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A Dynamic Model of Union Behaviour. The Role of an Endogenous Outside Option and Bargaining Centralisation

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Dresden University of Technology
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MARCUS DITTRICH

BEATE SCHIRWITZ

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Address of the author(s):

Marcus Dittrich
Dresden University of Technology
Department of Economics
D-01062 Dresden

e-mail : marcus.dittrich@tu-dresden.de

Beate Schirwitz
Ifo Institute for Economic Research
Einsteinstrasse 3
D-01069 Dresden

e-mail : schirwitz@ifo.de

Editors:

Faculty of Business Management and Economics, Department of Economics

Internet:

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Working paper coordinator:

Dominik Maltritz
e-mail: wpeconomics@mailbox.tu-dresden.de

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Marcus Dittrich
Dresden University of Technology
Department of Economics
D-01062 Dresden
marcus.dittrich@tu-dresden.de

Beate Schirwitz
Ifo Institute for Economic Research

D-01069 Dresden
schirwitz@ifo.de

Abstract:

We analyse the role of bargaining centralisation when both the union's outside option and union membership are endogenous and considered in a dynamic framework. A dynamic two-sector model is developed where the wage rate in the first sector is either set by a monopoly union or is the result of efficient bargaining between union and firm. The union's outside option is employment in the second, competitive sector. We extend the dynamic analysis by modelling the outside option as endogenous and show that dynamic models may also overstate employment distortions in this case if bargaining is conducted on a highly centralised stage. Additionally, we offer reflexions along the optimisation process in different scenarios and a comparative static analysis, thus presenting some new general insights into the topic.

JEL-Classification: C61, C78, J51

Keywords: Dynamic wage bargaining, unions, dual labour market, endogenous outside option, endogenous membership

1 Introduction

We analyse the role of bargaining centralisation when both the union's outside option and union membership are endogenous and considered in a dynamic framework. The general result that conventional static models may overstate the labour market distortions caused by unionism is known from the literature (Jones, 1987; Kidd and Oswald, 1987; Jones and McKenna, 1994; Chang and Lai, 1997; Chang, Lai and Chang, 1998). But these kind of models have in common that a worker's outside option is unemployment benefit which is exogenously given. Another branch of literature uses static models with endogenous outside options. These often make the assumption of a second sector that is competitive, with wages adjusting to clear the market (McDonald and Solow, 1985). In the bargaining process, though, the wage in the competitive sector is still taken as exogenous by firms and unions. However, this approach implies a large number of relatively small unions and bargaining taking place at the firm level. Each union then has a negligible impact on the competitive wage. Therefore, when each union acts independently, it maximises only its own utility and ignores the effects on other unions (Fuest and Thum, 2001; Beissinger and Egger, 2004). But this consideration does not hold anymore in the case of centralised wage formation, i. e. when there is only one large union in the economy.[1] This union should take into account that a higher wage in the unionised sector increases labour supply in the competitive sector, partly consisting of union members. The seminal work by Calmfors and Driffill (1988) considers the impact of different degrees of wage setting centralisation in a static framework. They postulate that both a very high and a very low degree lead to lower wage and higher employment rates than intermediate institutional settings, resulting in a hump-shaped relation between centralisation and real wages.

This paper aims to combine these different approaches and conduct a straightforward analysis concerning the employment consequences of various institutional wage settings. In line with the dynamic union literature, we develop a two-sector model where the wage rate in the first sector is either set by a monopoly union or the result of efficient bargaining between union and firm. The union's outside option is employment in the second, competitive sector. Dynamic models take into account at least

[1] Countries with rather centralised wage settings are particularly Austria, Norway and Denmark. Alternatively, instead of considering the whole economy, the scenario would also apply to a specific sector or region within the economy which is – in terms of employment migration – rather secluded from other parts. Then the possibility of centralised wage setting is also quite realistic.

two important empirical facts: First, unions last for more than one period and bargain repeatedly with firms. Second, union membership is changing over time, presumably related to changes in the unemployment rate (Sanfey, 1995). Taking into account these empirical findings concerning union membership, we model union dynamics in a rather general setting. We further extend the dynamic analysis by modelling the outside option as endogenous, with potential impacts on employment and wages in both sectors. As we show, there is a further bargaining centralisation impact on employment in addition to that discussed by Calmfors and Driffill (1988). Two different cases are distinguished to analyse the effect of centralisation: first, decentralised bargaining at the firm level and second, centralised bargaining between a large union covering all workers and an employer's federation covering all firms. Also the various centralisation degrees are analysed both in a monopoly union and an efficient bargaining framework, respectively.

We show that dynamic models may also overstate employment distortions if the union's outside option is determined endogenously. A large centralised union takes into consideration that a higher union wage drives down both employment in the unionised sector and the wage in the competitive sector. Then a higher degree of centralisation leads to higher employment and lower wages in the unionised sector.[2] Additionally, we offer reflexions along the optimisation process in different scenarios and a comparative static analysis, thus presenting some new general insights into the topic of union wage setting/bargaining and its effect on labour market outcomes.

The paper is organised as follows: Section 2 introduces the model economy consisting of firms, workers and unions. Sections 3 and 4 consider the cases of a monopoly union and efficient bargaining, respectively, each under decentralised as well as under centralised wage setting. In Section 5, a comparative static analysis is conducted while Section 6 concludes.

[2] Dittrich (2005) develops a similar static monopoly union model but he neglects dynamic bargaining and membership effects.

2 The Framework

2.1 Firms and Workers

We consider an economy which is divided into a unionised and a competitive labour market. There are γ identical firms and an equal number of unions in the unionised sector, whereas the number of firms in the competitive sector is normalised to unity. Workers who are not employed in the unionised sector always find a job in the competitive sector. Each individual supplies one unit of labour. Total available workforce denoted by z consists of workers employed in the unionised and of workers in the competitive sector. Let n denote employment in each of the γ unionised firms and c employment in the competitive sector. Then the workforce in the competitive sector can be written as

$$c_t = z - \gamma n_t, \tag{1}$$

implying the clearing of the labour market.

Production functions in both sectors are characterised by diminishing returns to labour and obey the Inada conditions. The production function of a representative firm in the unionised sector is given by $f(n_t)$, with t denoting time. The output price is set to unity. Thus, a firm's profit in period t can be written as

$$\pi_t = f(n_t) - w_t n_t, \tag{2}$$

where w_t denotes the union wage in t.

The production technology in the competitive sector is denoted by $g(c_t)$. Since employment here is residual from that in the unionised sector, the wage b_t will be determined such that the marginal productivity condition holds:

$$b_t = g'(c_t). \tag{3}$$

2.2 Unions

Our starting point in the consideration of union behaviour is the seminal dynamic formulation in Jones (1987) and Kidd and Oswald (1987). We assume utilitarian unions

that maximise the utility of their members. Since the unions' bargaining behaviour may result in some union members not being employed in the unionised sector but in the competitive one, the general objective function for every union in any one particular period t depends on the level of wage and employment in both sectors:

$$v_t = u(w_t)n_t + u(b_t)[m_t - n_t], \tag{4}$$

where $u(.)$ is the individual worker's state-independent concave utility function and m_t denotes membership per union. We assume the union to care about both the utility of current and future members. Thus, the intertemporal formulation of the union's utility (4) can be stated as

$$V = \int_0^\infty v_t \mathrm{e}^{-rt}\,\mathrm{d}t, \tag{5}$$

where r denotes the rate of time preference. In the following, we assume time to be continuous and suppress time indices for notational simplicity.

A crucial point in our approach is modelling union membership. We assume membership to depend on employment in the union sector. To be more specific, some union workers who lose their jobs there will leave the union.[3] This assumption originates from the empirical evidence that changes in membership move with changes in unemployment (Kidd and Oswald, 1987). But since there is empirical evidence that a still significant part of unemployed persons keep union members (Visser, 2006), we assume that only a part of workers not employed in the union sector will leave the union. These facts can be expressed by the differential equation

$$\dot{m} = n - m + \sigma\left[\frac{z - \gamma n}{\gamma}\right] \tag{6}$$

where $\dot{m}$ denotes the change in union membership over time. The fraction of workers in the competitive sector that remain union members is given by $\sigma \in (0,1)$. That is, union membership arises from employment in the union sector plus a fraction σ of workers in the competitive sector. In other words, the share $1-\sigma$ of workers not employed in the union sector will leave their union. Hence, we relax the restricting assumption in

[3] See Blackorby et al. (1995, 2002) for the use of relevant utility functions and an elaborate welfare analysis if population size is changing over time.

Kidd and Oswald (1987), where all unemployed are assumed to leave the union, and use this more general formulation. We can shorten (6) as follows:

$$\dot{m} = [1-\sigma]n - m + \sigma\frac{z}{\gamma}. \tag{7}$$

In the following, we differentiate in two dimensions between two respective basic scenarios of wage determination. One dimension is about the institutional procedure of wage determination. In the first case, the wage is set by a monopolistic union. For the given wage, firms then unilaterally choose the number of workers they want to employ, according to the marginal productivity condition

$$w_t = f'(n_t). \tag{8}$$

Since there is one-to-one correspondence from employment n to the wage w given by (8), w can be replaced by n as the union's instrument of optimisation. As known from the literature, however, the monopoly union model – and also the more general right-to-manage approach – generate inefficient outcomes (McDonald and Solow, 1981). This inefficiency is due to the fact that solutions have to lie on the labour demand curve. Thus, both parties will be better off if this restriction is abandoned and if there is bargaining over both wage and employment. Implementing this fact would not be far from reality since the outcome of union-firm bargaining may in practise not always be a mere agreement about the wage but also about other variables. For instance, Svejnar (1986) suggests that for many firms in the U.S. industry the outcome can be better described by efficient bargaining. Therefore, in the second case, we analyse the effects of union centralisation in a dynamic efficient bargain model.

The second dimension is the degree of union centralisation. We consider two extreme cases: on the one hand totally decentralised wage determination on the firm level, and on the other hand centralised wage determination for all the unionised sector.

In each case of these scenarios, the representative union has to solve an infinite-horizon dynamic optimisation problem, i.e. it maximises the discounted utility of its members taking into account the membership dynamics and the specific institutional conditions, respectively. Section 3 shows this for the monopoly union framework, while the efficient bargaining case is analysed in Section 4.

3 The Monopoly Union

3.1 Decentralised Wage Setting

We first consider the case where the wage is set by a monopolistic union in a decentralised structure. If the wage rate is determined at the firm level and there is a relatively large number of firms, each individual union has a negligible influence on the competitive wage and thus takes it as given. Accordingly, the union's maximisation problem is given by

$$\begin{aligned} \max_{n} \quad & \int_0^\infty [u(w)n + u(b)[m-n]]\,\mathrm{e}^{-rt}\,\mathrm{d}t \\ \text{s.t.} \quad & \dot{m} = [1-\sigma]n - m + \sigma\frac{z}{\gamma} \\ & w = f'(n), \end{aligned} \tag{9}$$

where all variables are functions of time. Let λ be the costate variable. Then the present-value Hamiltonian appropriate to the optimisation problem (9) can be written as

$$H = \left[u(f'(n))n + u(b)[m-n]\right]\mathrm{e}^{-rt} + \lambda(t)\left[[1-\sigma]n - m + \sigma\frac{z}{\gamma}\right]. \tag{10}$$

The corresponding first order conditions to (10) include

$$\frac{\partial H}{\partial n} = \left[u(w) + u'(w)\,f''(n)n - u(b)\right]\mathrm{e}^{-rt} + \lambda[1-\sigma] = 0 \tag{11}$$

$$\frac{\partial H}{\partial m} = u(b)\mathrm{e}^{-rt} - \lambda = -\dot{\lambda}. \tag{12}$$

Equation (11) captures the change in union's utility caused by a marginal variation in n. For mathematical convenience, we define $\beta(n) \equiv u(w) + u'(w)\,f''(n)n$. This term represents that part of change arising from the unionised sector: First, the number of employees varies marginally there, and this way also the number of individual utilities taken into account, which is embodied in $u(w)$. Second, due to changes in the number of employees, the wage reacts for all n of them, and hence also utility caused by the wage, given by $u'(w)\,f''(n)n$. Additionally, employment also changes in the com-

petitive sector and with it union's utility issued there, too. In the current framework, the union considers in particular variations in the number of union members employed there, which mirrors that in the unionised sector. This is linked to a change in the number of individual utilities summed up and captured in the term $-u(b)$. Finally, the last term in (11) reflects the variation in the state variable m due to a marginal variation of n, times the shadow price of m, i.e. the change in a union's utility due to a marginal variation of m, which is given by λ. Equation (12), on the other hand, complementary describes the development of this shadow price in reaction to a marginal change in m.

The λ-term in (12) can now be eliminated using (11) and its derivative with respect to time.[4] The optimal time path of the number of employees in the unionised firm is given by

$$\dot{n} = \frac{1+r}{\beta_n}\left[\beta(n) - \frac{\sigma+r}{1+r}u(b)\right], \tag{13}$$

where β_n is

$$\frac{\partial \beta}{\partial n} = 2u'(w)f''(n) + u''(w)f''(n)^2 n + u'(w)f'''(n)n. \tag{14}$$

The first two terms in (14) have a negative sign, while the third term can be either negative or positive, depending on $f'''(n)$. For our further analysis, we assume that $\beta_n < 0$.[5] In the following, we focus on the characteristics of the long-run equilibrium. The steady-state is attained when $\dot{n} = 0$. Hence, long-run wage and employment are given by

$$\beta(n) = \frac{\sigma+r}{1+r}u(b) \tag{15}$$

together with (8). Note that the equivalent static solution without membership dynamics is given by $\beta(n) = u(b)$.[6] The dynamic consideration complements this term by the discount factor $\frac{\sigma+r}{1+r}$. The reason for this factor to occur is simply the fact that

[4] A detailed derivation is given in the appendix.

[5] This holds either if $f'''(n) < 0$ or if $f'''(n) > 0$ but having a relatively small value, that is, if $2u'(w)f''(n) + u''(w)f''(n)^2 n < -u'(w)f'''(n)n$. The condition $\beta_n < 0$ will be satisfied if $f(n)$ is represented by a Cobb-Douglas production function, e. g. $f(n) = n^{\frac{1+\varepsilon}{\varepsilon}}$ with $\varepsilon < -1$ being the elasticity of labour demand, or by any conventional kind of constant elasticity production function.

[6] See Booth (1995) for an analysis of union behaviour in a static framework.

current decisions about n influence the future stock of union members, represented by σ. Lower employment in the unionised sector drives down future membership, with corresponding consequences for the sum of utility the union strives to maximise. However, future utility is valued less than the current one, which is captured by the time preference rate r. The discount factor assesses this effect on union's utility due to membership dynamics and incorporates it into the condition of optimal behaviour.

Since $\sigma \in (0,1)$ and β is decreasing in n as explained above, it is easy to see that employment distortions caused by unions are lower if union membership is endogenous in a dynamic consideration. Balancing both effects of a decrease in n – a present gain by higher wages and a future loss in the number of members – ends up in higher employment and lower wages in the unionised sector compared to the static case. However, in our more general framework, employment is not as high as Kidd and Oswald (1987) predict, since there is still a fraction of workers in the competitive sector that remain union members.

3.2 Centralised Wage Setting

The above findings are only valid if the wage setting is decentralised at the firm level and if there is a sufficiently large number of firms. Then, every union can neglect the consequences of its wage setting behaviour on the aggregate wage and employment. However, this assumption cannot be maintained if the wage setting is centralised. In this section, the case of a large union covering all workers is analysed. Now the union has to take into account the wage effect in the competitive sector when it determines the wage in the unionised sector. The idea is straightforward: a higher wage in the unionised sector leads to lower employment there and therefore to higher employment and a lower wage in the competitive sector. Since the union sets a mark-up on the competitive wage, which is implicitly given by (15), a lower competitive wage reduces the union wage.

The dynamic optimisation problem is now also subject to the restriction $b = g'(z - \gamma n)$. Furthermore, the union decides for its members in all γ unionised firms. So we end up with

$$\max_{n} \quad \int_0^\infty \gamma [u(w)n + u(b)[m-n]]\, \mathrm{e}^{-rt}\, \mathrm{d}t \tag{16}$$

$$\begin{aligned} \text{s.t.} \quad & \dot{m} = [1-\sigma]n - m + \sigma\frac{z}{\gamma} \\ & w = f'(n) \\ & b = g'(z-\gamma n). \end{aligned}$$

Maximising the corresponding Hamiltonian results in the following first order conditions:

$$\gamma\left[\beta(n) - u(b) - \gamma u'(b)g''(z-\gamma n)[m-n]\right]\mathrm{e}^{-rt} + \lambda[1-\sigma] = 0 \tag{17}$$

$$\gamma u(b)\mathrm{e}^{-rt} - \lambda = -\dot{\lambda}. \tag{18}$$

As before, $\beta(n)$ represents the instantaneous utility change from a unionised firm caused by a marginal variation in employment. Furthermore, we define $\alpha(n) \equiv u(b) + \gamma u'(b)\ g''(z-\gamma n)[m-n]$ as its competitive sector counterpart. In contrast to (11), not only the variation in the number of employees is now taken into consideration but also the change in the competitive wage and its consequences for the union's utility.

Now we use (17) and its derivative with respect to time together with (18) to eliminate λ. We end up with an equation determining the optimal movement of n:

$$\dot{n} = \frac{1+r}{\beta_n - \alpha_n}\left[\beta(n) - \alpha(n) + \frac{1-\sigma}{1+r}u(b)\right]. \tag{19}$$

There is a strong similarity to (13), adjusted to the current framework: as the union also takes into consideration the wage consequences in the competitive sector of a variation in n, the effect on union's utility arising from there is captured by the more complex $\alpha(n)$ instead of $u(b)$.

In the steady-state, the condition

$$\beta(n) - \alpha(n) = -\frac{1-\sigma}{1+r}u(b) \tag{20}$$

must hold. Because also $\dot{m} = 0$ applies there, it follows from (7) that $m - n = \frac{\sigma}{\gamma}[z-\gamma n]$. By rearrangement of (20) we have that

$$\beta(n) = \frac{\sigma+r}{1+r}u(b) + \phi(n), \tag{21}$$

with $\phi(n) = u'(b)g''(c)\sigma[z-\gamma n] < 0$. As before, employment is higher than a static

monopoly union model would predict (Dittrich, 2005). There, employment is implicitly given by $\beta(n) = u(b) + \phi(n)$. But moreover, with $\phi(n) < 0$, (21) implies a higher employment level in the unionised sector compared to the result under decentralised wage setting, which is given by (15). Hence, usual dynamic models with exogenous outside option or with unions being too small to have significant influence on the outside option overstate the labour market distortions caused by unions in the case of centralised wage setting.

4 Efficient Bargaining over Wages and Employment

4.1 Decentralised Bargaining

In an efficient bargaining framework where wage and employment are bargained over separately, we first consider bargaining at the firm level. Each single union disregards the outside option consequences of the bargaining outcome. Since there is bargaining over both wage and employment, the solution is not restricted to the marginal productivity condition (8). Instead, the firm seeks to realise some minimum level of profit $\overline{\Pi}$ over its (infinite) planning horizon. According to Kidd and Oswald (1987), we express the dynamic optimisation problem as follows:

$$\begin{aligned} \max_{n,w} \quad & \int_0^\infty [u(w)n + u(b)(m-n)]\,\mathrm{e}^{-rt}\,\mathrm{d}t \\ \text{s.t.} \quad & \int_0^\infty [f(n) - wn]\,\mathrm{e}^{-rt}\,\mathrm{d}t \geq \overline{\Pi} \\ & \dot{m} = (1-\sigma)n - m + \sigma\frac{z}{\gamma}. \end{aligned} \tag{22}$$

The corresponding Hamiltonian is given by

$$\begin{aligned} H = [u(w)n + u(b)[m-n]]\,\mathrm{e}^{-rt} + \mu\,[f(n) - wn]\,\mathrm{e}^{-rt} \\ + \lambda(t)\left[[1-\sigma]n - m + \sigma\frac{z}{\gamma}\right], \end{aligned} \tag{23}$$

with μ being a multiplier that does not depend on time. Hence, we end up with the following first order conditions:

$$\frac{\partial H}{\partial n} = u(w) - u(b) + \mu \left[f'(n) - w \right] + \lambda [1 - \sigma] \mathrm{e}^{rt} = 0 \tag{24}$$

$$\frac{\partial H}{\partial w} = u'(w) - \mu = 0 \tag{25}$$

$$\frac{\partial H}{\partial m} = u(b) \mathrm{e}^{-rt} - \lambda = -\dot{\lambda}. \tag{26}$$

The optimal wage, being constant over time, is implicitly given by (25). Differentiating (24) with respect to time and combining with (24), (25) and (26) yields an equation defining the optimal employment movement:

$$\dot{n} = \frac{1+r}{\delta'(n)} \left[\delta(n) - \frac{\sigma + r}{1+r} u(b) \right] \tag{27}$$

with $\delta(n) \equiv u(w) + u'(w) [f'(n) - w]$ denoting the efficient bargaining counterpart to $\beta(n)$. Consequently, in the steady-state ($\dot{n} = 0$), we have

$$\delta(n) = \frac{\sigma + r}{1+r} u(b), \tag{28}$$

which is in congruence with (15). Condition (28) is equivalent to the so-called contract curve known from the union bargaining literature and determines the efficient bargaining outcome together with the rent division curve. The latter is a weighted average of the marginal and the average product of labour and defines the explicit wage-employment combination on the contract curve depending on the bargaining strengths of both parties (Booth, 1995). In our model, it is implicitly given by combining (28) and $\int_0^\infty [f(n) - wn] \, \mathrm{e}^{-rt} \, \mathrm{d}t \geq \overline{\Pi}$.

Since the equivalent static solution is given by $\delta(n) = u(b)$, it is easy to see that employment is higher if the union optimises an intertemporal utility function taking into account membership dynamics, i.e. the fact that lower employment in the unionised sector drives down future membership.

4.2 Centralised Bargaining

In a last step, we analyse bargaining over wage and employment between a large union covering all workers and an employer's federation covering all firms. As in the monopoly union case, the union takes into account that the outside option depends on employment in the unionised sector. Therefore, the dynamic optimisation problem (22) is additionally subject to $b = g'(z - \gamma n)$ and the bargaining covers all γ firms. Hence, the first order conditions of the corresponding Hamiltonian are given by

$$\gamma[u(w) - \alpha(n)] + \mu\gamma\left[f'(n) - w\right] + \lambda[1 - \sigma]\mathrm{e}^{rt} = 0 \tag{29}$$

$$u'(w) - \mu = 0 \tag{30}$$

$$\gamma u(b)\mathrm{e}^{-rt} - \lambda = -\dot{\lambda}. \tag{31}$$

Solving in an analogous manner as before yields the optimal time path of employment in the unionised sector:

$$\dot{n} = \frac{1+r}{\delta'(n) - \alpha'(n)}\left[\delta(n) - \alpha(n) + \frac{1-\sigma}{1+r}u(b)\right], \tag{32}$$

which again is equivalent to the monopoly union framework, given in (19). Finally, we obtain the long-run equilibrium using the steady-state condition $\dot{n} = 0$ and, from (7) with $\dot{m} = 0$, $m - n = \frac{\sigma}{\gamma}[z - \gamma n]$. Thus, we end up with

$$\delta(n) = \frac{\sigma + r}{1+r}u(b) + \phi(n). \tag{33}$$

The union takes into account that lower employment in the unionised sector will drive down the outside option in the competitive sector. Therefore, since $\phi(n) < 0$, employment is higher under centralised bargaining than in the decentralised case (28). The degree of wage bargaining hence is crucial in the analysis of labour market outcomes.

5 Comparative Statics

The steady-state equilibrium conditions of the model in the two analysed institutional frameworks, both under decentralised and centralised wage setting are assembled in table 1.

	Decentralised	**Centralised**
Monopoly union	$\beta(n) = \frac{\sigma+r}{1+r}u(b)$	$\beta(n) = \frac{\sigma+r}{1+r}u(b) + \phi(n)$
Efficient bargaining	$\delta(n) = \frac{\sigma+r}{1+r}u(b)$	$\delta(n) = \frac{\sigma+r}{1+r}u(b) + \phi(n)$

Table 1: *Steady-state equilibria in the monopoly union and efficient bargaining model.*

We are now interested in how the labour market outcomes in the steady state respond to changes in the exogenous parameters. Therefore, we differentiate the steady state equilibria given in table 1.

Monopoly Union

To derive the comparative statics results of decentralised wage setting in the monopoly union model, we first totally differentiate (15) recalling (3) and (8). The changes in employment in the unionised sector with respect to changes in the exogenous parameters are

$$\begin{aligned}
\frac{\mathrm{d}n}{\mathrm{d}z} &= \frac{1}{\gamma}\frac{\rho}{\beta_n+\rho} && > 0 \\
\frac{\mathrm{d}n}{\mathrm{d}\gamma} &= \frac{-n}{\gamma}\frac{\rho}{\beta_n+\rho} && < 0 \\
\frac{\mathrm{d}n}{\mathrm{d}\sigma} &= \frac{\frac{u(b)}{1+r}}{\beta_n+\rho} && < 0 \\
\frac{\mathrm{d}n}{\mathrm{d}r} &= \frac{1-\sigma}{(1+r)^2}\frac{u(b)}{\beta_n+\rho} && < 0
\end{aligned}$$

with $\rho \equiv \frac{\sigma+r}{1+r}\gamma u'(b)g''(c) < 0$. Since there is a negative correlation between labour demand and the wage, it can be verified from (14) that $\beta_w = f''^{-1}(w)\beta_n > 0$. Hence, the derivatives of w with respect to the exogenous parameters have the opposite signs

as the respective derivatives of n and are given by $\frac{\mathrm{d}n}{\mathrm{d}i} = f''^{-1}(w)\frac{\mathrm{d}w}{\mathrm{d}i}$, with $i = \gamma, \sigma, r$. Furthermore, it can be obtained from (1) and (14) that $\beta_c = -\frac{\beta_n}{\gamma} > 0$, $\beta_z = \frac{\beta_n}{\gamma} < 0$ and $\beta_\gamma = \frac{c-z}{\gamma^2}\beta_n > 0$. Employment effects in the competitive sector caused by changes in the exogenous parameters can then be derived from

$$\begin{aligned}
\frac{\mathrm{d}c}{\mathrm{d}z} &= \frac{\beta_n}{\beta_n+\rho} && > 0 \\
\frac{\mathrm{d}c}{\mathrm{d}\gamma} &= \frac{c-z}{\gamma}\,\frac{\beta_n}{\beta_n+\rho} && < 0 \\
\frac{\mathrm{d}c}{\mathrm{d}\sigma} &= -\gamma\,\frac{\frac{u(b)}{1+r}}{\beta_n+\rho} && > 0 \\
\frac{\mathrm{d}c}{\mathrm{d}r} &= \frac{\gamma(\sigma-1)}{(1+r)^2}\,\frac{u(b)}{\beta_n+\rho} && > 0.
\end{aligned}$$

The reaction of b regarding changes in the exogenous parameters have the opposite signs, respectively, since there is a negative correlation between wage and employment given by (3). The partial derivatives of b are given by $\frac{\mathrm{d}b}{\mathrm{d}i} = \gamma g''(c)\frac{\mathrm{d}c}{\mathrm{d}i}$, with $i = \gamma, \sigma, r$.

Similarly, the results of comparative statics in the case of a centralised wage setting can be obtained. Therefore, we need the derivatives of ϕ with respect to the endogenous variables. Exemplifying the changes in ϕ with respect to n indicates

$$\phi_n = -\gamma\sigma\left[u'(b)g''(c) + u''(b)g''(c)^2 c + u'(b)g'''(c)c\right] < 0, \tag{34}$$

which is satisfied if $g(c)$ is a conventional production function with constant elasticity. Then the term in square brackets has a positive sign since $u'(b)g''(c) + u''(b)g''(c)^2 c > -u'(b)g'''(c)c$. Furthermore, using (1), it can be checked that $\phi_c = \phi_z = -\frac{\phi_n}{\gamma} > 0$ and $\phi_\gamma = \frac{n}{\gamma}\phi_n < 0$.

Total differentiation of (21) yields

$$\begin{aligned}
\frac{\mathrm{d}n}{\mathrm{d}z} &= \frac{1}{\gamma}\,\frac{\rho-\phi_n}{\beta_n+\rho-\phi_n} && > 0 \\
\frac{\mathrm{d}n}{\mathrm{d}\gamma} &= \frac{-n}{\gamma}\,\frac{\rho-\phi_n}{\beta_n+\rho-\phi_n} && < 0 \\
\frac{\mathrm{d}n}{\mathrm{d}\sigma} &= \frac{\frac{u(b)}{1+r}+\frac{\phi}{\sigma}}{\beta_n+\rho-\phi_n} && \gtrless 0
\end{aligned}$$

$$\frac{\mathrm{d}n}{\mathrm{d}r} = \frac{1-\sigma}{(1+r)^2}\,\frac{u(b)}{\beta_n+\rho-\phi_n} < 0.$$

The signs may not be obvious at first view, but they can easily be pointed out if we consider the term $\rho-\phi_n$. Using (34) and reformulating yields

$$\rho-\phi_n = \gamma\sigma\left[\left(1+\frac{\sigma+r}{\sigma(1+r)}\right)u'(b)g''(c)+u''(b)g''(c)^2c+u'(b)g'''(c)c\right] < 0.$$

As $\sigma \in (0,1)$ and thus $\frac{\sigma+r}{\sigma(1+r)} > 1$, the term in square brackets has a negative sign. Hence, it can be verified that $\frac{\mathrm{d}n}{\mathrm{d}z} < 0$ under both decentralised and centralised wage setting. However, the quantitative effects are stronger in the decentralised case. Since $\frac{\rho-\phi_n}{\beta_n+\rho-\phi_n} < \frac{\rho}{\beta_n+\rho}$, we can state that $\frac{\mathrm{d}n}{\mathrm{d}z}$ is lower under centralised than under decentralised wage setting. The opposite result is obtained for $\frac{\mathrm{d}n}{\mathrm{d}\gamma}$, i. e. the effect is less negative there. Furthermore, the impact of an increase in the rate of time preference r has a stronger negative impact in the centralised setting while the effect of an increase in σ is ambiguous there.

Changes in c with regard to the exogenous parameters can be obtained from

$$\begin{aligned}
\frac{\mathrm{d}c}{\mathrm{d}z} &= \frac{\beta_n}{\beta_n+\rho-\phi_n} && > 0\\
\frac{\mathrm{d}c}{\mathrm{d}\gamma} &= \frac{c-z}{\gamma}\,\frac{\beta_n}{\beta_n+\rho-\phi_n} && < 0\\
\frac{\mathrm{d}c}{\mathrm{d}\sigma} &= -\gamma\,\frac{\frac{u(b)}{1+r}+\frac{\phi}{\sigma}}{\beta_n+\rho-\phi_n} && \gtrless 0\\
\frac{\mathrm{d}c}{\mathrm{d}r} &= \frac{\gamma(\sigma-1)}{(1+r)^2}\,\frac{u(b)}{\beta_n+\rho-\phi_n} && > 0.
\end{aligned}$$

Exemplifying $\frac{\mathrm{d}c}{\mathrm{d}z}$ and recalling (14), (34) and $\rho > 0$, it is easy to see that $\frac{\beta_n}{\beta_n+\rho-\phi_n} > \frac{\beta_n}{\beta_n+\rho} > 0$. Hence, the employment effect in the competitive sector of a population increase is indeed positive in both settings but is higher if wage setting takes place centrally.

These effects can easily be shown in a similar way for the wages in both sectors. In general, the comparative statics results do not vary qualitatively between decentralised and centralised wage setting, i.e. the signs remain the same. The only exceptions are changes in the endogenous variables with respect to σ where the signs are ambiguous

under centralised wage setting.

Efficient Bargaining

We now analyse the efficient bargaining equilibrium with decentralised wage setting. Therefor, we have to calculate the derivatives of δ with respect to the endogenous variables. Exemplifying the changes in δ with respect to n gives

$$\delta_n = u'(w) f''(n) + u''(w) \left[f'(n) - w \right] \frac{\mathrm{d}w}{\mathrm{d}n} < 0 \tag{35}$$

where the sign is negative if $\frac{\mathrm{d}w}{\mathrm{d}n} < 0$. This condition holds because of the concavity of the production function (Booth, 1995). Totally differentiating of (28) yields

$$\begin{aligned}
\frac{\mathrm{d}n}{\mathrm{d}z} &= \frac{1}{\gamma} \frac{\rho}{\delta_n + \rho} && > 0 \\
\frac{\mathrm{d}n}{\mathrm{d}\gamma} &= \frac{-n}{\gamma} \frac{\rho}{\delta_n + \rho} && < 0 \\
\frac{\mathrm{d}n}{\mathrm{d}\sigma} &= \frac{\frac{u(b)}{1+r}}{\delta_n + \rho} && < 0 \\
\frac{\mathrm{d}n}{\mathrm{d}r} &= \frac{1-\sigma}{(1+r)^2} \frac{u(b)}{\delta_n + \rho} && < 0.
\end{aligned}$$

It can be checked that the comparative statics do not vary qualitatively between the monopoly union and the efficient bargaining model but only quantitatively since $\beta_n \neq \delta_n$. The same effects can be shown for all other variables in both institutional settings.

Results

The comparative statics results obtained for the monopoly union and the efficient bargaining model are outlined in table 2 and can be interpreted as follows. A population increase, i.e. an increase of the available workforce z, always has a positive impact on both employment in the unionised and the competitive sector. These effects point in the same direction under both wage setting frameworks but they vary quantitatively. That is, a population increase leads to even more employment in the unionised sector while there is a less positive impact on employment in the competitive sector if the wage setting is decentralised, respectively. This is due to the fact that employment is

	z		γ		σ		r	
n	$++$	$+$	$--$	$-$	$-$	?	$-$	$--$
w	$--$	$-$	$++$	$+$	$+$	?	$++$	$+$
c	$+$	$++$	$-$	$--$	$+$	?	$+$	$++$
b	$-$	$--$	$+$	$++$	$-$	?	$-$	$--$

Table 2: *Comparative statics of stationary equilibria in the monopoly union and the efficient bargaining model. The first sign in each cell indicates the effect in the decentralised setting while the second one points out the centralised case. Double signs indicate a stronger impact, respectively.*

already higher under centralised wage setting. Hence, the marginal employment effect is less significant there.

The converse results are obtained for wages. A population increase lowers wages in both sectors whereas this effect is more negative in the unionised sector and less negative in the competitive one under decentralised wage setting, respectively.

The discount factor r measures the devaluation of future utility compared to instant utility. The higher r the less the appreciation of future gains. Consequently, a rise in r will raise the wage in the unionised sector, which is equivalent to a decrease in n. The negative effects of this instant utility gain, resulting from the exit of union members not employed there, will only take place in the future and is therefore valued less in the present.

Somewhat surprising is the indefiniteness of a change in σ in the centralised case. For a small union a rise in this parameter is only synonymous to less future exits of union members in reaction to insufficient employment in the union sector. Hence potentially employment in the union sector falls at rising wages there while the opposite holds in the competitive sector; see the first signs in the respective column of Table 2. A large centralised union, on the other hand, additionally takes into consideration that high wages in the unionised sector drive down wages in the competitive one. The more workers keep union members, the stronger is the utility shrinking effect the union experiences from higher union wages. Because it is not a priori clear which of these two opposing effects is the dominant one, there is no clear statement about the qualitative

effects from a change in σ in the centralised case.

6 Concluding Remarks

The paper provides some new insights in the discussion on labour market distortions caused by unionism. Two important propositions can be derived from the model: First, equilibrium employment in all four cases is higher than static models predict. The interpretation is straightforward: As the union maximises the utility of both current and future members, it is partially interested in an employment increase. Under dynamic consideration the union has to take into account the fact that some of the workers not employed in the unionised sector but in the competitive one will leave the union. This fact drives down the wage and increases employment in the unionised sector, respectively. These results repeat the findings of the seminal works of Jones (1987) and Kidd and Oswald (1987) in a more general setting of union dynamics.

Second, we have shown that the degree of bargaining centralisation plays an important role in dual labour markets. Employment is higher under centralised bargaining compared to the situation with decentralised bargaining at the firm level. A large centralised union will consider the consequences of its behaviour on the outcome in the competitive sector. A union acting in a decentralised manner will not take into account these effects and will thus set a higher wage. Ceteris paribus, employment in the unionised sector is higher under centralised bargaining. Standard models with exogenous outside option or ignorant unions can not capture these differences. These results are in line with the idea of Olson (1982). He argues that organised interest groups are more harmful when they are strong enough to have significant influence and cause disruptions but not extensive enough to bear the costs of their actions. There is, however, no clue of a hump-shaped relationship between centralisation and the wage in our analysis. In contrast to the work of Calmfors and Driffill (1988), the impact we consider just operates one-way, causing higher employment with higher centralisation. Future research could combine their static framework with our dynamic analysis to find the total effects of bargaining centralisation on wage and employment. Of course, the wage and employment effects of an endogenous outside option are not the only crucial factors – but otherwise they may not be disregarded in the discussion on the degree of bargaining centralisation.

Appendix: Optimal Employment Paths

Monopoly Union

To derive the optimal employment time path under decentralised wage setting (13), we rearrange the first-order conditions (11) and (12) as follows:

$$\lambda = \frac{\beta(n) - u(b)}{\sigma - 1} \, \mathrm{e}^{-rt} \tag{A.1}$$

$$\lambda = u(b)\mathrm{e}^{-rt} + \dot{\lambda} \tag{A.2}$$

Equating (A.1) with (A.2) eliminates λ and yields an equation in $\dot{\lambda}$:

$$\dot{\lambda} = \left[\frac{\beta(n) - u(b)}{\sigma - 1} - u(b) \right] \mathrm{e}^{-rt}. \tag{A.3}$$

Differentiating (A.1) with respect to time produces a second equation in $\dot{\lambda}$:

$$\dot{\lambda} = \frac{\beta'(n)\dot{n} - r\left(\beta(n) - u(b)\right)}{\sigma - 1} \, \mathrm{e}^{-rt} \tag{A.4}$$

which can be used together with (A.3) to eliminate $\dot{\lambda}$ and to get the optimal employment path (13).

The solution under centralised wage setting can be derived in an analogous manner. Rearranging the first-order conditions (18) and (17) gives

$$\lambda = \gamma \, \frac{\beta(n) - \alpha(n)}{\sigma - 1} \, \mathrm{e}^{-rt} \tag{A.5}$$

$$\lambda = \gamma u(b)\mathrm{e}^{-rt} + \dot{\lambda} \tag{A.6}$$

while equating yields an equation in $\dot{\lambda}$:

$$\dot{\lambda} = \gamma \left[\frac{\beta(n) - \alpha(n)}{\sigma - 1} - u(b) \right] \mathrm{e}^{-rt}. \tag{A.7}$$

Differentiating (A.5) with respect to time yields

$$\dot{\lambda} = \gamma \, \frac{\left(\beta'(n) - \alpha'(n)\right)\dot{n} - r\left(\beta(n) - \alpha(n)\right)}{\sigma - 1} \, \mathrm{e}^{-rt} \tag{A.8}$$

while combining (A.7) with (A.8) and solving for $\dot{n}$ gives the optimal employment path (19).

Efficient Bargaining

To derive the dynamic efficient bargaining solution, we rearrange the first-order condition (24) and substitute μ by $u'(w)$ from (25):

$$\lambda = \frac{u(w) - u(b) + u'(w)\,(f'(n) - w)}{\sigma - 1}\,\mathrm{e}^{-rt}. \tag{A.9}$$

Combining with (26) gives an equation in $\dot{\lambda}$:

$$\dot{\lambda} = \left[\frac{u(w) - u(b) + u'(w)\,(f'(n) - w)}{\sigma - 1} - u(b)\right]\mathrm{e}^{-rt}. \tag{A.10}$$

Differentiating (A.9) with respect to time yields

$$\dot{\lambda} = \frac{u'(w)\,f''(n)\dot{n} - r\,(u(w) - u(b) + u'(w)\,(f'(n) - w))}{\sigma - 1}\,\mathrm{e}^{-rt} \tag{A.11}$$

which can be used with (A.10) to eliminate $\dot{\lambda}$:

$$\begin{aligned} u(w) - u(b) + u'(w)\left(f'(n) - w\right) - (\sigma - 1)u(b) = \\ u'(w)\,f''(n)\dot{n} - r\left(u(w) - u(b) + u'(w)\left(f'(n) - w\right)\right) \end{aligned} \tag{A.12}$$

Simplifying and solving for $\dot{n}$ yields the optimal employment path (27).

In a similar way, the labour market outcome under centralised bargaining can be calculated. From (29) and (30) we have

$$\lambda = \gamma\,\frac{\delta(n) - \alpha(n)}{\sigma - 1}\,\mathrm{e}^{-rt} \tag{A.13}$$

which can be combined with (31) such that we get an equation in $\dot{\lambda}$:

$$\dot{\lambda} = \gamma\left[\frac{\delta(n) - \alpha(n)}{\sigma - 1} - u(b)\right]\mathrm{e}^{-rt}. \tag{A.14}$$

By differentiating (A.13) with respect to time, we end up with

$$\dot{\lambda} = \gamma \frac{(u'(w)\, f''(n) - \alpha'(n))\, \dot{n} - r\,(\delta(n) - \alpha(n))}{\sigma - 1}\, \mathrm{e}^{-rt}. \tag{A.15}$$

Equating (A.14) with (A.15) and solving for $\dot{n}$ gives the optimal time path of employment (32).

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