

Lemma 1 In the commitment equilibrium, if $L_t = L_{t-1}$ then $w_t = w_{t-1}$.

Proof

$L_t = L_{t-1}$ means inaction at time t. Inaction, in turn, is only possible if the wage w_t lies in the interval $[\underline{w}_t,\ \overline{w}_t]$. In this interval the hiring and firing constraints 6-7 are not 'active', i.e. $I_t^F = I_t^H = 0$. As a consequence, by equation 10, $\Sigma_t = \Sigma_{t-1}$ and $\Lambda_t = \Lambda_{t-1}$. In turn, by equation A1:

$$U_w(w_t, L_t) = U_w(w_{t-1}, L_{t-1})$$

Finally, the latter implies that $L_t = L_{t-1}$ is only possible if $w_t = w_{t-1}$.○

Lemma 2 In the commitment equilibrium, if $L_t \neq L_{t-1}$ then

$$U_L(w_t, L_t) = dU_w(w_t, L_t) \tag{A10}$$

Proof

Multiply both sides of equation $A9$ by I_t^I and notice that $(I_t^I)^2 = I_t^I$, then run the equation forward:

$$\gamma_t I_t^I = \sum_j \left(\frac{1}{1+r}\right)^j E_t \left\{ \prod_{i=0}^{j} I_{t+i}^I \left[U_L(w_{t-1}, L_{t-1}) - dU_w(w_{t-1}, L_{t-1}) \right] \right\} \tag{A11}$$

In this expression employment is set at the constant level L_{t-1} since $\prod_{i=0}^{j} I_{t+i}^I$ is equal to 1 only if employment remains constant from $t-1$ to $t+j$ and 0 otherwise. By lemma 1, constant employment implies constant wages. Thus the wage is also fixed at level w_{t-1}. As a consequence of constant employment and wages, equation $A11$ can be rewritten as follows:

$$\gamma_t I_t^I = B \; \left[U_L(w_{t-1}, L_{t-1}) - dU_w(w_{t-1}, L_{t-1}) \right] \quad \text{with} \quad B = \sum_j \left(\frac{1}{1+r}\right)^j E_t \left(\prod_{i=0}^{j} I_{t+i}^I \right)$$

Finally, use the latter in equation A9:

$$\gamma_t I_t^I = \left[U_L(w_t, L_t) - dU_w(w_t, L_t) \right] \left[1 + \frac{1}{1+r} B \right] \tag{A12}$$

If employment changes at time t, then $I_t^I = 0$ so that equation $A10$ follows immediately from equation $A12$. ○

Lemma 3 In the commitment equilibrium, $\alpha_t = \alpha_{t-1}$ and employment inaction at $t-1$ imply employment inaction at t.

Proof

Inaction at time $t-1$ means $L_{t-1} = L_{t-2}$ and, as noticed in the proof of Lemma 1, $\Sigma_{t-1} = \Sigma_{t-2}$ and $\Lambda_{t-1} = \Lambda_{t-2}$. Thus, if $\alpha_t = \alpha_{t-1}$, it follows immediately $Y_t = Y_{t-1}$. L_t is equal to L_{t-1} since $L(Y_t) = L(Y_{t-1})$.○

Proposition A1

In the commitment equilibrium, if $\alpha_t = \alpha_{t-1}$ then $L_t = L_{t-1}$.

Proof

Here it is only proved by contradiction that $L_t > L_{t-1}$ and $\alpha_t = \alpha_{t-1}$ can not be part of an equilibrium. The proof for $L_t < L_{t-1}$ is similar and, henceforth, omitted.

Suppose that $L_t > L_{t-1}$ with $\alpha_t = \alpha_{t-1}$. Lemma 3 dictates $L_{t-1} \neq L_{t-2}$, in fact $\alpha_t = \alpha_{t-1}$ and $L_{t-1} = L_{t-2}$ would imply $L_t = L_{t-1}$. Thus, by lemma 2, the equality in

$A10$ holds both at $t-1$ and t. In turn, equation $A10$ and $L_t > L_{t-1}$ imply

$$w_t > w_{t-1} \tag{A13}$$

Next, use equation 2 to subtract labour demand at time $t-1$ from labour demand at time t:

$$w_t - w_{t-1} = (\alpha_t - \alpha_{t-1}) - d\,(L_t - L_{t-1}) - (S_t - S_{t-1}) + 1/(1+r)\,(E_t S_{t+1} - E_{t-1} S_t)$$

The inequality $L_t > L_{t-1}$ implies $S_t \geq S_{t-1}$ since $S_{t-1} \in [-F, 0]$ and $S_t = 0$. Furthermore, the inequality implies $E_t S_{t+1} \leq E_{t-1} S_t$ since inheriting an higher employment level does not increase the expected shadow value of labour. Putting together these results with the equality $\alpha_t = \alpha_{t-1}$ it easy to see that above equation requires

$$w_t < w_{t-1} \tag{A14}$$

Inequalities in $A14$ and $A13$ are contradictory.∘

Proposition A2
If $r = 0$ and $v(w)$ is CARA, isoelastic or logaritmic then average employment decreases with F.
Proof
Set $r = 0$, use equation 1 and solve the two programs 15-16 and 17-18 with respect to the wage:

$$G(w_j^c) \equiv w_j^c + \frac{v(w_j^c) - v(\widetilde{w})}{v'(w_j^c)} = X_j \qquad j = g, b \qquad X_g = \alpha_g - qF \qquad X_b = \alpha_b + qF$$

Since labour demand is linear and F enters symmetrically in the two schedules (with $r = 0$), an increase in F does not affect average employment *for a given average wage*. Thus, average employment decreases only if the average wage increases as a consequence of higher firing costs. In turn, the average wage increases with F by the Jensen's inequality if $G^{-1}(X)$ is concave or, equivalently, if $G(w)$ is convex.
Define $\widetilde{v} = v(\widetilde{w})$ and $\Theta = -v''/v'$ and compute the first derivative of $G(w)$:

$$G' = 1 + \frac{(v')^2 - v''(v - \widetilde{v})}{(v')^2} = 2 + \Theta\frac{v - \widetilde{v}}{v'} > 0$$

If v is CARA, the coefficient of absolute risk aversion Θ is constant; G'' is positive as $(v - \overline{v})/v'$ is increasing with respect to w. Next, if v is isoelastic, Θ/v' is proportional to $1/v$ since $w\Theta$ is constant and wv' is proportional to v; G'' is positive as $(v - \overline{v})/v$ is increasing. Finally, if v is logaritmic, $\Theta/v' = 1$; G'' is positive as $v - \overline{v}$ is increasing.∘

The equilibrium under no-commitment
Lemma 4 In the no-commitment equilibrium, if $L_t = L_{t-1}$ then $w_t = \overline{w}(\alpha_t, L_{t-1})$.

Proof

Under no-commitment - $\Sigma_{t-1} + \Lambda_{t-1} = 0$ - the union program 11 becomes

$$\begin{aligned} W(\alpha_t, L_{t-1}) &= \max_{w_t,\, L_t,\, \sigma_t,\, \lambda_t,\, \gamma_t} U(w_t, L_t) + \left(\sigma_t I_t^H + \lambda_t I_t^F\right)(\alpha_t - dL_t - w_t) + \\ & +\lambda_t I_t^F F + \gamma_t I_t^I (L_{t-1} - L_t) + \frac{1}{1+r} E_t W(\alpha_{t+1}, L_t) \end{aligned}$$

If in state (α_t, L_{t-1}) the union chooses a wage w_t such that employment does not change from the previous level, i.e. $\sigma_t I_t^H = \lambda_t I_t^F = 0$ and $L_{t-1} = L_t$, the discounted flow of returns $W(\alpha_t, L_{t-1})$ becomes:

$$W(\alpha_t, L_{t-1}) = U(w_t, L_{t-1}) + \frac{1}{1+r} E_t W(\alpha_{t+1}, L_{t-1})$$

The wage w_t appears only in the utility function U. Thus, the union has no incentive to choose a wage below the maximum consistent with inaction.∘

Lemma 5 In the no-commitment equilibrium, the value for the union of lagged employment is decreasing with respect to lagged employment:

$$\frac{d\gamma_t I_t^I}{dL_{t-1}} < 0 \tag{A15}$$

Proof

By lemma 4 equation $A11$ becomes:

$$\begin{aligned} \gamma_t I_t^I &= \sum_j \left(\frac{1}{1+r}\right)^j E_t \left\{ \prod_{i=0}^{j} I_{t+i}^I \left[U_L(\overline{w}, L_{t-1}) - dU_w(\overline{w}, L_{t-1})\right] \right\} = \\ &= B\ \left[U_L(\overline{w}, L_{t-1}) - dU_w(\overline{w}, L_{t-1})\right] \end{aligned}$$

Differentiate $\gamma_t I_t^I$ with respect to L_{t-1} and observe that, by equation 4, $d\overline{w}/dL_{t-1} = -d$:

$$\frac{d\gamma_t I_t^I}{dL_{t-1}} = B\ \left[U_{LL} - 2dU_{wL} + d^2 U_{ww}\right] \tag{A16}$$

Equation $A15$ is true since $U_{LL} - 2dU_{wL} + d^2 U_{ww} < 0$.∘

Lemma 6 In the no-commitment equilibrium, if $\alpha_t = \alpha_{t-1}$, employment inaction at time $t-1$ implies employment inaction at time t.

Proof

Equalities $\alpha_t = \alpha_{t-1}$ and $L_{t-1} = L_{t-2}$ imply that state vectors at the beginning of periods t and $t-1$ are the same. As a result, the wage chosen by the union and the employment level are the same.∘

Proposition 3A

In the no-commitment equilibrium, if $\alpha_t = \alpha_{t-1}$ then $L_t = L_{t-1}$.

Proof

Here it is only proved by contradiction that $L_t > L_{t-1}$ and $\alpha_t = \alpha_{t-1}$ can not be part of an equilibrium. The proof for $L_t < L_{t-1}$ is similar and, henceforth, omitted.

Thus, suppose that $L_t > L_{t-1}$ and $\alpha_t = \alpha_{t-1}$. As in the proof of proposition A1, consistency with the optimal behaviour of firms requires

$$w_t < w_{t-1} \tag{A17}$$

Next, consider the union optimal behaviour. The inequality $L_t > L_{t-1}$ implies $\gamma_t I_t^I = 0$. Further, by lemma 6, $L_{t-1} \neq L_{t-2}$ and, as a consequence, $\gamma_{t-1} I_{t-1}^I = 0$. Use these results in equation $A9$:

$$\begin{aligned} dU_w(w_{t-1}, L_{t-1}) - U_L(w_{t-1}, L_{t-1}) - \frac{1}{1+r} E_t\left[\gamma_t I_t^I\right] &= 0 \\ dU_w(w_t, L_t) - U_L(w_t, L_t) - \frac{1}{1+r} E_t\left[\gamma_{t+1} I_{t+1}^I\right] &= 0 \end{aligned}$$

The expression $dU_w - U_L - \frac{1}{1+r} E\left[\gamma I^I\right] = 0$ can be though of as an implicit functions of w in terms of L. Apply the implicit function theorem and use equation $A16$

$$\frac{\partial w}{\partial L} = -\frac{dU_{wL} - U_{LL} - \frac{1}{1+r} B \ \left[U_{LL} - 2dU_{wL} + d^2 U_{ww}\right]}{dU_{ww} - U_{wL}} > 0$$

Thus, $L_t > L_{t-1}$ implies

$$w_t > w_{t-1} \tag{A18}$$

Equations $A17$ and $A18$ are contradictory.∘

Lemma 7

In a no-commitment equilibrium,

a) for spells that start with hiring, the wage increases by F in the second period and remains constant until the end of the spell.

b) for spells that start with firing, the wage is constant throughout the spell.

Proof

a) Suppose that in state (α_t, L_{t-1}) a new spell starts and suppose that the spell starts with hiring. Further, suppose that the spell lasts for at least two periods: $\alpha_t = \alpha_{t+1}$. Finally, notice that under no-commitment the shadow value $S(\alpha_t, w_t, L_{t-1})$ can be written as $S(\alpha_t, L_{t-1})$ since $w_t = w(\alpha_t, L_{t-1})$.

As the spell starts with hiring at time t, the shadow value of labour is $S(\alpha_t, L_{t-1}) = 0$. By contrast, Proposition 3A and Lemma 4 imply that at time $t+1$ $S(\alpha_{t+1}, L_t) = -F$. Use these results in equation 2 and derive labour demand at t and $t+1$:

$$\begin{aligned} 0 &= \alpha_t - dL(\alpha_t, L_{t-1}) - w(\alpha_t, L_{t-1}) + \frac{1}{1+r} E_t\left[S(\alpha_{t+1}, L_t)\right] \\ -F &= \alpha_{t+1} - dL(\alpha_{t+1}, L_t) - w(\alpha_{t+1}, L_t) + \frac{1}{1+r} E_{t+1}\left[S(\alpha_{t+2}, L_{t+1})\right] \end{aligned}$$

Observe that: 1) by assumption $\alpha_{t+1} = \alpha_t$, 2) by proposition 3A $L(\alpha_{t+1}, L_t) = L(\alpha_t, L_{t-1})$ and 3) by the Markov property $E_t [S(\alpha_{t+1}, L_t)] = E_{t+1} [S(\alpha_{t+2}, L_{t+1})]$. Use these equalities and subtract the first from the second equation:

$$w(\alpha_{t+1}, L_t) = w(\alpha_t, L_{t-1}) + F$$

Notice that, it the spell continues in period $t+2$, i.e. $\alpha_{t+1} = \alpha_{t+2}$, it is easy to see that $w(\alpha_{t+2}, L_{t+1}) = w(\alpha_{t+1}, L_t)$. By induction, this implies that, once the wage has increased at $t+1$, it remains constant until the end of the spell.

b) For spells that start with firing, the shadow value lies on the firing barrier in the first and in all other periods. Proving part b) is straightforward.$\circ$

Data appendix

Unemployment *Source*: OECD, Standardised Unemployment Rates, Quarterly Labour Force Statistics, Economic Outlook 2000 and 2005;

Inflation *Definition*: Annual Change in the GDP Deflator; *Source*: OECD, Economic Outlook 2006 (1), 2004 (1), 1999 (1).

Cooperative Industrial Relations (index) *Source*: World Economic Forum, Global Competitiveness Report from the 1996 issue to the 2004-5 issue and World Competitiveness Report from the 1990 issue to the 2005 issue. *Note*: even if the wording of the question has changed from time to time, in all years but 1996 (omitted) the purpose of the question has been that of assessing the degree of cooperation in industrial relations. The index ranges between 1 and 7 as respondents are required to report 1 in case of ID "generally confrontational" and 7 if ID are "generally cooperative".

Tax Wedge *Definition*: Income tax plus employee and employer contributions (as a % of the labour costs), single person without children. *Source*: OECD, Taxing Wages 2004/2005, Table D.1 pag.448.

Replacement Rate *Definition*: weighted average of the gross unemployment benefit replacement rates for two earnings levels, three family situations and three durations of unemployment. *Source*: OECD, Tax-Benefits models, OECD website. *Note*: the information provided by the OECD does not cover all years between 1990 and 2004. Thus, for the 1990-94 period we have averaged data referred to 1991 and 1993, for 1995-1999 we have averaged data referred to 1995, 1997 and 1999 and, finally, for 2000-2004 we have averaged data referred to 2001 and 2003.

EPL index *Definition*: summary index for the stringency of legal restrictions to the freedom of hiring and firing permanent as well as temporary workers. *Source*: OECD, Employment Outlook 2004 chap. 2. *Note*: the OECD computes 2 Epl indexes. Index 1 does not account for cross-countries heterogeneity in collective dismissals regulations while index 2 does. On the other hand, index 1 has been computed in 1990, 1998 and 2003 while index 2 has only been computed in 1998 and 2003. For this reason we use index 1 in our estimation.

Centralisation, Density, Coverage, Coordination *Source*: OECD, Employment Outlook 2004 ch. 3

Quaderni dell'Istituto di Economia dell'Impresa e del Lavoro

1. Solimene L., *Market Failures and State Intervention*
2. Solimene L., *The Efficiency under Private and Public Ownership: Some Empirical Evidence*
3. Baici E., Dell'Aringa C., *The EMS Effect on the Italian Labour Market*
4. Lucifora C., *Union Density and Relative Wages: Is there a Relationship?*
5. Lucifora C., Sestito P., *Determinazione del salario in Italia: una rassegna della letteratura empirica*
6. Martini G., *Testing Different Bargaining Theories: A Pilot Experiment*
7. Lucifora C., Rappelli F., *Profili retributivi e carriere:un'analisi su dati longitudinali*
8. Dell'Aringa C., Lucifora C., *Wage Dispersion and Unionism: Are Unions Egalitarian?*
9. Martini G., *Horizontal Price Fixing and Antitrust Policy: A Sequentially Rational Design*
10. Cassuti G., Dell'Aringa C., Lucifora C., *Labour Turnover and Unionism*
11. Solimene L., *Regolamentazione ed incentivi all'innovazione nel settore delle telecomunicazioni*
12. Bigard A., Guillotin Y., Lucifora C. e F. Rappelli, *An International Comparison of Earnings Mobility: The Case of Italy and France*
13. Martini G., *Laboratory Tests of a Kinked Demand Curve Model with Discounting and Game-theoretic Foundations*
14. Martini G., *A Multi-period Antitrust Game: The Dynamic Effects of Competition Policy*
15. Piccirilli G., *Monetary Business Cycles with Imperfect Competition and Endogenous Growth*
16. Dell'Aringa C., *Pay Determination in the Public Service: An International Comparison*
17. Lucifora C., *Rules Versus Bargaining: Pay Determination in the Italian Public Sector*
18. Piccirilli G., *Hours and Employment in a Stochastic Model of the Firm*
19. Cappellari L., *The Covariance Structure of Italian Male Wages, 1974 – 1988*
20. Lucifora C., *Working Poors? An Analysis of Low Wage Employment in Italy*
21. Lucifora C., Origo F., *Alla ricerca della flessibilità: un'analisi della curva dei salari in Italia*
22. Dell'Aringa C., Vignocchi C., *Employment and Wage Determination for Municipal Workers: The Italian Case*
23. Cappellari L., *Wage Inequality Dynamics in the Italian Labour Market: Permanent Changes or Transitory Fluctuations?*
24. Cappellari L., *Low-pay transitions and attrition bias in Italy: a simulated maximum likelihood approach*
25. Pontarollo E., Vitali F., *La gestione del parco tecnologico elettromedicale tra outsourcing e integrazione verticale*
26. Cappellari L., *Do the 'Working Poors' Stay Poor? An Analysis of Low-Pay Dynamics in Italy*
27. Dell'Aringa C., Lucifora C., *Inside the black box: labour market institutions, wage formation and unemployment in Italy*
28. Filippini L., Martini G., *Vertical Differentiation and Innovation Adoption*
29. Lucifora C., Simmons R., *Superstar Effects in Italian Football: an Empirical Analysis*
30. Brunello G., Lucifora C., Winter-Ebmer R., *The Wage Expectations of European College Students*

31. Cappellari L., *Earnings dynamic and uncertainty in Italy: How do they differ between the private and public sectors?*
32. Piccirilli G., *Unions and Workforce Adjustment Costs*
33. Dell'Aringa C., *The Italian Labour Market: Problems and Prospects*
34. Bryson A., Cappellari L., Lucifora C., *Does Union Membership Really Reduce Job Satisfaction?*
35. Cappellari L., *The effects of high school choices on academic performance and early labour market outcomes*
36. Cappellari L., Jenkins S. P., *Transitions between unemployment and low pay*
37. Dell'Aringa C., Pagani L., *Collective Bargaining and Wage Dispersion*
38. Comi S., *University enrolment, family income and gender in Italy*
39. Ghinetti P., *The Wage Effect of Working in the Public Sector When Education and Sector Choices Are Endogenous: An Empirical Investigation for Italy*
40. Piccirilli G., *Unions, Job Protection and Employment*
41. Bryson A., Cappellari L., Lucifora C., *Why so unhappy? The effects of unionisation on job satisfaction*
42. Brunello G., Cappellari L., *The Labour Market Effects of Alma Mater: Evidence from Italy*
43. Dell'Aringa C., Pagani L., *Regional Wage Differentials and Collective Bargaining in Italy*
44. Dell'Aringa C., *Industrial Relations and Macroeconomic Performance*
45. Prandini A., *Structural Separation or Integration in Italian Fixed Tlc: Regulatory and Competition Issues*
46. Ghinetti P., *The Public-Private Job Satisfaction Differential in Italy*
47. Cappellari L., Ghinetti P., Turati G., *On Time and Money Donations*
48. Cappellari L., Leonardi M., *Earnings Instability and Tenure*
49. Cappellari L., Dorsett R., Haile G., *State dependence, duration dependence and unobserved heterogeneity in the employment transitions of the over-50s*
50. Piccirilli G., *Job protection, industrial relations and employment*