THE LABOR MARKET EFFECTS OF INDEXING UNEMPLOYMENT BENEFITS TO PREVIOUS EARNINGS

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In most Organization for Economic Cooperation and Development (OECD) countries, unemployment benefits are tied to previous labor earnings. The authors study the progressivity of this indexation with regard to its effects on employment, output, and wages in three non-Walrasian equilibrium models of the labor market. In the cases of decentralized union wage bargaining and search unemployment and Nash wage bargaining, employment, output, and wages increase with the degree of indexation. The indexation of unemployment benefits to previous earnings, however, has no effect in the case of efficiency wages. The results also suggest that a more progressive indexation of unemployment benefits is welfare enhancing if wages are bargained.

Keywords: *unemployment; benefits; progressive indexation; union wage setting*

1. INTRODUCTION

Unemployment insurance (UI) schemes are a distinctive feature of modern economies and have been frequently recognized to play an important role in determining labor market outcomes. The general argument usually put forward is that unemployment benefits improve the payoff from not working and decrease the incentives to supply labor. Accordingly, recent work on the employment effects of unemployment benefits emphasizes the moral hazard associated with the job search effort of the unemployed (Hansen and İmrohoroğlu 1992; Ljungqvist and Sargent 1998), the moral hazard associated with the job retention effort (Wang and Williamson 1996), and the direction of

the search effort to high-wage jobs (Burdett 1979; Acemoglu 2001; Acemoglu and Shimer 1999; Marimon and Zilibotti 1999). In all these models, (average) wages increase and employment declines. Fredriksson and Holmlund (2001) and Cahuc and Lehmann (2000) emphasize the fact that the duration period of most unemployment insurance programs is limited or declines over time. As unemployment insurance benefits increase, long-term unemployed workers not entitled to unemployment insurance have a higher incentive to search for a job and, in case they become unemployed again, receive higher benefits. Heer (2003), however, demonstrates in a calibrated general equilibrium model that this so-called "entitlement effect" is of small magnitude in comparison to the employment-reducing effects.

Even though employment is typically found to decline with a more generous unemployment insurance scheme, output and welfare do not need to decrease. In the models of Acemoglu (2001), Acemoglu and Shimer (1999), and Marimon and Zilibotti (1999), higher unemployment insurance improves the composition of jobs. As waiting is less costly, workers prefer to wait for high-productivity jobs to arrive. As a consequence, output and, hence, welfare may even increase with unemployment benefits. Unemployment benefits may also help to smooth consumption by providing insurance against low income and alleviating liquidity constraints during times of unemployment, as in Costain (1997). Furthermore, if the duration of unemployment benefits is limited, a higher level of unemployment benefits increases the precautionary savings of the short-term unemployed worker who, on one hand, faces a much higher unemployment probability in the next period than the employed worker and who, on the other hand, will also receive lower benefits in the case of continued unemployment. In a general equilibrium model, Heer (2002) shows that higher short-term benefits may even increase aggregate savings and the equality of the wealth distribution.

The literature discussed in the preceding two paragraphs, however, considers the level of benefits to be exogenous.[1] In reality, unemployment benefits are usually endogenous as they are indexed to previous earnings. It is a common feature of modern UI systems that the benefit level is, at least to some extent, tied to the last wage received during employment.[2] The closer possible future unemployment benefits are

tied to labor income, the higher will be the incentive effect to supply labor during times of employment.

In our model, unemployment benefits depend on previous labor earnings. We investigate the effects of an indexation of unemployment benefits in the framework of three simple theoretical non-Walrasian labor market representations. We introduce UI payments that consist of both a lump-sum component and a component proportional to previous labor income into a model with decentralized bargaining of unions, a labor market model with search frictions, and an efficiency wage model. Comparative statics in partial equilibrium, in which we do not consider the financing of the UI payments, imply that, for a given benefit level,[3] a higher indexation of UI benefits leads to lower wages and thus higher employment in the first two settings. In contrast, there is no impact at all if unemployment is caused by firms setting efficiency wages because the optimizing behavior of the firms is not affected.

We further endogenize the financing of the unemployment insurance payments. The government runs a balanced budget so that an increase in total spending on unemployment insurance necessitates an equal increase in revenues from labor income taxation (the income taxes can equally be interpreted as unemployment insurance contributions). Given the balanced-budget constraint for the government, however, two countervailing effects on the tax base occur: on one hand, higher indexation results in higher employment, while on the other hand, wages may decrease. The net effect on tax revenues is ambiguous and depends on fundamental parameters characterizing the preferences of the households and the unemployment insurance scheme. As this ambiguity cannot be resolved analytically, we follow Pissarides (1998) in choosing plausible parameters to "estimate" the sign of the overall effect of higher wage indexation of UI benefits on tax revenues and, consequently, on the equilibrium tax rate, employment, and wages. We still find a positive impact of indexation on employment in the union bargaining and search unemployment models.

This article is organized as follows. Section 2 introduces the labor demand side of the model. Section 3 introduces the unemployment insurance scheme. Sections 4 to 6 consider decentralized unions, search unemployment, and efficiency wages, respectively. Section 7 concludes.

2. THE DEMAND FOR LABOR

We distinguish three non-Walrasian equilibrium models of the labor market: union wage bargaining, search unemployment, and efficiency wages. As we use the same model specification as in Pissarides (1998), with the exception of the specification of unemployment insurance, we will keep the exposition of the model rather brief and refer the interested reader to Pissarides.

Let $t = 0, 1, \ldots$ be the index time. At each date t, there is a single final commodity that is produced using a constant returns-to-scale technology with capital k_t and labor N_t as inputs. Any agent using k_t units of capital and N_t units of labor can produce $F(k_t, N_t)$ units of the final good at t. We assume that $F(.)$ has the following constant-elasticity-of-substitution (CES) form:

$$y_t \equiv F(k_t, N_t) = A\left[\alpha k_t^{\frac{\sigma-1}{\sigma}} + (1-\alpha)N_t^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \ \sigma > 0. \tag{1}$$

A is a technology parameter, and $\sigma > 0$ is the elasticity of substitution between labor and capital. Profit maximization implies the following first-order condition:

$$(1-\alpha)A^{\frac{\sigma-1}{\sigma}}\left(\frac{y_t}{N_t}\right)^{\frac{1}{\sigma}} = (1+\tau)w_t, \tag{2}$$

where w_t and τ denote the wage rate in period t and the wage tax rate, respectively. Following Pissarides (1998), we set the capital stock $k_t = 1$ constant in every period t as we do not study capital accumulation.

Obviously, income taxation is distortionary. Labor demand is reduced as the tax rate τ increases.

3. UNEMPLOYMENT BENEFITS

Existing unemployment compensation systems in the Organization for Economic Cooperation and Development (OECD) are tied to previous earnings. Let w_{t-1} denote the wage earned during the last

period of employment. Accordingly, unemployed workers receive benefits at the amount of υw_{t-1}. In addition, modern unemployment compensation systems also redistribute income from high-income to low-income households.[4] For example, most countries provide unemployment compensation that consists of unemployment insurance and, if the household income is too low, social assistance. Consequently, even countries with a proportional earnings-related benefit, such as Germany or the United States, effectively provide a minimum income, even though the expenditures on unemployment compensation might be financed by different government entities. For example, in Germany, unemployment insurance is provided by the federal government, while social assistance is paid for by the local government. In addition, existing unemployment compensation systems also specify a maximum benefit level, as in Germany or in France. Therefore, different from Pissarides (1998), we specify the unemployment benefits b_t as being calculated from a linear unemployment benefit schedule with a lump-sum component B according to the following:

$$b_t = B + \upsilon w_{t-1}. \tag{3}$$

As the central problem of this study, we examine how a change in the progressivity υ of the unemployment compensation system affects equilibrium employment and wages—that is, how a change in υ, which is compensated for by a change in B, in order to keep b unchanged, affects aggregate employment N and wages w.

4. DECENTRALIZED UNIONS

Unions are decentralized so that each firm negotiates with a single union and the negotiating partners do not assume that they can exert any influence on aggregate employment. The firm and the union bargain over wages. Following Pissarides (1998), we apply the utilitarian approach and assume the following union objective function:[5]

$$V_i = n_i \frac{w_i^{1-\gamma}}{1-\gamma} + (m_i - n_i)\left[(1-N)\frac{b^{1-\gamma}}{1-\gamma} + N\frac{w^{1-\gamma}}{1-\gamma}\right], \tag{4}$$

where m_i is union membership, and n_i is union employment ($n_i < m_i$). w_i and w denote the wage rate negotiated between the union and the firm in sector i and the wage rate elsewhere, respectively. The union objective function considers the utility of their workers employed in sector i, who receive wage w_i, and their workers not employed in sector i, who either find a job elsewhere in the economy with probability N or have to rely on unemployment benefits with probability $1 - N$. Again, N denotes aggregate employment, and the measure of the labor force is normalized to 1. Furthermore, the union is assumed to be risk averse, with the coefficient of risk aversion being equal to $\gamma > 0$.

The surplus of firm i is given by the difference in output from equation (1) and labor costs:

$$\pi_i = y_i - (1 + \tau)w_i n_i. \tag{5}$$

The wage is determined by decentralized Nash bargains:

$$w_i = \arg\ \max (V_i - V)^{\delta}\ \pi_i^{1-\delta}, \tag{6}$$

where δ denotes the bargaining power of the union, and the union's fall-back position V is the utility of the union if employment among its members is zero, $n_i = 0$ (the fall-back position of the firm is the case of no production and, hence, zero profits).

In equilibrium, all unions and firms are equal so that they will negotiate the same employment levels $n_i = N$ and wages $w_i = w$ (assuming that the measure of unions is equal to 1). We will restrict our attention to a production function (1) of the Cobb-Douglas form, $\sigma = 1$. In this case, the substitution of equations (4) and (5) into the solution of equation (6) implies the following wage equation:

$$\delta\alpha\left[1-(1-N)\upsilon\left(\frac{b}{w}\right)^{-\gamma}\right]-(1-\alpha+\alpha\delta)\frac{1-N}{1-\gamma}\left[1-\left(\frac{b}{w}\right)^{1-\gamma}\right]=0. \tag{7}$$

The effects of a rise of υ on equilibrium employment and wages are straightforward and can easily be understood by inspection of the maximization condition for the Nash bargain, $\delta\dfrac{(V_i - V)'}{V_i - V} + (1-\delta)\dfrac{\pi_i'}{\pi_i} = 0$, where the derivatives $(V_i - V)'$ and π_i' are taken with respect to the

wage w_i. Assume $\hat{w}_i$ to be the optimal wage rate for an initial earnings-related component υ of unemployment benefits. An increase of υ for constant b reduces $(V_i - V)'$ for the wage rate $\hat{w}_i$ because the fall-back position of the union member improves as well. As b remains constant, however, $V_i - V$ does not change. The profits of the firms (and the derivative with respect to the wage rate) are also unaffected by a change in υ for given wage level $\hat{w}_i$. As a consequence, the relative loss of the union, $-\frac{(V_i - V)'}{V_i - V}$, following a decrease in the wage rate below the level $\hat{w}_i$ is smaller than the relative gain from an increase in profits for the firm. More intuitively, the firm takes into consideration that a decline in wages also results in a lower fall-back position of the union (compared to the case with lower earnings-related unemployment benefits) and hence a higher gain from employment for the union.

Result 1: In partial equilibrium, a more progressive indexation of unemployment benefits to previous individual labor earnings, which keeps unemployment benefits constant, results in a decrease of unemployment $1 - N$ and wages w. Furthermore, both union utility and profits increase.

Proof. Equations (1), (2), (4), (5), and (7), together with $b = B + \upsilon w$, are six simultaneous equations in the endogenous variables N, w, y, B, V_i, and π_i. From the equation system, we can easily derive the partial derivatives $\frac{\partial N}{\partial \upsilon}$, $\frac{\partial y}{\partial \upsilon}$, $\frac{\partial w}{\partial \upsilon}$, $\frac{\partial \pi_i}{\partial \upsilon}$, and $\frac{\partial V_i}{\partial \upsilon}$.

Next, consider the "general equilibrium" case in which additional government expenditures on unemployment insurance are to be financed by an offsetting increase in labor income taxation so that the government budget balances:

$$b(1 - N) = \tau w N. \tag{8}$$

In "general equilibrium", the effect of a rise in υ is not unanimous anymore: again, higher indexation, ceteris paribus, results in fewer benefit payments and a positive contribution base effect on the taxable labor income as unemployment declines. However, the fall in the indi-

vidual gross labor income due to the fall in wages reduces taxable income per capita and could even make a higher unemployment insurance contribution rate necessary. As this ambiguity cannot be solved analytically, we have computed the comparative statics for equations (1), (2), (4), (5), (7), and (8), together with $b = B + \upsilon w$ in the endogenous variables N, w, y, B, V_i, π_i, and τ, and evaluated the resulting partial derivatives for standard numerical parameter values (see the appendix for details). A general statement can then be made that for a "normal" rate of employment N (i.e., $N > 0.5$) and empirically observable values of α (i.e., α around 0.3) and b/w (i.e., b/w around 0.6), the positive effect of higher employment relative to the negative (partial equilibrium) effect of the lower wage rate on the tax base prevails such that the UI contribution rate τ is smaller in a high-indexation equilibrium. This leads, in turn, to an increase in labor demand and strengthens the positive employment effect of indexation. As a consequence of increased labor demand and lower income taxes, general equilibrium wages will be even higher than in the case of less indexation.

A normative analysis of unemployment insurance is complicated by the presence of unions. The wage does not equal the marginal product of labor, and profits are not independent of the earnings-related component υ of unemployment benefits. As households are the ultimate owners of the firms, we simply use $V_i + \pi_i$ as our measure of welfare. m_i is set equal to 1 so that every worker is a member of a union. In general equilibrium, the effect of a change in υ on the union's objective function V_i, the wage tax τ, and profits π_i cannot be derived analytically. However, in our numerical examples (see the appendix), it turns out that welfare increases in all cases considered. In general equilibrium, both union utility and profits go up as wages increase, but labor costs decrease (due to lower taxation).

5. SEARCH UNEMPLOYMENT

Labor markets are subject to frictions and characterized by a two-sided search. Time and transaction costs are involved to match vacancies with searching agents. The number of aggregate matches M is an increasing function of both aggregate vacancies v and aggregate

searching agents $1 - N$, assuming that all unemployed agents are searching with the same intensity. More formally, the number of job matches M is described by the following constant returns-to-scale technology:

$$M = \mu(1-N)^{\eta} v^{1-\eta},\ 0 < \eta < 1. \tag{9}$$

We define $\theta = (1 - N)/v$ to be the ratio of the number of searching agents and the number of vacancies implying the job-filling probability $q(\theta) \equiv M/v = \mu\theta^{-\eta}$ and the job-finding probability $\theta q(\theta) \equiv M/(1 - N) = \mu\theta^{1-\eta}$.

Firms are subject to idiosyncratic negative shocks, which arrive at a constant rate s. If the firm is subject to the shock, workers have to be dismissed and enter the unemployment pool. If N denotes aggregate employment, the flow sN of agents enters unemployment each period. The flow into employment is equal to $\mu\theta^{1-\eta}(1 - N)$. In equilibrium, the flow into employment is equal to the flow out of employment, implying the *Beveridge equation*:

$$1 - N = \frac{s}{s + \mu\theta^{1-\eta}}. \tag{10}$$

As our wage equation is slightly different from the one derived by Pissarides (1998), we will describe the wage determination in our economy in more detail. Posting a vacancy costs the firm c per unit period. Let V and J denote the expected return from a vacant job and from a filled job, respectively, satisfying

$$rV = -c + q(\theta)(J - V), \tag{11}$$

$$rJ = y' - (1 + \tau)w - s(J - V), \tag{12}$$

where r denotes the interest rate. In equation (11), the capital market return of a vacant job, rV, is equal to the expected capital gain $q(\theta)(J - V)$ from filling a vacancy minus the vacancy cost c. In (12), the capital return from a filled vacancy, rJ, is equal to the worker's marginal product, y', minus his or her labor costs, $(1 + \tau)w$, and the expected loss from the destruction of the job, $s(J - V)$. In equilibrium, firms will

offer vacancies until the expected return from a vacant job is zero, $V = 0$, implying

$$J = \frac{c}{q(\theta)}. \tag{13}$$

Similarly, the worker's expected return from unemployment U and employment E is valued by markets at

$$rU = B + \upsilon w + \theta q(\theta)(E - U), \tag{14}$$

$$rU = w - s(E - U), \tag{15}$$

where the worker receives labor income w (compensated income $B + \upsilon w$) if employed (unemployed). Wages result from decentralized bargaining between the firm and the worker. Both the firm and the worker receive a rent from a successful match. More specifically, the wage w_i is determined by Nash bargaining, which maximizes a product of weighted surpluses of the individual expected discounted returns E_i, U_i, and J_i for the household and the firm:

$$w_i = \arg\ \max (E_i - U_i)^{\beta} (J_i - V)^{1-\beta}, \tag{16}$$

where the bargaining power of the workers is denoted by β with $0 < \beta < 1$. The first-order condition of the maximization problem is given by

$$E_i - U_i = \varepsilon \frac{\beta}{(1-\beta)(1+\tau)} J_i, \tag{17}$$

with $\varepsilon = \dfrac{(1-\upsilon)r + \theta q(\theta)}{(1-\upsilon)(r + \theta q(\theta))}$.[6] For a production function of the Cobb-Douglas case, $\sigma = 1$, substitution of equations (13), (14), and (15) into (17) implies the following wage equation:

$$w = \frac{(1-\upsilon)r + \theta q(\theta)}{(1-\upsilon)(r + \theta q(\theta))} \frac{\beta c}{(1-\beta)(1+\tau)} \left(\frac{r+s}{\mu} + \theta^{1-\eta} \right) \theta^{\eta} + \frac{B}{1-\upsilon}. \tag{18}$$

In addition, labor demand of the firm is affected by the presence of vacancy costs (Pissarides 1990), implying (for $\sigma = 1$)

$$(1-\alpha)\frac{y}{N}-(1+\tau)w-\frac{r+s}{\mu}c\theta^{\eta}=0. \tag{19}$$

The effects of a rise in υ for constant unemployment benefits b are similar to those in the case of a unionized economy, as presented in the previous section. In particular, firms consider the cut in the fall-back position of workers following a decrease of negotiated wages. If we neglect any effects from the funding of unemployment compensation, wages fall as a consequence of the higher earnings-related component of unemployment insurance.

Result 2: In partial equilibrium, a more progressive indexation of unemployment benefits to previous individual labor earnings results in a decrease of wages w and an increase of employment N and output y.

Proof. Equations (1), (19), $b = B + \upsilon w$, (13), (15), (14), and (18) are seven simultaneous equations in the endogenous variables N, w, y, B, J, E, and U. From the equation system, we can easily derive the partial derivatives $\frac{\partial N}{\partial \upsilon}$, $\frac{\partial y}{\partial \upsilon}$, $\frac{\partial w}{\partial \upsilon}$, $\frac{\partial J}{\partial \upsilon}$, $\frac{\partial E}{\partial \upsilon}$, and $\frac{\partial U}{\partial \upsilon}$.

In analogy to the union model, if the UI budget constraint in equation (8) is taken into consideration, a higher indexation equilibrium is influenced by the reaction of the tax base to a change in υ. As there is no analytical answer about the sign of the effect, we have again evaluated the partial derivatives from comparative statics analysis of equations (1), (19), $b = B + \upsilon w$, (13), (15), (14), (18), and (8). For the choice of numerical parameters (see the appendix for details), it turns out that, as aggregate employment increases, the decrease in the expenditures on unemployment compensation is more pronounced than the change in the tax base. Consequently, the wage tax rate τ is reduced, and firms increase labor demand and bid up wages so that the total effect of a rise in υ on wages w is even positive.

We use two different measures of welfare W: the sum of the aggregate value of firms plus the aggregate value of employed and unemployed agents, $W \equiv NJ + NE + (1 - N)U$, and total output minus vacancy costs. As several counterbalancing economic forces influence welfare, only a numerical illustration is possible. For our choice of parameters, a higher indexation of UI has sufficiently positive

employment and output effects to overcompensate the utility loss that workers face because of lower wages. In general equilibrium, this effect is reinforced by lower taxation. Accordingly, our results suggest that higher indexation might be welfare improving in the presence of search unemployment.

6. EFFICIENCY WAGES

In models of efficiency wages, the employer is offering the worker a premium over the competitive wage to motivate him or her to supply more effective labor. The model presented in this section is built on the work by Shapiro and Stiglitz (1984), assuming that higher wages discourage workers from shirking (supplying zero effort).

Let U, E, E^s, and E^{ns} denote the expected returns from unemployment, employment, shirking, and not shirking, respectively. The return of an unemployed worker is given by his or her unemployment compensation, $b = B + \upsilon w$, and the expected gain from finding a job:

$$rU = B + \upsilon w + \frac{sN}{1-N}(E - U). \tag{20}$$

Again, N is aggregate employment, s denotes the job separation rate, and $1 - N$ is the number of unemployed workers. Accordingly, the job-finding probability is given by $sN/(1 - N)$.

If the worker is employed, he or she can either shirk, supplying zero effort, or does not shirk, supplying effort e. If the worker shirks, he or she gets detected with probability q and is fired; otherwise, he or she receives the same wage w as the nonshirking worker, implying

$$rE^{ns} = w - e - s(E^{ns} - U), \tag{21}$$

$$rE^{s} = w - (s + q)(E^{s} - U). \tag{22}$$

The firm sets wages w to induce the agent to supply effort e. However, the firm owner has no incentive to raise the return of the nonshirking agent further above the return of the shirking agent, implying that

$$E^{ns} = E^{s} \equiv E, \tag{23}$$

and, together with equations (20), (21), and (22),

$$w = rU + \frac{r+s+q}{q}\, e, \tag{24}$$

which constitutes the "no-shirking" condition. From equation (24), it is clear that the efficiency wage has to compensate the worker for his or her opportunity costs rU and, in addition, includes a premium for the fact that he or she will exert any effort at all. More explicitly,

$$w = \frac{1}{1-\upsilon}\left(B + \frac{N}{1-N}\,\frac{se}{q} + \frac{r+s+q}{q}\, e\right). \tag{25}$$

Equation (25) implies that there is a positive relationship between the efficiency wage and the level of unemployment benefit (determined by υ and B). However, the equilibrium wage w does not depend on the form of indexation on previous earnings. The reason is that, contrary to the unionized economy and the search equilibrium considered in the previous two sections, wages are not bargained but are set unilaterally by the firm, which only has to make sure that it pays according to equation (24). As long as the total amount of unemployment benefits b is held constant, rU will not change, and thus there is no need to set a new efficiency wage. Therefore, the efficiency wage equilibrium will be unaffected by changes in the structure of UI benefit payments.

Result 3: A more progressive indexation of unemployment benefits to previous individual labor earnings that keeps unemployment benefits constant has no effect on employment and wages.

Proof. Equations (1), (19), $b = B + \upsilon w$, (8), and (25) are five simultaneous equations in the endogenous variables N, w, y, B, and τ. From the equation system, we can easily derive the partial derivatives $\frac{\partial N}{\partial \upsilon}$, $\frac{\partial y}{\partial \upsilon}$, and $\frac{\partial w}{\partial \upsilon}$.

Our result, in particular, is independent of our assumption that shirking workers receive unemployment compensation. Even if the government is able to distinguish workers who got dismissed because

of missing effort (at rate q) from those who got dismissed because of exogenous job destruction (at rate s) and only pays unemployment compensation to the latter agents, a more progressive indexation of unemployment compensation does not have any effects on the equilibrium allocation.[7]

7. CONCLUSION

In this article, we have investigated the effects of an indexation of unemployment benefits to previous earnings in three different labor market settings: in a framework of decentralized union bargaining over wages, in a labor market with search frictions, and in an efficiency wage model. By calculating comparative statics for partial equilibrium models in which we do not impose any finance restrictions on unemployment insurance expenditures, we find that, for a given benefit level, a higher indexation of UI benefits results in lower wages and thus higher employment in the first two cases.[8] A change in the structure of the UI payments is shown to have no effect on the efficiency wage model.

In a "general equilibrium" context, in which additional expenditure on unemployment insurance is to be financed by an increase of labor income taxes, there are no clear-cut analytical results on the impact of higher indexation of UI benefits to previous earnings. Due to a possible negative effect on the workers' contribution to unemployment insurance caused by potentially lower wages, a raise in the contribution tax rate might be necessary to keep the government budget balanced. Higher taxes or, equally, Social Security contributions result in an increase of labor costs, thus potentially offsetting the positive employment effect of a higher indexation. To gain some additional insight on the overall employment effect of more progressive indexation, we have evaluated the general equilibrium effects by using a set of parameters that have been prominently applied in labor market research. In the case of union bargaining and search frictions, the higher indexation equilibrium is still associated with a higher employment level. The higher employment equilibrium can even be sustained, although the firms pay higher wages because this is associated

with a decrease in labor income taxes. In conclusion, our results suggest that we should be careful to draw firm policy conclusions from studies that treat the UI benefits as exogenous and that we should carefully distinguish among different institutional features of the labor market.

APPENDIX A
Union Wage Bargaining

The example that we compute for the case of decentralized union bargaining presupposes a Cobb-Douglas production function (i.e., $\sigma = 1$). The capital coefficient is set equal to $\alpha = 0.3$. Following Pissarides (1998) in his short-run argument, $A = k = 1$. With regard to the parameters of the unemployment insurance system, the replacement ratio of unemployment insurance was set at $b/w = 0.6$ and the indexation coefficient at $\upsilon = 0.4$ (the parameter choices are broadly motivated by the German system). We assume equal bargaining strength for the firm and the union (i.e., $\delta = 0.5$). We calculate the equilibrium for different degrees of risk aversion in the union utility function: (1) motivated by the estimation of Carruth and Oswald (1985), we set the risk aversion parameter at $\gamma = 0.8$, which corresponds to an employment approximately equal to $N \sim 0.7$. (2) For comparison, the case of a risk-neutral union is also calculated (i.e., with $\gamma = 0$). In this case, equilibrium employment is about 10 percentage points lower. However, the results are qualitatively the same, which can be seen from Table A1.

TABLE A1: Comparative Statics for Decentralized Union Wage Bargaining

Case	*Partial/ General*	$\frac{\partial N}{\partial \upsilon}$	$\frac{\partial w}{\partial \upsilon}$	$\frac{\partial V_i}{\partial \upsilon}$	$\frac{\partial \pi_i}{\partial \upsilon}$	$\frac{\partial W}{\partial \upsilon}$	$\frac{\partial \tau}{\partial \upsilon}$
(1)	Partial	+	−	−	+	+	
(1)	General	+	+	+	+	+	−
(2)	Partial	+	−	−	+	+	
(2)	General	+	+	+	+	+	−

APPENDIX B
Search Unemployment

For the numerical examples, unemployment insurance is again assumed to have a replacement ratio of 0.6 and an indexation coefficient of 0.4. Periods correspond to years. Following Pissarides (1998), the separation rate s amounts to 0.2, while $\mu = 3.3$. We consider two cases with low and high unemployment: (1) $N = 0.7$ and (2) $N = 0.9$, respectively. Vacancy costs c are calibrated to guarantee the chosen level of employment. The matching parameter is set at $\eta = 0.5$ in accordance with empirical studies of British data by Pissarides (1986) and U.S. data by Blanchard and Diamond (1989), respectively. The annual real interest rate is set equal to $r = 0.05$ (results are qualitatively the same for $r = 0.10$). Employer and worker have equal bargaining strength (i.e., $\beta = 0.5$).[9] Again, results do not vary much over employment levels (cf. Table B1).

TABLE B1: Comparative Statics for Search Unemployment

Case	*Partial/ General*	$\frac{\partial N}{\partial \upsilon}$	$\frac{\partial w}{\partial \upsilon}$	$\frac{\partial \theta}{\partial \upsilon}$	$\frac{\partial W}{\partial \upsilon}$	$\frac{\partial \tau}{\partial \upsilon}$
(1)	Partial	+	−	+	+	
(1)	General	+	+	−	+	−
(2)	Partial	+	−	+	+	
(2)	General	+	+	−	+	−

NOTES

1. A notable exception is Pissarides (1990, 2000). He studies progressivity of wage taxes in a search model and briefly discusses the relation to the case in which unemployment compensation is tied to the wage rate. Our analysis confirms his conjecture that both instruments work in the same direction and, hence, have analogous effects. Moreover, we take the financing of unemployment insurance (UI) expenditures into account.

2. A critical and comprehensive review of the analysis of unemployment compensation is given by Atkinson and Micklewright (1991). For the features of the different UI schemes in practice, see the Organization for Economic Development and Cooperation (OECD 1991, 1996).

3. Contrary to the studies cited in the first two paragraphs of the introduction, we do not derive the optimal level of benefits; instead, we assume the level of benefits to be exogenous, as the outcome of a political process. Given the level of benefits, however, it may prove optimal to index them to previous earnings and not to provide them lump sum.

4. A classification of OECD countries according to the proportionality of their unemployment compensation system with regard to previous earnings can be found in OECD (1991).

5. Goerke and Madsen (2003) also analyze the effects of earnings-related benefits in a unionized economy. In addition to our analysis, they also consider the case of an insider-dominated union in which only the gain in utility of its employed members is considered. However, contrary to our study, Goerke and Madsen only examine a partial equilibrium and do not consider the effects of a change in unemployment benefit payments on the government budget and tax rate and, hence, labor demand.

6. Our equation (17) differs from equation (A.7) in Pissarides (1998). In particular, equation (17) coincides with (A.7) in Pissarides (1998) only for the case without indexation of unemployment compensation, $\upsilon = 0$, implying $\varepsilon = 1$.

7. The derivation of this result is available from the authors upon request.

8. Note that the similarity in outcomes of the union and the search model is not surprising as the bargaining mechanism is the same.

9. Notice that by this choice of β and η, the Hosios condition is satisfied (Hosios 1990). In the absence of taxation, the equilibrium allocation is efficient; consequently, we judge the effect of search externalities on our welfare results to be modest in our calibrated model.

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