

WAGE BARGAINING AND EMPLOYER OBJECTIVES*

by

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This paper compares union wage bargaining outcomes across different types of employers. Five different employer objectives are discussed: profit, welfare and output maximization, and two specifications of a Leviathan. The model shows that the ordering of the union wage level across employer types depends on the functional form of product demand. With constant elasticity of product demand wage tends to be lowest in the output maximization case, while with a linear product demand wage tends to be lowest under welfare maximization.

1 INTRODUCTION

In the literature on trade union influence, the focus has mainly been on the role of bargaining structure, bargaining issues and union preferences within profit-seeking firms. While much is known of how union preferences influence bargaining outcomes,¹ little attention is given to employers' objectives. There are probably larger differences in employer objectives, for example between for-profit and non-profit firms, than in union preferences, which at least clearly include the wage level. During the last few decades, a growing fraction of the workforce has been employed in public and non-profit sectors.² Trade unions are present to a greater degree in the public sector than in the profit-seeking industries.³ There are also numerous reasons why for-profit enterprises may not be solely described by profit-maximizing behaviour. This paper compares wage bargaining outcomes across different types of employers.

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¹ See, for example, Booth (1984), Carruth and Oswald (1987), Pemberton (1988), Pencavel (1991) and Oswald (1993).

² Between 1960 and 1990, government employment as a share of total employment rose from 12.8 to 27.7 per cent in Norway, from 11.1 to 17.6 per cent in the UK and from 14.7 to 15.0 per cent in the USA; see Blank (1993) for a comparison between the UK and the USA. In the USA, the value added in non-profit enterprises as a share of total value added rose from 2.9 to 4.3 per cent between 1980 and 1997 (Ruhm and Borkoski, 2000).

³ Around 1990, the union density rate was higher in the public sector than in the private sector in 13 out of the 14 OECD countries with available data (Blanchflower, 1996). In the USA, the density rate was 36.7 per cent in the public sector and 12.9 per cent in the private sector. The corresponding numbers for the UK were 55.4 and 37.8 per cent.

Some theoretical papers have compared the outcome of collective bargaining in the private and public sectors.⁴ Gravelle (1984) examines bargaining covering both wage and employment levels in a profit-maximization firm versus a welfare-maximization firm. Haskel and Szymanski (1993) examine a wage bargaining model using similar assumptions regarding employer objectives. They find that without any weight on union utility in the objective of the public firm, the only sources of different wage levels are differences in bargaining power or product market power. Holmlund (1997) assumes that the public sector consists of agencies maximizing output subjected to a budget constraint. With bargaining at the agency level, the wage is higher in the public sector than in the private sector with equal union bargaining powers unless the market powers of the private firms are substantial. The model in the present paper assumes that product demand is independent of employer type, in order to focus on the effect of employer objectives. In contrast to the above studies, the present model includes fixed costs and considers alternative functional forms of product demand.

Welfare maximization is an ideal position for governments and non-profit organizations. In practice, when managers run subsidized public firms or agencies, output maximization is a description of an idealistic type of management. Freeman (1975) presents a comparison of non-profit and profit-seeking enterprises in this case. For a given price, an output-maximizing employer equates average costs and the price, in contrast to a profit-maximizing employer who sets the marginal cost equal to the price.

Managers in all sectors are likely to have preferences that diverge from the preferences of the owners of the enterprises. The degree of influence of the managers' objectives is likely to depend on enterprise size and ownership structure. I discuss two extreme cases of enterprise behaviour when the objectives of the management and the owners differ. Both cases assume that the management's preferences unilaterally describe the employer. In the first case, the Leviathan maximizes revenue, and in the second case, the Leviathan has preferences over manager wage and management size.

The rest of this paper is organized as follows. Section 2 presents the different employer objectives that are discussed. The bargaining model is set out in Section 3, while the comparative results are derived in Section 4. Section 5 presents the conclusions of this paper.

2 EMPLOYER OBJECTIVES

The following cases of employer objectives V are discussed:

⁴A growing number of papers in the literature have investigated the effects of unions in the public sector. Recent theoretical contributions include those by Babcock *et al.* (1997), Ström (1999) and Falch (2001). Gregory and Borland (1999) summarize the empirical literature on public sector labour markets.

- Case 1: Profit maximization; $V = \Pi = \text{profit}$
 Case 2: Welfare maximization; $V = \Pi + \text{CS} = \text{profit} + \text{consumer surplus}$
 Case 3: Output maximization; $V = X = \text{output}$
 Case 4: Revenue maximization; $V = R = \text{revenue}$
 Case 5: Management maximization; $V = v(M, \omega) = \text{the managers' utility}$ (M is the number of managers and ω is their wage)

In all cases, the utility functions must be interpreted as the loss that will be incurred in closing the firm or agency. Case 1 is the traditional profit-seeking firm. Cases 2 and 3 are the prevailing objectives of public firms or other non-profit organizations in the existing literature on collective bargaining. While welfare maximization is the traditional description of a 'benevolent dictator', application of welfare maximization by managers in public agencies gives few and weak control mechanisms for the government. Holmlund (1997) and Falch (2001) assume that bargaining occurs within government departments or bureaus that maximize the volume of public services. Output maximization is a description of second-best preferences in decentralized non-profit organizations, where the managers seek to enhance productivity.

Cases 1–3 neglect economic behaviour within the management in complex organizations. Cases 4 and 5 are two specifications of the objectives when the management behaves in a selfish way; both cases are relevant for large business firms, non-profit enterprises, as well as the public sector. An implicit assumption in Case 4 is that the things from which managers derive satisfaction vary directly with the size of the enterprise, as suggested by Baumol (1959) for private firms and by Niskanen (1971) for public agencies. Case 5 specifies the types of expenditures managers prefer. The utility of managers is assumed to be positively related to their wage level and the management size.

Figure 1 illustrates the differences between the cases. Under profit maximization, optimality occurs when the marginal cost and the marginal income are equalized, as illustrated by point C1. In the optimum under welfare maximization, point C2, the marginal cost is equal to the marginal propensity to pay. In the figure, there is a positive profit because the marginal cost is increasing and the fixed costs are low. Under output maximization, the output increases until total costs become equal to the income, as illustrated by point C3. This is also the optimum under revenue maximization if the marginal revenue is positive at this point. If not, it is optimal with a lower production as illustrated by point C4. The last case, management maximization, can be seen as the management seeks to extract rents from the market in order to pay excess management wage costs. Thus, management utility is potentially at its maximum when profit is maximized. The outcome will be $C5 = C1$.

With wage bargaining, the marginal cost is determined not only by technology but also in part by the bargaining outcome. The impact of the dif-

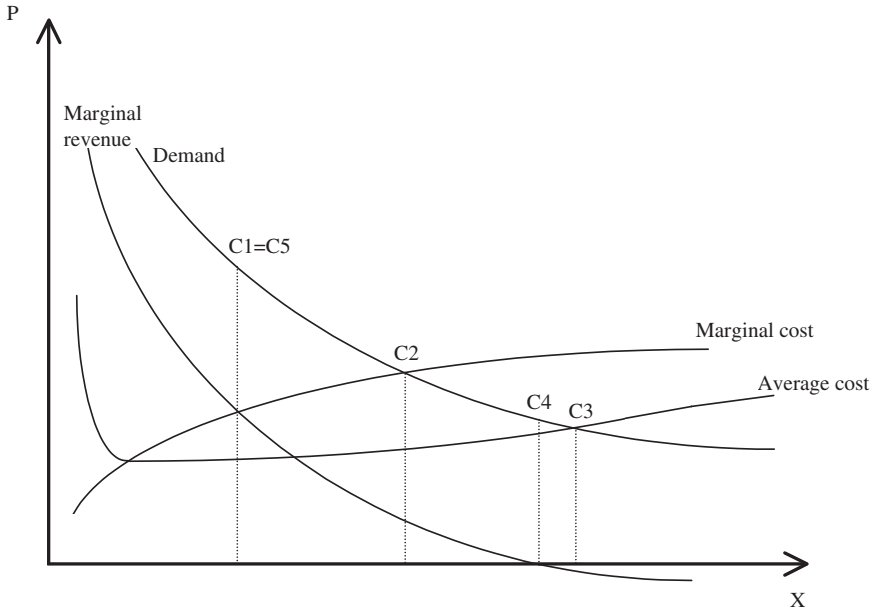


FIG. 1 Outcome and Employer Type

ferent employer objectives on the bargaining outcome will reduce (increase) the output differences between the cases if the 'high production' employers have a worse (better) bargaining position than the 'low production' employers. Since employment differences can be deduced from Fig. 1, the rest of this paper concentrates on wage differentials.

3 THE BARGAINING MODEL

Assume a rent-maximizing trade union covering all workers. The union loss during a dispute is $U = N(w - \bar{w})$, where w is the wage of the union members N , and \bar{w} is their reservation wage. The determination of \bar{w} will not be discussed in this paper. The present analysis considers whether different employer objectives give rise to wage differentials within a given economic structure, and does not analyse any general equilibrium effects of changes in the objectives for a large segment of firms.

As there seems to be some disagreement on whether unions have bargaining power over issues other than wages (see, for example, Pencavel, 1991; Oswald, 1993), only wage bargaining is considered in the present paper. In

addition, the main part of the literature is followed by considering only a static ‘one-shot’ bargaining game, and by assuming that the employer unilaterally sets the employment after the wage bargain.⁵

The Nash bargaining solution illustrates the bargaining outcome. The Nash maximand is

$$\Omega = V^\gamma U \tag{1}$$

where γ is the relative bargaining power of the employer. Maximizing (1) with respect to the union wage yields the wage markup over the reservation wage as

$$\frac{w - \bar{w}}{w} = - \frac{1}{\epsilon_{Nw} + \gamma \epsilon_{Vw}} \tag{2}$$

There are two potential sources of wage differentials between employer types. The values of the wage elasticity of demand for labour $\epsilon_{Nw} = (\partial N / \partial w)(w / N)$ and the wage elasticity of the employer objective $\epsilon_{Vw} = (\partial V / \partial w)(w / V)$ may depend on the preferences of the employer. With an elastic demand for labour the union wage demand is low since a marginal increase in wage has a large negative impact on employment. The employer’s resistance against paying a higher wage is only related to how much the objective is reduced. When evaluating the elasticities, one must take into account two constraints facing the employers. The profit must be non-negative, $\Pi = R - wN - \omega M \geq 0$, and the wage must not fall short of the reservation wage, $w \geq \bar{w}$ and $\omega \geq \bar{\omega}$.

In order to highlight the effect of different employer objectives, capital is extracted from the model, as in for example Booth (1984), Carruth and Oswald (1987) and Oswald (1993). In addition, the demand and production functions are assumed to be equal in all cases. The following production function is used throughout the paper.

$$X = \begin{cases} 0 & \text{if } M < 1 \\ aN^\alpha & \text{if } M \geq 1, \alpha \leq 1 \end{cases} \tag{3}$$

Management is introduced into the model in order to discuss a more realistic Leviathan-type of organization than simply revenue maximization. For the other cases, there are fixed costs. It is assumed that production requires a coordinating management. The minimum number of managers is normalized to unity, and a rise in management size above unity is assumed to have no effect on production. With this production function, it is optimal in Cases 1–4 to set $M = 1$ and the manager’s wage equal to his reservation wage $\bar{\omega}$.

⁵Repeated wage bargaining games were introduced by Espinosa and Rhee (1989) and Strand (1989). For example, Grout (1984) and Falch (2001) assume that employment is determined prior to the wage bargain.

Thus, in these cases, $\bar{\omega}$ is the fixed administrative costs or the fixed operational-dependent costs.⁶

The specification of the production function merits some discussion of the employer objective in Case 5. If one thinks about a firm where the owner initially hires one manager, which is the minimum required, Case 5 implies that this manager prefers to have others by his side, but that the utility function will not change as more managers are hired. One can interpret the utility function as that of the CEO, as in Migué and Bélanger (1974). But notice that the union wage and employment will be independent of the functional form of the manager(s) utility function, which only determines how management rent is divided between manager wage and management size.

In order for the union to be able to increase the wage, there must be rents to share. In a perfectly competitive industry without any barriers for the entry of firms, e.g. entry costs, there will be no profit, and no rents can be captured by a trade union. Union influence is only possible in cases where $\Pi > 0$ if $\gamma \rightarrow \infty$, a fact that is clearly acknowledged in the literature (see, for example, Dowrick, 1989). In general equilibrium types of models it is conventional to assume that all firms are equal, as in Layard *et al.* (1991), implying that the number of firms in the market is given, which is explicitly assumed by Dowrick (1989). An alternative is to assume exogenous fixed costs to entry, as in Bughin (1999). Since only partial equilibrium is discussed in the present paper, I assume that the market power of the firm is exogenously determined and that no market power is a special case of the model.

Often, different types of employers operate in different product markets. How the product demand influences union wages, however, is well illustrated in the literature. For example, increased elasticity of product demand will make a wage rise more costly for the union because the loss of employment increases. To emphasize the pure effect of employer objectives, it is assumed that the product demand is equal in all cases discussed.⁷

The inverse demand function is $P = P(X)$ and the revenue is $R = P(X)X$. The elasticity of the revenue with respect to production, denoted by $\kappa =$

⁶Allowing the optimal management size to depend on output size will complicate the model considerably without introducing new mechanisms.

⁷For public sector agencies, the government often determines the demand. A downward sloping demand function may thus require a justification. Consider a simple median voter model the standard framework in public finance. The median voter is decisive and solely determines the behaviour of the government. The median voter is faced with the budget constraint $Y_m(1 - t) = C_m$ (Y_m is the income level, t is the tax rate and C_m is the private consumption). The budget constraint of the government is $tY = PX$ (Y is total private income and P is the price of the publicly provided good X). Combining the budget constraints yields $Y_m = \tau PX + C_m$, where $\tau = Y_m/Y$ is the tax share of the median voter. τ and P are assumed to be exogenous in these types of model. Maximizing a quasi-concave median voter utility function, $v = v(X, C_m)$, subject to $Y_m = \tau PX + C_m$, yields the demand function $X = X(P, Y_m, \tau)$, where $\partial X/\partial P < 0$. In this case, the budget of the public sector agency R must be seen as determined by a rule corresponding to such a demand function, which implies that the size of the budget depends on the wage level.

TABLE 1
WAGE ELASTICITIES

	ϵ_{Nw}	ϵ_{Vw}
Case 1 (Profit maximization)	$\frac{1}{\alpha\kappa_1 + (\epsilon_{\kappa N})_1 - 1}$	$\frac{\alpha\kappa_1}{\alpha\kappa_1(1 + \bar{\omega}/w_1N_1) - 1}$
Case 2 (Welfare maximization)	$\frac{1}{\alpha\kappa_2[1 + J(\bar{\omega}/w_2N_2)] - 1}$	$\frac{\alpha(1 - J\kappa)[1 - J + J(w_2N_2 + \bar{\omega})/CS_2]}{\alpha(1 - J + J\kappa)(1 + \bar{\omega}/w_2N_2) - 1 - (1 - J)\alpha(CS_2/w_2N_2)}$
Case 3 (Output maximization)	$\frac{1}{\alpha\kappa_3(1 + \bar{\omega}/w_3N_3) - 1}$	$\frac{\alpha}{\alpha\kappa_3(1 + \bar{\omega}/w_3N_3) - 1}$
Case 4 (Revenue maximization)	$\frac{1}{\alpha\kappa_4(1 + \bar{\omega}/w_4N_4) - 1}$	$\frac{\alpha\kappa_4}{\alpha\kappa_4(1 + \bar{\omega}/w_4N_4) - 1}$
Case 5 (Management maximization)	$\frac{1}{\alpha\kappa_5 + (\epsilon_{\kappa N})_5 - 1}$	$\frac{\alpha\kappa_5}{\alpha\kappa_5 - 1}$

$(\partial R/\partial X)(X/R) = \kappa(X) \leq 1$, is interpreted as an indicator of product market competitiveness. For a given price, $\kappa = 1$,⁸ while the marginal revenue is equal to zero for $\kappa = 0$.⁹ The elasticity of product market competitiveness with respect to employment is denoted by $\epsilon_{\kappa N} = (\partial \kappa/\partial N)(N/\kappa)$.

Table 1 presents the expressions for ϵ_{Nw} and ϵ_{Vw} in the different cases, where the numbers in subscript denote the cases. J is an indicator variable that indicates whether the profit constraint is binding or not,

$$J = \begin{cases} 0 & \text{if } \Pi > 0 \\ 1 & \text{if } \Pi = 0 \end{cases} \tag{4}$$

Profit is assumed to be positive in Case 1 ($\Pi_1 > 0$), while the profit constraint is binding in Cases 3 and 5 ($\Pi_3 = \Pi_5 = 0$). For a given wage, there may be a positive profit in the optimum in Case 4. But since the employer cares only

⁸If the firm has no market power ($\kappa = 1$) and constant returns to scale ($\alpha = 1$) without fixed costs ($\omega M = 0$), the profit will be equal to zero and it is impossible for the union to increase the wage above the reservation wage.

⁹Some have argued that the demand for numerous governmental services is likely to be inelastic, i.e. κ is low. The empirical evidence, however, indicates that the wage elasticity of demand for labour is not substantially different in the public and private sectors (Ehrenberg and Schwarz, 1986; Freeman, 1986).

about revenue, increased wage does not decrease the employer utility level if $\Pi_4 > 0$. Thus, in bargaining optimum, $\Pi_4 = 0$.

The wage elasticities of labour demand and the employer objective may differ across employer types for five reasons. These are described in the next section.

4 COMPARATIVE RESULTS

Because discrete different outcomes will be compared, the functional form of product demand must be specified. I will consider both demand with constant elasticity as well as linear demand.

4.1 Constant Elasticity Product Demand

Assume that the inverse demand function is given by $P = bX^{-\Psi}$, $0 < \Psi < 1$. The revenue is $R = bX^\kappa$, where $\kappa = 1 - \Psi$. Now κ is equal in all cases and $\varepsilon_{\kappa V} = 0$. In Case 2, the consumer surplus $CS_2 = [(1 - \kappa)/\kappa]R_2$, which yields the wage elasticity of the employer objective as

$$(\varepsilon_{V_w})_2 = \frac{\alpha\kappa}{\alpha\kappa(1 + \bar{\omega}/w_2N_2) - 1} \quad (5)$$

$(\varepsilon_{V_w})_2$ is independent of whether the profit constraint is binding ($\Pi_2 = 0$) or not ($\Pi_2 > 0$).

The comparative results are summarized in two propositions. In the first proposition, fixed costs are neglected, and Case 5 is not taken into account.

Proposition 1: For constant elasticity product demand and $\bar{\omega} = 0$, $w_3 \leq w_1 = w_2 = w_4$. Strict inequality holds for $\gamma > 0$.

Proof: The results follow from inspection of ε_{N_w} and ε_{V_w} in Table 1.

In a monopoly union ($\gamma = 0$), wage is solely determined by the labour demand elasticity. Without fixed administrative costs ($\bar{\omega} = 0$), the elasticity is equally determined by the parameters α and κ in all cases, and it follows that the union wage is independent of the employer objective. When the employer has bargaining power ($\gamma > 0$), the size of the wage elasticity of the employer objective matters. This is basically the same model as the one used by Haskel and Szymanski (1993) and Holmlund (1997). As in the model used by Haskel and Szymanski (1993), the present model implies equal wages under profit and welfare maximization. Holmlund (1997) shows that an output-maximizing employer may have stronger incentives to withstand union wage pressure than a profit-maximizing employer, because in the former case the objective is more sensitive to wage changes. In the present model where the product market competitiveness is equal for all employer types, in contrast

to Holmlund's model, output maximization stands out as a special case. The wage elasticity of the employer objective is equal in all cases except in Case 3, where the elasticity is larger, $|(\varepsilon_{V_w})_i| < |(\varepsilon_{V_w})_3|$, $i = 1, 2, 4$.¹⁰ A wage increase is more 'costly' under output maximization than in the other cases. When the wage increases, some of the increased cost is compensated by a higher price. This increases revenue, which partly reduces the negative effect of a higher wage on the employer utility level, in all cases except Case 3. Under output maximization, monetary measures are not explicitly included in the objective. This will be denoted as the *non-monetary objective effect*.¹¹

Proposition 2 extends the comparison to take into account the fixed costs ($\bar{\omega} > 0$), which makes it possible to include Case 5 in the analysis.

Proposition 2: For constant elasticity product demand and $\bar{\omega} > 0$,

- (i) when $\gamma = 0$, $w_3 = w_4 < w_1 = w_5$. If $\Pi_2 > 0$, $w_2 = w_1 = w_5$. If $\Pi_2 = 0$, $w_2 = w_3 = w_4$.
- (ii) when $\gamma > 0$, $w_1 < w_5$ and $w_3 < w_4 < w_5$. If $\Pi_2 > 0$, $w_1 < w_2 < w_5$. If $\Pi_2 = 0$, $w_2 = w_4$.

Proof: The results follow from inspection of ε_{N_w} and ε_{V_w} in Table 1.

Without employer bargaining power ($\gamma = 0$), introducing fixed costs obviously does not influence the employment level under profit maximization because the employment decision of the firm only depends on marginal values. Case 5 may be described as a two-step maximization. First, profit is maximized and then it is divided between M and ω . Only the first step is relevant for the determination of N . Thus, from the union's point of view, there are no differences between Cases 1 and 5. In Cases 3 and 4, however, employment must be reduced when $\bar{\omega}$ increases. The profit constraint implies that after a wage rise, and thereby reduced employment, each worker must cover a larger share of the fixed costs. The vertical distance between the average cost curve and a curve describing average variable costs increases. Thus, the wage elasticity of labour demand is more elastic in Cases 3 and 4 than in

¹⁰Holmlund (1997) considers only public sector agencies with a fixed budget, implying $\kappa = 0$. Thus, the wage elasticity of demand for labour is more elastic in the private sector than in the public sector, working in the direction of lower wage in the private sector. Setting $\kappa = 0$ in Case 3 in the present model, it follows that $w_3 < w_1$ if $\kappa_1 < 1/(1 + \alpha)$. Then the *non-monetary objective effect* dominates the effect of the different labour demand elasticities.

¹¹Strøm (1999) presents two additional arguments for lower wage in the local public sector than in the private sector, within a monopoly union model with inelastic labour demand. First, with inelastic demand, higher wage has to be financed by higher taxes, which partially lowers the disposable wage for all union members. Second, higher wage means that fewer local public services are available to the union members. Both effects are likely to be absent for firm-specific unions in the private sector.

Cases 1 and 5, which is also demonstrated by Freeman (1975). This will be denoted as the *fixed costs' labour demand effect*, which consequently works in the direction of low wage in Cases 3 and 4. If the profit constraint is not binding in Case 2 ($\Pi_2 > 0$), then the employment level is independent of the size of $\bar{\omega}$ as in Cases 1 and 5. If the magnitude of the fixed costs implies that the profit constraint is binding in Case 2 ($\Pi_2 = 0$), however, then the constraint determines the labour demand in Case 2 in the same way as in Cases 3 and 4.

Part (ii) of Proposition 2 reveals a third channel through which wage differentials may arise. The *fixed costs' employer objective effect* follows from the fact that fixed costs influence the wage elasticity of the employer objective differently across cases. While administrative costs are only a cost component in Cases 1–4, they influence the management utility level directly in Case 5. Thus, in Case 5, ωM is a component that contributes to increased employer utility, and thereby $|(\varepsilon_{V_w})_5| < |(\varepsilon_{V_w})_i|$, $i = 1, 2, 3, 4$. Combined with the fact that $|(\varepsilon_{N_w})_5| \leq |(\varepsilon_{N_w})_i|$, the *fixed costs' employer objective effect* yields that the wage is highest in Case 5.

A comparison of Cases 1–4 reveals that the fixed costs as a share of union wage costs, $\bar{\omega}/wN$, differs across cases simply because the employment levels differ. The *fixed costs' employer objective effect* is the only difference between Cases 1 and 2 when $\Pi_2 > 0$. Because $\bar{\omega}/w_2N_2 < \bar{\omega}/w_1N_1$, $|(\varepsilon_{V_w})_2| < |(\varepsilon_{V_w})_1|$ and, consequently, $w_1 < w_2$. Since the only difference between Cases 3 and 4 is the *non-monetary objective effect*, $w_3 < w_4$. All this proves that the wage is lowest either in Case 1 or in Case 3. The *fixed costs' labour demand effect* and the *non-monetary objective effect* work in the direction of lowest wage in Case 3, while the *fixed costs' employer objective effect* works in the direction of lowest wage in Case 1. $|(\varepsilon_{V_w})_3| < |(\varepsilon_{V_w})_1|$ requires a high value of both $\bar{\omega}$ and κ . In order to have $w_1 < w_3$, it is also necessary that γ should be high since $|(\varepsilon_{N_w})_1| < |(\varepsilon_{N_w})_3|$. Thus, although it is, in general, ambiguous whether the wage is lowest in Case 1 or 3, it is likely to be lowest in Case 3. A small numerical version of the model is presented in Table 2 to throw more light on the role of the parameters $\bar{\omega}$, γ and κ .

The benchmark example in Table 2 is the monopoly union model without fixed costs. In Example 2, the relative bargaining power of the employer is 0.67, and from Proposition 1 it is evident that wage is lowest in Case 3. Introducing fixed costs when $\gamma = 0$ reduces the wage in cases with a binding profit constraint. In the other cases, the labour demand elasticity remains unchanged. Example 4 combines Examples 2 and 3, and the wage still remains lowest in Case 3. Example 5 increases the product market competitiveness κ and normalizes employment in Case 3 to be at the same level as in Example 4. In this example, κ , γ and $\bar{\omega}$ are high, and the wage is equal in Cases 1 and 3. Table 2 also confirms that the wage in Cases 1–4 is never higher than in Case 5. Regarding Cases 2 and 4, the wage tends to be lowest in Case 4, but the differences are small.

TABLE 2
SIMULATED OUTCOMES, INVERSE DEMAND IS $P = bX^{-\gamma}$

Example	1		2		3		4		5	
Parameter values	$\bar{\omega} = 0$ $\gamma = 0$ $\kappa = 0.5$ $b = 20$		$\bar{\omega} = 0$ $\gamma = 2$ $\kappa = 0.5$ $b = 20$		$\bar{\omega} = 5$ $\gamma = 0$ $\kappa = 0.5$ $b = 20$		$\bar{\omega} = 5$ $\gamma = 2$ $\kappa = 0.5$ $b = 20$		$\bar{\omega} = 5$ $\gamma = 2$ $\kappa = 0.8$ $b = 5.3^a$	
Dependent variable	w	N	w	N	w	N	w	N	w	N
Case 1 (Profit maximization)	2.50	6.9	1.50	16.3	2.50	6.9	1.45	17.2	1.14	29.8
Case 2 (Welfare maximization)	2.50	22.1	1.50	51.7	2.50	22.1	1.49	52.5	1.17	52.2
Case 3 (Output maximization)	2.50	32.0	1.30	95.2	2.34	32.0	1.29	90.0	1.14	90.0
Case 4 (Revenue maximization)	2.50	32.0	1.50	75.0	2.34	32.0	1.48	71.3	1.17	84.7
Case 5 (Management maximization)	—	—	—	—	2.50	6.9	1.50	16.3	1.19	26.8

Notes: Parameter values are $a = \bar{\omega} = 1$ and $\alpha = 0.8$. The values of b , $\bar{\omega}$, γ and $\kappa = 1 - \Psi$ are given in the second row of the table.

^aIn Example 5, the value of b is chosen such that the employment in Case 3 is equal in Examples 4 and 5.

4.2 Linear Product Demand

Are Propositions 1 and 2 due to the assumed functional form of product demand? The assumption of constant elasticity of product demand is extreme in the sense that the marginal revenue is always positive. For a more ‘linear’ product demand, the marginal revenue may be negative, and the product market competitiveness κ decreases in output size. The comparative results under a linear product demand function are presented in the following propositions.

Proposition 3: For linear product demand and $\bar{\omega} = 0$,

- (i) when $\gamma = 0$, $w_2 \leq w_1$ and $w_2 \leq w_3 = w_4$. Strict inequalities hold for $\alpha < 1$.
- (ii) when $\gamma > 0$, $w_2 \leq w_1$ and $w_2 < w_3 < w_4$. Strict inequality holds for $\alpha < 1$.

Proof: See the Appendix.

Cases 3 and 4 are equal from the union’s point of view, and $w_3 = w_4$ when $\gamma = 0$. Comparing Cases 2–4, it is evident that $N_2 \leq N_3 = N_4$, where strict

inequality holds for $\alpha < 1$. Because $\partial\kappa/\partial X < 0$, $\kappa_2 \geq \kappa_3 = \kappa_4$, and κ 's labour demand effect yields $w_2 \leq w_3 = w_4$. Comparing Cases 2–4 with Case 1 is complicated by the fact that $\varepsilon_{\kappa V} < 0$, which works in the direction of lowest wage in Cases 2–4. The κ 's labour demand effect is not solely determined by the value of κ but also by that of $\varepsilon_{\kappa V}$. The Appendix proves that the effect via $\varepsilon_{\kappa V}$ dominates when Cases 1 and 2 are compared, resulting in $w_2 \leq w_1$. By comparing Cases 1 and 3 it is evident that the result depends on the value of α . For $1 < \alpha < 0.5$, $w_1 < w_3$, while for $\alpha < 0.5$, $w_3 < w_1$.

The last factor influencing the wage differentials is the effect of κ on the value of ε_{Vw} . This κ 's employer objective effect works in the same direction as the κ 's labour demand effect. The Appendix demonstrates that the κ 's employes objective effect dominates the non-monetary objective effect, which gives $w_2 < w_3$ when $\bar{\omega} = 0$.

In Proposition 4, all five mechanisms of wage differentials influence the results.

Proposition 4: For linear product demand and $\bar{\omega} > 0$,

- (i) when $\gamma = 0$, $w_2 < w_1 = w_5$ and $w_3 = w_4$. If $\Pi_2 = 0$, $w_2 = w_3 = w_4$.
- (ii) when $\gamma > 0$, $w_1 < w_5$, $w_2 < w_5$ and $w_3 < w_4$. If $\Pi_2 = 0$, $w_2 < w_3$.

Proof: See the Appendix.

Comparing Case 2 and Cases 3–4, when $\gamma = 0$, the fixed costs' labour demand effect works in the opposite direction to the κ 's labour demand effect if the profit constraint is not binding in Case 2 ($\Pi_2 > 0$), making the sign of the wage differential ambiguous. In the most general case with both employer bargaining power ($\gamma > 0$) and fixed costs ($\bar{\omega} > 0$) the wage can be lowest in Case 1, 2 or 3. It is not possible to determine the sign of the wage differential between Cases 1 and 2 because the fixed costs' employer objective effect works in the direction of lowest wage in Case 1. Comparing Cases 2 and 3, the fixed costs' labour demand effect may give the lowest wage in Case 3 if the profit constraint is not binding in Case 2. However, since both the labour demand effect and the κ 's employer objective effect work in the direction of a lower wage in Case 2 than in Cases 1 and 3, it is likely that the wage is lowest under welfare maximization.

The wage is highest in one of the Leviathan cases. While the fixed costs' labour demand effect and the fixed costs' employer objective effect work in the direction of highest wage in Case 5, κ 's labour demand effect and κ 's employer objective effect work in the direction of highest wage in Case 4. To investigate the importance of the two latter effects, Table 3 presents simulations similar to those in Table 2.

In the first example, the parameter values are chosen such that the values of κ_3 and N_3 are equal to the values in Example 1 of Table 2. The results

TABLE 3
SIMULATED OUTCOME, INVERSE DEMAND IS $P = m - nX$

Example	1		2		3		4		5	
Parameter values	$\bar{\omega} = 0$ $\gamma = 0$ $m = 7.50^a$ $n = 0.1563^a$		$\bar{\omega} = 0$ $\gamma = 2$ $m = 7.50$ $n = 0.1563$		$\bar{\omega} = 5$ $\gamma = 0$ $m = 7.50$ $n = 0.1563$		$\bar{\omega} = 5$ $\gamma = 2$ $m = 7.50$ $n = 0.1563$		$\bar{\omega} = 5$ $\gamma = 2$ $m = 5.00^b$ $b = 0.0775^b$	
Dependent variable	<i>w</i>	<i>N</i>	<i>w</i>	<i>N</i>	<i>w</i>	<i>N</i>	<i>w</i>	<i>N</i>	<i>w</i>	<i>N</i>
Case 1 (Profit maximization)	2.42	13.1	1.50	24.0	2.42	13.1	1.45	24.7	1.24	25.1
Case 2 (Welfare maximization)	2.17	27.8	1.41	51.0	2.17	27.8	1.39	51.9	1.21	47.9
Case 3 (Output maximization)	2.50	32.0	1.66	54.3	2.34	32.0	1.61	52.7	1.33	52.7
Case 4 (Revenue maximization)	2.50	32.0	2.08	41.9	2.34	32.0	1.98	41.4	1.45	45.7
Case 5 (Management maximization)	2.42	13.1	1.50	24.0	2.42	13.1	1.50	24.0	1.29	23.9

Notes: Parameter values are $a = \bar{\omega} = 1$ and $\alpha = 0.8$. The values of m , n , $\bar{\omega}$ and γ are given in the second row of the table.

^aThe values of m and n are chosen such that κ and N are equal in the present and previous (Table 2) simulations for Case 3 in Example 1.

^bIn Example 5, κ is increased by reducing n . The value of m is chosen such that the employment in Case 3 is equal in Examples 4 and 5.

confirm that κ 's labour demand effect yields the lowest wage in Case 2, and the highest wage in Cases 3 and 4 since $\alpha > 0.5$. Introducing the bargaining power of the employer (Example 2) has a small effect in Case 4 because κ is low at the present high employment level. A revenue-maximization employer will be in a weak position with regard to wage bargaining when $\partial \kappa / \partial X < 0$. When κ becomes low, the employer has little to lose from a wage increase. The non-monetary objective effect markedly reduces the wage in Case 3 compared to Case 4. However, the wage in Case 3 is still higher than in Cases 1 and 5. The non-monetary objective effect is not strong enough to alter the sign of the wage differential between these cases.

With administrative costs and a monopoly union (Example 3), the wage in Cases 3 and 4 is lower than in Cases 1 and 5, reflecting that the fixed costs' labour demand effect is stronger than κ 's labour demand effect when these cases are compared. However, with some employer bargaining power, κ 's employer objective effect results in a relatively bad performance in Cases 3 and 4 from the employers' point of view.

In the simulations, wage is always lowest in Case 2.¹² It is striking that in the simulations with constant elasticity of product demand, wage is lowest in Case 3, while the three cases with lower employment have lower wages in the simulations with a linear demand. The counterpart to this result is that in the latter simulations wage is always lowest in Case 2, while in the former simulations Case 2 is among the cases with the highest wage. The functional form of the product demand seems to be extremely important in determining how well a specific type of employer will perform in wage bargaining.

5 CONCLUSION

Employers differ for a variety of reasons. This paper has revealed five channels through which wage bargaining outcomes may depend on employer objectives. Four of these channels influence the wage bargaining outcomes across all types of employers by altering the wage elasticities of labour demand and the employer objective. The different channels are summarized in Table 4, which presents the effects on the relative wage in the profit-maximizing case and in the other cases discussed.

The *non-monetary objective effect* is specific to the output maximization case. When the employer does not care about monetary issues, changes in monetary values have no direct effect on the utility level. Thus, increased price following a wage rise has no independent effect on the employer objective, making such an employer more hesitant about wage increases than employers with monetary objectives. To the extent that public sector objectives are related to non-monetary issues, this effect may contribute to a lower wage in the public sector than in the private sector, consistent with the evidence of lower union wage markup in the public sector than in the private sector in the USA (Ehrenberg and Schwarz, 1986; Blanchflower, 1996). Unfortunately, little work has been done on this issue outside the USA, but Blanchflower (1996) finds only a minor difference in the union wage markup between sectors in the UK.

The *fixed costs' labour demand effect* works in the direction of low wage when the employer is faced with a profit constraint because, then, fewer workers must cover the fixed costs after a wage rise. The *fixed costs' employer objective effect* works in the direction of low wage in cases with relatively low employment because, then, fixed costs per worker will be high. The *κ 's labour demand effect* and the *κ 's employer objective effect* indicate how differences in the level of product market competitiveness, κ , influence the wage elasticities. When κ is negatively related to output size (the product demand function is more 'linear' than under constant elasticity), both

¹²Notice that the profit constraint in Case 2 is never binding in the simulations in Table 3.

Table 4
EFFECTS ON THE RELATIVE WAGE IN THE PROFIT MAXIMIZATION CASE (CASE 1) AND THE OTHER CASES

	<i>Case 2, $\Pi_2 > 0$ (Welfare maximization)</i>	<i>Case 2, $\Pi_2 = 0$ (Welfare maximization)</i>	<i>Case 3 (Output maximization)</i>	<i>Case 4 (Revenue maximization)</i>	<i>Case 5 (Management maximization)</i>
Non-monetary objective effect	None	None	Positive	None	None
Fixed costs' labour demand effect	None	Positive	Positive	Positive	None
Fixed costs' employer objective effect	Negative	Negative	Negative	Negative	Negative
κ 's labour demand effect	Positive	Positive	Negative if $\alpha > 0.5$	Negative if $\alpha > 0.5$	None
κ 's employer objective effect	Positive	Positive	Negative	Negative	None

channels work in the direction of lower wage under welfare maximization than in the other cases.

The formal analysis and the simulations reveal some notable findings. Increased ‘linearity’ of product demand tends to favour employers with low production. The Leviathan type of employer with low production considered (management maximization) performs quite well in wage bargaining under a linear product demand and performs badly under a product demand with constant elasticity. For the other case of a Leviathan considered (revenue maximization), the production is high, and the performance of the employer is related to the product demand function in a manner contrary to the former case. Another important finding is that employers maximizing both welfare and output may perform better in wage bargaining than a profit-maximizing employer. The condition for output maximization to perform better than profit maximization is that the product demand is not ‘too linear’. As ‘linearity’ increases, the disadvantage of high production in the output maximization case outweighs the advantage of having a non-monetary objective. On the other hand, a welfare-maximizing employer will perform better in wage bargaining than a profit-maximizing employer provided the product demand is ‘linear enough’. As linearity increases, the advantage of a product demand that is more elastic than the marginal revenue outweighs the disadvantage of high production.

APPENDIX

Proof of Proposition 3

Consider the inverse linear product demand function $P = m - nX$. Then the first-order conditions in the different cases can be written

$$w_i N_i = \alpha(m - 2nX_i)X_i \quad i = 1, 5 \quad (\text{A1})$$

$$w_i N_i = [\alpha + J(1 - \alpha)](m - nX_i)X_i - J\bar{\omega} \quad i = 2, 3, 4 \quad (\text{A2})$$

where $J = 1$ in Cases 3 and 4 and if $\Pi_2 = 0$. Further, it follows that

$$\kappa = \frac{m - 2nX}{m - nX} \quad (\text{A3})$$

$$\varepsilon_{\kappa N} = \alpha \frac{\partial \kappa}{\partial X} \frac{X}{\kappa} = - \frac{\alpha n m X}{(m - 2nX)(m - nX)} \quad (\text{A4})$$

Utilizing (A1)–(A4), the wage elasticities of the demand for labour can be written

$$(\varepsilon_{N_w})_i = \frac{m - 2nX_i}{\alpha(m - 4nX_i) - (m - 2nX_i)} \quad i = 1, 5 \quad (\text{A5})$$

$$(\varepsilon_{N_w})_i = \frac{m - nX_i - J(\bar{\omega}/X_i)}{\alpha(m - 2nX_i) - (m - nX_i) + J(\bar{\omega}/X_i)} \quad i = 2, 3, 4 \quad (\text{A6})$$

Utilizing (A1)–(A4) and that the consumer surplus $CS = \frac{1}{2}nX^2$, the wage elasticities of the employer objective can be written

$$(\varepsilon_{V_w})_1 = \frac{\alpha(m - 2nX_1)}{\alpha(m - 2nX_1) - (m - nX_1) + \bar{w}/X_1} \tag{A7}$$

$$(\varepsilon_{V_w})_2 = \frac{(1 + J)\alpha[m - nX_2 - J(\bar{w}/X_2)]}{\alpha\{[m - (1 + J)nX_2] - [m - \frac{1}{2}(1 + J)nX_2]\} + \bar{w}/X_2} \tag{A8}$$

$$(\varepsilon_{V_w})_3 = \frac{\alpha(m - nX_3 - \bar{w}/X_3)}{\alpha(m - 2nX_3) - (m - nX_3) + \bar{w}/X_3} \tag{A9}$$

$$(\varepsilon_{V_w})_4 = \frac{\alpha[(m - 2nX_4)/(m - nX_4)](m - nX_4 - \bar{w}/X_4)}{\alpha(m - 2nX_4) - (m - nX_4) + \bar{w}/X_4} \tag{A10}$$

$$(\varepsilon_{V_w})_5 = \frac{\alpha(m - 2nX_5)}{\alpha(m - 2nX_5) - (m - nX_5)} \tag{A11}$$

Proof of part (i): It follows from (2) that $w_2 \leq w_1$ if $|(\varepsilon_{N_w})_1| \leq |(\varepsilon_{N_w})_2|$ (recall that $\gamma = 0$). Inspection of (A5) and (A6) reveals that this is true if (recall that $\bar{w} = 0$ and that $J = 0$ when $\bar{w} = 0$)

$$\frac{m - 4nX_1}{m - 2nX_1} \leq \frac{m - 2nX_2}{m - nX_2} \tag{A12}$$

(A12) is fulfilled if $X_2 \leq 2X_1$, or equivalently, $N_2 \leq 2^{1/\alpha}N_1$. Thus, evaluating the first-order conditions (A1) and (A2) for $N_2 = 2^{1/\alpha}N_1$, it is evident that $w_2 \leq w_1$. Inserting $N_2 = 2^{1/\alpha}N_1$ into (A2), it follows that $w_2 \leq w_1$ if $2^{(\alpha-1)/\alpha} \leq 1$. This is always fulfilled for $\alpha \leq 1$, with strict inequality for $\alpha < 1$. This proves that $w_2 \leq w_1$.

Recall that the expressions of ε_{N_w} are equal in Cases 2 and 3 when $\bar{w} = 0$. Thus, it follows that $w_3 \leq w_1$ if $N_3 \leq 2^{1/\alpha}N_1$. And by a similar reasoning as above, it is evident that $w_3 \leq w_1$ if $2^{(\alpha-1)/\alpha} \leq \alpha$. This is fulfilled if $\alpha \leq 0.5$. For $\alpha > 0.5$, the condition is not fulfilled. Thus, $w_1 = w_3$ if $\alpha = 1$ or $\alpha = 0.5$, $w_1 < w_3$ if $0.5 < \alpha < 1$, and $w_3 < w_1$ if $\alpha < 0.5$.

Comparing Cases 2 and 3, it is evident that $N_2 \leq N_3$, where strict inequality holds for $\alpha < 1$. Thus, $\kappa_2 \geq \kappa_3$ because $\partial\kappa/\partial X < 0$. This proves that $|(\varepsilon_{N_w})_3| \leq |(\varepsilon_{N_w})_2|$ and $w_2 \leq w_3$. Lastly, $w_3 = w_4$ because the first-order conditions, determining the wage elasticities of the demand for labour, are equal in these cases.

Proof of part (ii): The effects on the wages via the preferences of the employers work in the direction of lower wage in Case 2 than in Case 1 if $|(\varepsilon_{V_w})_1| < |(\varepsilon_{V_w})_2|$. Inspection of (A7) and (A8) reveals that $|(\varepsilon_{V_w})_1| \leq |(\varepsilon_{V_w})_2|$ if (recall that $\bar{w} = 0$)

$$\frac{m - 2nX_1}{m - nX_1} \leq \frac{m - nX_2}{m - \frac{1}{2}nX_2} \tag{A13}$$

(A13) is fulfilled if $X_2 \leq 2X_1$. This is the same condition as for $|(\varepsilon_{N_w})_1| \leq |(\varepsilon_{N_w})_2|$. Thus, both $|(\varepsilon_{N_w})_1| \leq |(\varepsilon_{N_w})_2|$ (κ 's labour demand effect) and $|(\varepsilon_{V_w})_1| \leq |(\varepsilon_{V_w})_2|$ (κ 's employer objective effect), proving that $w_2 \leq w_1$. Strict inequalities hold for $\alpha < 1$.

$N_1 < N_4$ yields that $\kappa_4 < \kappa_1$. Thus, from (A7) and (A8), it follows that $|(\varepsilon_{V_w})_4| \leq |(\varepsilon_{V_w})_1|$. The κ 's employer objective effect works in the direction of lower wage

in Case 1 than in Case 4. Combined with $|(\varepsilon_{Vw})_1| \leq |(\varepsilon_{Vw})_2|$ and $|(\varepsilon_{Nw})_4| \leq |(\varepsilon_{Nw})_2|$, this proves that $w_2 < w_4$. Because $(m - 2nX)/(m - nX) < 1$, it follows from (A9) and (A10) that $|(\varepsilon_{Vw})_4| \leq |(\varepsilon_{Vw})_3|$. This proves that $w_3 < w_4$.

Comparing Cases 2 and 3, it follows from (A8) and (A9) that $|(\varepsilon_{Vw})_3| \leq |(\varepsilon_{Vw})_2|$ if

$$X_2 < 2kX_3 \quad \text{where} \quad k = \frac{\alpha m}{m + (2\alpha - 1)nX_3} \tag{A14}$$

or equivalently, $N_2 < (2k)^{1/\alpha}N_3$. Recalling that $|(\varepsilon_{Nw})_3| \leq |(\varepsilon_{Nw})_2|$, it must follow from (A2) that $w_2 < w_3$ for $N_2 = (2k)^{1/\alpha}N_3$ if (A14) holds. Inserting $N_2 = (2k)^{1/\alpha}N_3$ into the first-order condition in Case 2, it follows that $w_2 < w_3$ if

$$X_3 > \frac{m}{n}K \quad \text{where} \quad K = \frac{2^{(\alpha-1)/(2\alpha-1)}\alpha - 1}{2\alpha - 1} \tag{A15}$$

For $\alpha = 1$, $K = 0$. For $\alpha < 1$ and $\alpha \neq 0.5$, $K < 0$. Thus, $K \leq 0$ for each $\alpha \neq 0.5$, and (A15) is fulfilled for each $\alpha \neq 0.5$. For $\alpha = 0.5$, it follows directly from (A14) that $|(\varepsilon_{Vw})_3| < |(\varepsilon_{Vw})_2|$ because $X_2 < X_3$ (recall that $\Pi_2 > 0$ when $\bar{w} = 0$). This proves that $w_2 < w_3$.

Proof of Proposition 4

Consider again the linear product demand $P = m - nX$. Then the relevant elasticities are given by (A5)–(A11).

Proof of part (i): Because the first-order conditions are equal in Cases 1 and 5, $w_1 = w_5$. If the profit constraint is not binding in Case 2 ($\Pi_2 > 0$), the wage elasticities in Cases 1, 2 and 5 are independent of the value of \bar{w} . Thus, the result from part (i) of Proposition 3 carries over. Notice, however, that $\Pi_2 > 0$ only if $\alpha < 1$ when $\bar{w} > 0$. Thus, w_2 is strictly lower than $w_1 = w_5$. If the profit constraint is binding in Case 2 ($\Pi_2 = 0$), utilizing (A5) and (A6) gives that $w_2 < w_1$ if

$$\frac{m - 4nX_1}{m - 2nX_1} < \frac{m - 2nX_2}{m - nX_2} + \frac{m - 2nX_2}{m - nX_2} \frac{\alpha\bar{w}}{(m - nX_2)X_2 - \bar{w}} \tag{A16}$$

Compared to (A12), there is a new term on the right hand side of the inequality. Clearly, if $X_2 = 2X_1$, the condition is fulfilled with strict inequality in contrast to the situation when $\bar{w} = 0$. Thus, $w_2 < w_1$ if $X_2 \leq 2X_1$, which always holds even when the profit constraint is not binding as proved above. This proves that $w_2 < w_1 = w_5$.

If $\Pi_2 = 0$, the outcomes in Cases 2–4 are equally determined by the profit constraint, and thus $w_2 = w_3 = w_4$. This implies that $w_3 (= w_4) < w_1$ when $\Pi_2 = 0$. Fixed costs increase $|(\varepsilon_{Nw})_3|$, which may make $w_3 < w_1$ even though $\alpha > 0.5$. Thus, when \bar{w} is so high that $\Pi_2 = 0$ in Case 2, $|(\varepsilon_{Nw})_3|$ increases to such an extent that the wage is always lower in Case 3 than in Case 1.

If $\Pi_2 > 0$, two opposite effects may make $|e_{Nw}|$ smaller or larger in Case 3 than in Case 2. First, $N_2 < N_3$, giving the result in part (i) of Proposition 3 (κ 's labour demand effect). Second, $|(\varepsilon_{Nw})_3|$ is increasing in the fixed cost \bar{w} (the fixed costs' labour demand effect). For a small \bar{w} , the former effect dominates, making $w_2 < w_3$. For a large \bar{w} , N_3 will be small and close to N_2 . Thus, the former effect is minor while the latter

effect is large. There exists a critical level of \bar{w} , say \bar{w}^c , for which $w_2 < w_3 = w_4$ if $\bar{w} < \bar{w}^c$ and $w_3 = w_4 < w_2$ if $\bar{w} > \bar{w}^c$.

Proof of part (ii): From (A7) and (A11), it follows that $|(\epsilon_{Vw})_3| < |(\epsilon_{Vw})_1|$ because \bar{w} is not included in $(\epsilon_{Vw})_5$. Since $(\epsilon_{Nw})_1 = (\epsilon_{Nw})_5$, this proves that $w_1 < w_5$. From (A8) and (A11), it is clear that $|(\epsilon_{Vw})_3| < |(\epsilon_{Vw})_2|$, independent of the size of Π_2 . Since $|(\epsilon_{Nw})_3| < |(\epsilon_{Nw})_2|$, this proves that $w_2 < w_5$. Comparing Cases 3 and 4, it follows from (A9) and (A10) that $|(\epsilon_{Vw})_4| < |(\epsilon_{Vw})_3|$. Since $(\epsilon_{Nw})_3 = (\epsilon_{Nw})_4$, this proves that $w_3 < w_4$.

Comparing Cases 1 and 2, two opposite effects may make $|e_{Vw}|$ smallest or largest in Case 2. First, without fixed costs, $|(\epsilon_{Vw})_1| < |(\epsilon_{Vw})_2|$ (κ 's employer objective effect). Second, fixed costs have a larger effect on $|(\epsilon_{Vw})_1|$ than on $|(\epsilon_{Vw})_2|$ (the fixed costs' employer objective effect). When $\Pi_2 > 0$, $|(\epsilon_{Vw})_1| < |(\epsilon_{Vw})_2|$ if

$$\frac{m-2nX_1}{m-nX_1} \left(1 - \frac{\bar{w}}{X_2}\right) \leq \frac{m-nX_2}{m-\frac{1}{2}nX_2} \left(1 - \frac{\bar{w}}{X_1}\right) \tag{A17}$$

Since $X_1 < X_2$, the value of the parentheses on the left hand side of the inequality is greater than the value of the parentheses on the right hand side. Thus, $X_2 \leq 2X_1$ is not a sufficient condition for (A17) to hold, and, generally, it is ambiguous whether the wage is lowest in Case 1 or 2.

If $\Pi_2 > 0$, the sign of the wage differential between Cases 2 and 3 is ambiguous by part (i) of the proposition. If $\Pi_2 = 0$, the outcome in the two cases will be equal if the wage is equal. Because $(\epsilon_{Nw})_2 = (\epsilon_{Nw})_3$, it follows that $w_2 < w_3$ if $|(\epsilon_{Vw})_3| < |(\epsilon_{Vw})_2|$ for $X_2 = X_3$. Comparing (A8) and (A9), it is clear that this is fulfilled. This proves that $w_2 < w_3$ if $\Pi_2 = 0$.

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