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The impact of fringe benefits on payment profiles

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Summary

Several explanations are proposed for the observed domination of wages in the wage-fringe benefit mix. Domination occurs if fringe benefits are taxed at a higher level or marginal rate, or if trading fringe benefits incurs transaction costs. A central result shows wage domination, even in the absence of these effects, due to intertemporal effects of durable fringe benefits, which can be consumed in periods of disagreement. This enables workers to extract a higher bargaining surplus, and leads the firm to resist fringe benefit payments. Finally, the paper gives a novel reason for tenure effects in both wages and fringe benefits.

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1. Introduction

It is commonly observed that wages rather than fringe benefits are the dominant payment form in the labour market. The purpose of this paper is two-fold. First it is to provide theoretical explanations for this apparent stylized fact, which surprisingly remains largely unexplained. We therefore investigate the profile of the wage-fringe benefit mix. Furthermore, empirical evidence suggests that there is a positive relationship between the payment a worker receives and his age. The additional purpose of this paper is therefore to investigate how wages and fringe benefits change and interact over time, and we demonstrate seniority payments both in fringe benefits and wages. Whereas several explanations for why wages rise with seniority can be found (see Hart and Moutos, 1995), little attention has been given to the impact of tenure on fringe benefits. The interactions between fringe benefits

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and wages over time has similarly been ignored, and this paper seeks to rectify these omissions in the literature.

We look at three potential sources for wage dominance. Consider first the tax system. It is demonstrated that if wages were taxed at a lower rate than fringe benefits it could cause the observed effect. However, many types of fringe benefits are not taxed or are taxed at a much lower rate than wages (see Vella, 1993). The above issue has not received adequate attention in the literature which usually assumes a wage-fringe benefit mix despite the observed difference in tax regimes (e.g. Wales, 1973; Wales and Woodland, 1979; Woodbury, 1983; Parker and Rhine, 1991). Still, it is shown that, although the levels of taxation are lower on non-wage benefits, wages could dominate if the marginal tax rate levied on fringe benefits is sufficiently high. Second, consider a symmetric tax treatment, but where there either are transaction costs in exchanging fringe benefits for other goods or where alternatively fringe benefits can not be traded at all. In either instance it is shown that wages will dominate as they give rise to a higher marginal utility. Third, let us consider the case where taxation is equalized and fringe benefits are fully tradable, but where to some extent they are also durable implying that they can be carried through time. It will be shown that current fringe benefits will influence future bargaining outcomes, when they can be consumed in future periods in the event of no bargaining agreement being reached. The reason for this is that a build up of fringe benefits renders a period of dispute less disagreeable to the workers.† That is, the utility the workers derive in such a period increases with the amount of fringe benefits. We will demonstrate that it enables the workers to extract a higher surplus in the bargain with the firm. The firm therefore loses out by building up fringe benefits and its resistance to this causes wages to be the dominant form of payment. This is similar to the literature in the Williamson hold-up tradition.‡ This literature relies critically on the inability to sign complete and binding contracts contingent on all future events.

† We will model the interaction between the parties as a Nash bargain and it should be noted, as Binmore *et al.* (1986) point out, that there might be some ambiguity about the interpretation of the Nash threat point. Binmore *et al.* (1986) argued that it can be identified either with the income stream received in a dispute or as the income stream elsewhere were the negotiations to break down and the parties separate. Thus, there are two channels through which fringe benefits may operate and affect the bargaining outcome. Either fringe benefits may increase the outside option by being transportable, or fringe benefits may render the period of dispute less disagreeable. The latter channel may be of particular importance if firms face sufficiently large administrative costs in recouping in-situ fringe benefits during a conflict which will have to be redistributed when and if an agreement is made.

‡ See Malcomson (1997) for a survey of hold-up in labour markets and Williamson *et al.* (1975) for early discussions of hold-up in a labour market context.

In the context of a bilateral labour arrangement, given the incompleteness of contracts, the phenomenon usually arises due to turnover costs or specific investments that are made unilaterally by one party. Thus rents in continuing the relationship are generated, some of which may in turn be captured by the other party. Such exploitation (or hold-up) may in itself give rise to inefficiencies. Classic examples of this are given in Grout (1984) and Crawford (1988), where workers in the absence of binding contracts exploit first stage sunk investment in the second stage bargaining process, which leads to a distortion in the first-period's capital decision—that is, to a less than optimal capital investment. A new argument presented in this paper is that fringe benefits may be used as a hold-up in a bargaining framework, causing the reluctance of firms to provide them. The first two cases of wage dominance will be dealt with initially under Theorems 1 and 2. However, the third case represents the most novel contribution to the literature, and the analysis of this will therefore occupy a central part of this paper. Its implications are given under the two central Theorems 3 and 4.

Underlying case 3 is the possibility that it is difficult for firms to restrict access to the consumption of certain types of fringe benefits. Thus in a period of industrial dispute it might still be possible for workers to consume in-situ fringe benefits. This implies that once fringe benefits are in place it could be difficult to restrict their access, even when no agreement has been reached between the workers and the firm. Examples of fringe benefits which may be consumed in periods of dispute could include a company car, subsidized housing, health insurance schemes and loans of various types of capital equipment. But it could also include company based training schemes that enhance general human capital, which can either be consumed directly and/or consumed through the increase of home production levels. It should be noted that not all fringe benefits belong to the above mentioned category. Indeed, it is important to distinguish the above category from other fringe benefits such as free telephones at work, subsidized canteen food and secretarial support that can only be consumed when production takes place. Since we do not allow for long-term binding contracts over future variables to be signed prior to or at the time of the initial fringe benefit exchange, workers can exploit the first type of sunk fringe benefits in subsequent periods. The firm is of course fully aware of this and seeks therefore to restrict these fringe benefit payments, thus causing wage dominance. There are two ways in which these fringe benefits are thought to affect the future bargaining outcomes. They can affect the firm's outside option in the sense that the firm might be locked into fringe benefit payments. Similarly they can also increase the outside option of the workers. This paper concentrates on the second case where the workers

can consume some fringe benefits even when no agreement is reached.†

In addition to looking at the payment profile in a single period, we also examine how the payment profile changes over time. The intertemporal aspect of fringe benefits will show that a firm will be less reluctant to agree to fringe benefit payments late in a worker's life, as the older worker will be less able to "hold-up" the firm. Hence, fringe benefits exhibit tenure effects. Since fringe benefits increase with a worker's age so will the wage, as the surplus that can be extracted in the bargain depends positively on the level of durable fringe benefit accumulation. Thus, in the two-period model of this paper both wages and fringe benefits are higher in period two than in period one. On the one hand, Topel (1986), Abraham and Farber (1987), Altonji and Shakotko (1987) have all argued that wages do not rise significantly with seniority, but attribute most of the wage rise to job mobility. On the other hand, Topel (1991) finds that wages do rise with tenure, as is consistent with the model presented here.

It should be noted that we are not claiming that case 3 gives the universal reason for wage dominance. Rather, it is claimed that all cases can together or separately cause the observed effect. It can also be argued, even if the last case is not the sole cause, that the results obtained under this case are novel and of sufficient importance to warrant investigation. Furthermore, were one to observe a disproportional lack of fringe benefits giving rise to case 3, caution should be given in concluding that this renders the analysis of this case as marginal or unimportant. The last case remains of interest even if the first two cases give the overriding reasons for wage dominance, since case 3 may help to explain the observed type of fringe benefit payments. One could reasonably suspect that firms who pay fringe benefits might strive to avoid fringe benefits payments that could be exploited in periods of disagreement. Thus the observed fringe benefit payment mix may include disproportionally fewer goods that may give problems associated with case 3.

This paper is organized as follows. Section 2 contains some empirical estimates of the extent of fringe benefits in various countries. Section 3 presents the general framework, whereas Section 4 discusses the static second-period bargain. This section

† Modelling of the first case could involve the following, by applying a two stage model: suppose fringe benefits are bought by the firm in the first stage but first supplied in the second stage. Assume also that the purchasing price exceeds the resale price of fringe benefits. Thus, if no agreement is reached in the second stage the firm would have to resell fringe benefits at a loss. This lock-in effect is exploited by workers who extract a higher surplus in the second stage bargain. Hence the presence of fringe benefits renders the firm worse off, and will seek to counter this by buying fewer fringe benefits in the first stage.

TABLE 1.
*Non-wage compensation as a percentage of total employee compensation for 12 OECD countries in 1993**

Austria:	Belgium:	Finland:	France:
18·71	26·76	21·91	28·13
Germany:	Japan:	Netherlands:	Norway:
19·30	13·95	14·33	14·80
Sweden:	Switzerland:	U.K.:	U.S.:
26·62	13·72	12·58	18·17

* Data for Norway pertains to 1991.

deals primarily with taxation and transaction cost issues. Section 5 looks at the first-period bargain and deals with the intertemporal issues and assumes that taxation is symmetric and that fringe benefits are fully tradable at zero transaction cost.

2. The empirical background

Some empirical estimations of the extent of fringe benefits have been attempted showing the observed wage dominance, although it should be noted that accurate and detailed data on fringe benefits are notoriously difficult to obtain (see Vella, 1993). Woodbury and Hammermesh (1992) estimate from national accounts that U.S. non-wage payments in 1988–1989 were 16·43% of the total compensation package. They also estimate from surveys that faculties at American Universities receive 18·49% of their compensation in a non-wage form, whereas the figure in large firms is 19·68%. A similar figure of 18% has been estimated for U.S. teachers (Powell *et al*. (1994)). Woodbury and Hammermesh (1992) further point to an upward trend in fringe benefit payments in the period 1960–1989. This supports a similar observation by Clain and Leppel (1989). Estimates outside the United States have been largely absent, and in order to illustrate the extent of fringe benefits we follow the Woodbury and Hammermesh (1992) methodology and compute the percentage of total compensation which is in a non-wage form from National accounts (as provided in OECD, 1995) for 12 OECD countries.

Table 1 shows the non-wage compensation ranges between 12·59% in the case of the United Kingdom to 28·13% in the case of France. The average non-wage compensation being 19·08%. Thus the fringe benefits are substantial but non-dominant for all these 12 key OECD countries. It is also worth noting that our 1993 U.S. figure is larger than the Woodbury and Hammermesh's (1989) figure indicating a continued rise in fringe benefits.

3. The model

We present a two-period bargaining model between a firm and its workers. The bargain in each period includes wages, severance payments, employment and fringe benefits. Only the employed workers, denoted N_i, receive wages and only the unemployed get severance payments, whilst fringe benefits are given to all workers, denoted M associated with the firm irrespective of whether they are employed or not.† This is done for simplicity, since it enables us to retain the attractive feature for modelling purposes of second-period worker homogeneity. To reflect the two categories of fringe benefits discussed in the introduction, we will assume that fringe benefits consist of two separate parts: a production-based, fixed level F_i (assumed to be non-negotiable); and additional fringe benefits fi which can also be consumed in periods of dispute. F_i can also be interpreted as the minimum level of fringe benefits that must be provided as long as production takes place. The workers' lifetime utility function, U, is given by:

$$\begin{aligned} U = & \frac{N_1}{M}u(w_1) + \frac{M-N_1}{M}u(s_1) + \alpha u(\rho_1(F_1+f_1)) \\ & + \frac{N_2}{M}u(w_2) + \frac{M-N_2}{M}u(s_2) + u(\rho_2(F_2+f_2)) \\ & + (1-\alpha)u(\rho_1(F_1+f_1)) \end{aligned} \tag{1}$$

The two-period value of staying with the firm for any worker is the sum of expected utilities in each period. First-period and second-period expected utilities are given in line one and by the two remaining lines of expression (1), respectively. It is in each instance given by the sum of the probability of working with the firm N_i/M times the utility of income whilst employed, the probability of being unemployed $(M-N_i)/M$ times the utility of income whilst unemployed and the utility derived from fringe benefits (where all M workers receive fringe benefits independent of employment status). Income when employed is comprised by the normal wage w_i whilst income when unemployed is given solely by a severance payment s_i. Fringe benefits in each period are given by a minimum level F_i, an additional negotiable fringe benefit level f_i and any fringe benefits carried over from the previous period.

† We are assuming that no one of the M members of the workforce leaves regardless whether or not the worker is one of the employed workers N_i or one of the unemployed workers $M-N_i$. Thus we ensure that membership remains constant across periods. The attachment of workers to firms is standard in the literature and is similar in spirit to Feldstein (1976) who shows that 75% of unemployed workers eventually return to their previous employer.

To reflect that fringe benefits may not result in the same level of utility as wages we assume that income derived from fringe benefits is given by the proportion ρ_i of the fringe benefit $F_i + f_i$. Furthermore, we assume that the fringe benefits paid out in period 2 are consumed in their entirety in period 2. First-period fringe benefits are durable and α and $(1-\alpha)$ are the shares of total utility derived from fringe benefits assigned to period 1 and period 2 respectively.

The firm's profit function, that is the sum of profits over the two periods, is given by:

$$\begin{aligned}\Pi = {} & R(N_1) - w_1 N_1(1+t_w) - s_1(M-N_1)(1+t_w) \\ & - f_1 M(1+t_f) - F_1 M(1+t_f) \\ & + R(N_2) - w_2 N_2(1+t_w) - s_2(M-N_2)(1+t_w) \\ & - f_2 M(1+t_f) - F_2 M(1+t_f) \end{aligned} \tag{2}$$

We have assumed that wages, severance payments and fringe benefits can be taxed, and that this tax is paid by the firms. Taxes, t_f, levied on fringe benefits are not necessarily the same as the taxes, t_w, levied on wages and severance payment. We will also assume that the marginal tax rates are not necessarily the same. However, for simplicity we assume that:

$$\frac{\partial^2 t_w}{\partial w^2} = \frac{\partial^2 t_f}{\partial (F_i + f_i)^2} = 0\dagger$$

The profit in each period is given by the revenue $R(N_i)$ in each period minus the total labour cost (i.e. wage bill, severance bill and fringe benefit bill), and the taxes paid on labour cost.

As is normal in multi-period models, the system is solved recursively. That is the second-period bargain is solved first and the outcome is then used to solve the first-period bargain. In other words, the firm and workers realize that the first-period bargain will affect the bargain in the second period. This realization forces them to anticipate (solve) the bargaining outcome in the second period, before they reach an agreement in the first period. The utility in the second period for the workers is now given by:

$$\begin{aligned} U_2 = {} & \frac{N_2}{M} u(w_2) + \frac{M-N_2}{M} u(s_2) + u(\rho_2(F_2 + f_2)) \\ & + (1-\alpha) u(\rho_1(F_1 + f_1)) \end{aligned} \tag{3}$$

†Notice in particular the assumption made that taxes on wages and severance pay are the same. This has been done so as to better focus on the difference between fringe benefits and wages. It is therefore solely a simplification which implies $\partial t_w / \partial w = \partial t_w / \partial s$.

Notice that the second-period utility is the same as the two last lines in expression (1). If no agreement is reached in the first period we assume that the workers receive no unemployment benefits and that the alternative wage is zero. However, the workers will be able to consume, even when no agreement is reached, some of the fringe benefits carried over from the previous period. We will assume that it is only possible for the workers to consume the part of fringe benefits that is not linked to production. This implies that in the case of disagreement in the second period that the workers can not consume F_1. Thus, the threat point or outside opportunity of the bargain is given by V_2:

$$V_2 = (1-\alpha)u(\rho_1 f_1) \tag{4}$$

The workers' second-period surplus of reaching an agreement with the firm, denoted S_W, is given by the difference between the utility obtained by reaching an agreement and the utility of not reaching an agreement:

$$\begin{aligned} S_W = \frac{N_2}{M}u(w_2) + \frac{M-N_2}{M}u(s_2) + u(\rho_2(F_2+f_2)) \\ +(1-\alpha)u(\rho_1(F_1+f_1)) - (1-\alpha)u(\rho_1 f_1) \end{aligned} \tag{5}$$

We assume that the firm has no outside opportunity and the surplus of the firm is therefore given by its second period profit Π_2:

$$\begin{aligned} \Pi_2 = R(N_2) - w_2 N_2(1+t_w) - s_2(M-N_2)(1+t_w) \\ -f_2 M(1+t_f) - F_2 M(1+t_f) \end{aligned} \tag{6}$$

Notice that the profit in the second period is also given by the two last lines in expression (2).

4. The second-period bargain

Solving the problem recursively we start with period 2. Since there are no periods following period 2 the agents will not have to consider intertemporal effects of period 2 variables on future periods. It is therefore well worth noting that period 2 yields the same results as a static one-period model. The bargain in the second period is solved by applying the Nash bargaining solution. This problem can be expressed by the maximization of the product B:

$$\text{Max } w_2, s_2, f_2, N_2 \qquad B = (S_W)^{\gamma}(\Pi_2)^{1-\gamma} \tag{7}$$

The relative bargaining strengths of the workers and the firm are given by γ and $1-\gamma$ respectively. The first order conditions of this maximization problem can after simplification be written as:†

$$\frac{\partial B}{\partial w_2}=\gamma\Pi_2\frac{N_2}{M}u'(w_2)-(1-\gamma)S_w\left(N_2\left(1+t_w+w_2\frac{\partial t_w}{\partial w_2}\right)\right)=0 \tag{8a}$$

$$\frac{\partial B}{\partial s_2}=\gamma\Pi_2\frac{M-N_2}{M}u'(s_2)$$
$$-(1-\gamma)S_w\left((M-N_2)\left(1+t_w+s_2\frac{\partial t_w}{\partial s_2}\right)\right)=0 \tag{8b}$$

$$\frac{\partial B}{\partial f_2}=\gamma\Pi_2\rho_2u'(\rho_2(F_2+f_2))$$
$$-(1-\gamma)S_w\left(M\left(1+t_f+(F_2+f_2)\frac{\partial t_f}{\partial f_2}\right)\right)=0 \tag{8c}$$

$$\frac{\partial B}{\partial N_2}=\gamma\Pi_2\frac{1}{M}(u(w_2)-u(s_2))$$
$$+(1-\gamma)S_w(R'(N_2)-w_2(1+t_w)-s_2(1+t_w))=0 \tag{8d}$$

From (8a) and (8b) we get the familiar complete insurance result from contracting literature, that is the marginal utilities of wage and severance pay are equalized. It implies that the firm pays the workers severance pay when unemployed such that utilities are equalized between the unemployed and employed workers. Thus, the firm offers complete insurance against unemployment risk and the payment to the worker is independent of employment status, that is $w_2=s_2$.‡ Thus, when agreement is reached all M employed and unemployed workers attached to the firm receive the same income, that is either the wage or the identical severance pay in addition to the status-independent fringe benefit payments. Using $w_2=s_2$ with expression (8d) yields:

$$R'(N_2)=0 \tag{9}$$

Since the alternative wage has been normalized to zero, expression (9) implies that employment is allocated efficiently.

† We will throughout assume interior solutions such that employment never exceeds membership, that is $N_i<M$.

‡ This is the well-known insurance result from the labour contracting literature, where a risk neutral firm offers complete insurance for risk averse workers; see Rosen (1985) for survey.

The equation at hand is whether wages or fringe benefits dominate as a form of payment. That is, do workers receive more wages (severance pay if unemployed) than fringe benefits? We define wage domination in period 2 as the case where $w_2 = s_2 > F_2 + f_2$. Fringe benefit dominance holds if the opposite is true. It can be seen from (8a) and (8c) that the following condition holds:

$$\frac{1}{u'(w_2)}\left(1 + t_w + w_2\frac{\partial t_w}{\partial w_2}\right) = \frac{1}{\rho_2 u'(\rho_2(F_2 + f_2))}\left(1 + t_f + (F_2 + f_2)\frac{\partial t_f}{\partial f_2}\right) \qquad (10)$$

Condition (10) has implications for the type of payment dominance. However, it is dependent on the parameter values.

THEOREM 1: *when* $\rho_2 = 1$ *there will be wage dominance (i.e.* $w_2 = s_2 > F_2 + f_2$*, in the cases)*:

(i) when $\frac{\partial t_w}{\partial w_2} = \frac{\partial t_f}{\partial f_2}$ i.i.f. $t_w < t_f$;

(ii) when $t_w = t_f$ i.i.f. $\frac{\partial t_w}{\partial w_2} < \frac{\partial t_f}{\partial f_2}$;

(iii) when $\frac{\partial t_w}{\partial w_2} < \frac{\partial t_f}{\partial f_2}$ and $t_w < t_f$.

Proof follows directly from (10).

Part (i) of Theorem 1 assumes that the marginal tax rate is the same for wages and fringe benefits, and it illustrates that the levels of taxation will be important in determining which type of payment will dominate. If, for instance, all taxes were proportional and the tax level on wages were above fringe benefit taxation, there would be fringe benefit dominance. Part (ii) of Theorem 1 assumes that the level of taxation on wages and fringe benefits are the same and shows that wages can still dominate if the fringe benefits are taxed more progressively. This illustrates an important point and can be put even more sharply. If the marginal utility of any payment level is identical for wages and fringe benefits but wages are taxed higher than fringe benefits it can still be possible for wages to dominate fringe benefits if the marginal tax rate on fringe benefits is sufficiently greater than that of wages. Part (iii) of Theorem 1 shows that there will be wage domination if wages are taxed both at a lower tax level and the marginal tax rate is lower than the tax-level and marginal tax rate for fringe benefits.

THEOREM 2: *there will be wage dominance,* $w_2 = s_2 > F_2 + f_2$*, in the case where*:

$$\frac{\partial t_w}{\partial w_2}=\frac{\partial t_f}{\partial f_2} \text{ and } t_w=t_f \quad \text{i.i.f. } u'(w_2)>\rho_2 u'(\rho_2(F_2+f_2))$$

Proof follows from (10).

Theorem 2 states that wage dominance can occur even if wages and fringe benefits are taxed symmetrically. If the marginal utility of wages is greater than the marginal utility of fringe benefits we would expect wages to dominate. Thus the worker values an additional unit increase in wages more than an additional unit increase in fringe benefits. A reason for this asymmetry is the existence of transaction costs. With wages a worker is free to choose his preferred consumption bundle, whereas if the worker is paid in fringe benefits he may face transaction costs when attempting to trade with them. This also raises the issue of property rights. Certainly, some fringe benefits can not be sold by the worker. For instance, workers may have the right to consume a firm's recreational facilities, such as a sports gym, but may not be permitted to trade this right.

Consider now the effect of first-period fringe benefits on the bargain in the second period. Note from (9) that employment depends only on the alternative wage (set equal to zero) and is independent of other factors. Thus, changes in first-period fringe benefits will leave second-period employment unchanged. Since the insurance result stated that wages must equal severance pay in the second period, it is sufficient to look at the effect of first-period fringe benefits on only one of these variables. The effect on wages is chosen, and, together with the effect of first-period fringe benefits on second-period fringe benefits, are given below:

LEMMA 1:

$$\frac{\partial w_2}{\partial f_1}>0, \quad \frac{\partial f_2}{\partial f_1}>0$$

Proof given in appendix.

The effect of first-period fringe benefits on the second-period bargaining outcome is shown to increase wages, severance payment and fringe benefits. The intuition behind this is simple; increasing first-period fringe benefits, which to some extent can be carried over to the next period, increases the workers' outside opportunity. Since the workers' threat point in the bargain has increased the workers' surplus extracted in the bargain increases. Since, through (9), second-period employment has been shown to be invariant to first-period fringe benefit increases, the increase in surplus is reflected purely by higher payment to the workers, i.e. higher wages, severance payments and fringe benefit payments.

LEMMA 2:

$$\frac{\partial U_2}{\partial f_2}>0, \quad \frac{\partial \Pi_2}{\partial f_1}<0$$

Proof follows from lemma 1 and expressions (3) and (6) respectively.

Lemma 2 suggests that the firm will lose by the existence of fringe benefits already in place. Thus, if the workers can consume some fringe benefits in periods of disagreement the workers become less impatient to reach an agreement in the second period. This is known to both parties and the firm must concede higher payments to the workers, leaving the workers better off and the firm worse off.

The bargaining outcome in the second period has now been determined and its dependence on first-period fringe benefits has been demonstrated. This enables us now to look upon the determination of the variables in the first-period bargain.

5. The first-period bargain

In this section we assume that all forms of payment face the same tax schedule. This is done to concentrate solely on the importance of intertemporal effects. The worker and the firm will take into account in the bargain the effect of any first-period variable on the outcome in the second period bargain. That is, they are aware of the inferences drawn from lemmas 1 and 2. Thus, the first-period maximization problem is subject to the second-period maximization solution and involves both the firm and workers seeking to maximize their lifetime expected objective functions. The relevant objective functions for the workers and the firm are given by the simplified version of expressions (1) and (2), respectively. For the sake of consistency assume further that the outside opportunities of both workers and firm are taken to be zero.† Again the Nash bargaining solution is imposed, and the solution of the first-period bargain can therefore be given by the maximization of product B1:

$$\text{Max } w_1, s_1, f_1, N_1 \qquad \text{B1} = (\text{U})^{\gamma}(\Pi)^{1-\gamma} \tag{11}$$

The first-order conditions for this maximization problem can be written as:

† Formally this means that the surplus in the bargain for the workers is the sum of expected utilities across the two periods, whilst the surplus to the firm is now the sum of profits. Note that we have for simplicity assumed that the firm faces zero fixed cost.

$$\frac{\partial \mathrm{B1}}{\partial w_1} = \gamma \Pi \frac{N_1}{M} u'(w_1) - (1-\gamma) U\left(N_1\left(1 + t_w + w_1 \frac{\partial t_w}{\partial w_1}\right)\right) = 0 \tag{12a}$$

$$\frac{\partial \mathrm{B1}}{\partial s_1} = \gamma \Pi \frac{M - N_1}{M} u'(s_1) - (1-\gamma) U\left((M - N_1)\left(1 + t_w + s_1 \frac{\partial t_w}{\partial s_1}\right)\right) = 0 \tag{12b}$$

$$\begin{aligned}\frac{\partial \mathrm{B1}}{\partial f_1} = {} & \gamma \Pi \rho_1 u'(\rho_1(F_1 + f_1)) - (1-\gamma) U\left(M\left(1 + t_f + (F_1 + f_1)\frac{\partial t_f}{\partial f_1}\right)\right) \\ & + \left\{\gamma \Pi u'(w_2) - (1-\gamma) U\left(M\left(1 + t_f + w_2 \frac{\partial t_f}{\partial w_2}\right)\right)\right\} \frac{\partial w_2}{\partial f_1} \\ & + \left\{\gamma \Pi \rho_2 u'(\rho_2(F_2 + f_2)) \right. \\ & \left. - (1-\gamma) U\left(M\left(1 + t_f + (F_2 + f_2)\frac{\partial t_f}{\partial w_2}\right)\right)\right\} \frac{\partial f_2}{\partial f_1} = 0\end{aligned} \tag{12c}$$

$$\begin{aligned}\frac{\partial \mathrm{B1}}{\partial N_1} = {} & \gamma \Pi \frac{1}{M}(u(w_1) - u(s_1)) \\ & + (1-\gamma) U(R'(N_1) - w_1(1 + t_w) + s_1(1 + t_w)) = 0\end{aligned} \tag{12d}$$

From (12a), (12b) it can be shown that first-period wages and severance payments again are equalized ($w_1 = s_1$), whilst (12d) implies that employment is efficient such that $R'(N_1) = 0$.† What is of interest now is the choice of first-period fringe benefits, as these will lead to intertemporal effects. We can now state the following theorem:

THEOREM 3: *wages dominate the payment profile in period 1—i.e.* $w_1 > F_1 + f_1$.

PROOF OF THEOREM 3: the proof is given by contradiction. Suppose the opposite of Theorem 3 is the case. Thus:

$$F_1 + f_1 \geq w_1 \tag{13}$$

† This is again because the outside wage (spotmarket wage) the workers can obtain were the relationship to break down is normalized to zero. We can note that as long as the external environment facing the firm is the same employment will remain constant across states.

On the one hand it can be seen that taking (13) together with lemma 1 implies:

$$w_2 > w_1 \tag{14}$$

On the other hand, from (13) and (12a), it can be seen that the first line in (12c) is negative, which implies that the two last lines of (12c) must be positive. This condition can with the use of (8a) and (8c) be written as:

$$\begin{aligned} &\left\{\Pi\frac{(1-\gamma)S_w}{\Pi_2}-(1-\gamma)U\right\}\ \frac{1}{\left(M\left(1+t_f+w_2\frac{\partial t_f}{w_2}\right)\right)}\frac{\partial w_2}{\partial f_1} \\ &\left\{\Pi\frac{(1-\gamma)S_w}{\Pi_2}-(1-\gamma)U\right\}\ \frac{1}{\left(M\left(1+t_f+(F_2+f_2)\frac{\partial t_f}{w_2}\right)\right)}\frac{\partial f_2}{\partial f_1}>0 \end{aligned} \tag{15}$$

This condition can only hold if:

$$\frac{S_w}{\Pi_2} > \frac{U}{\Pi}$$

Thus, this implies from (8a) and (12a):

$$\frac{u'(w_2)}{\left(1+t_w+w_2\frac{\partial t_w}{\partial w_2}\right)} > \frac{u'(w_1)}{\left(1+t_w+w_1\frac{\partial t_w}{\partial w_1}\right)} \tag{16}$$

This is only possible if

$$w_2 < w_1 \tag{17}$$

Expressions (14) and (17) can not both hold. Thus, a contradiction has been demonstrated and expression (13) can not hold. If (13) does not hold we have:

$$w_1 > F_1 + f_1 \tag{18}$$

We have therefore shown that in period 1 there is wage dominance. **QED.**

Theorem 3 gives a reason other than taxes or transaction costs for why wages might dominate fringe benefits. It states that wage dominance might occur even if all forms of payment are taxed at the same rate and the marginal utilities of a particular level of payment is invariant to the type of payment. The reason for this is the following. Fringe benefits are assumed in some extent to be carried into future periods, where the workers can consume some fringe benefits even in an industrial dispute. This increases the worker's future threat point and is exploited in the future bargain. Furthermore, this behaviour is fully anticipated by the firm. It is therefore reasonable to expect that the firm strives to limit the extent of the initial fringe benefit payments. The workers on the other hand will accept lower first-period fringe benefits if the first-period wages are sufficiently high. Thus, the firm "bribes" the worker into accepting lower fringe benefits by offering higher wages. This therefore leads to a payment profile where wages dominate fringe benefits in period 1.

Inferences can also be drawn on wage and fringe benefit profiles across periods:

THEOREM 4:

(i) *wages are higher in period 2 than in period 1 (i.e.* $w_2 > w_1$*);*
(ii) *fringe benefits are higher in period 2 than in period 1 (i.e.* $F_2 + f_2 > F_1 + f_1$*).*

Proof of Theorem 4 follows directly from Theorem 3, (12a) and (12c). That is the inequalities of (15)–(17) reversed.

Theorem 4 demonstrates the existence of both seniority wages as well as seniority fringe benefits. The reason for the seniority wages is that in the second period there are fringe benefits in place that can be exploited in the bargain. The reason for higher fringe benefits in the second period is two-fold. Firstly, there is already in place a level of fringe benefits carried over from the first period that puts upward pressure on second-period fringe benefits. In addition, second-period fringe benefits are higher than those of the first period due to the absence of intertemporal effects. The firm resists fringe benefit payments early in a worker's life-cycle as it fears "hold-up" in later periods. These intertemporal effects diminish as the worker grows older and the firm is more likely to agree to higher fringe benefit payments. This has an added "knock-on" effect on wages: As fringe benefits rise, the surplus the workers can extract also rises. This seems to fit empirical evidence that suggest a positive relationship between age and wages. There is, however, some dispute in the literature as to whether this

relationship is due to seniority. On the other hand, Topel (1986), Abraham and Farber (1987) and Altonji and Shakotko (1987) have all argued that wages do not rise with seniority, whereas Topel (1991) finds that wages do rise with seniority. His analysis shows that 10 years of seniority will for the average U.S. male worker increase the wage by 25%. Our additional result of a tenure profile on fringe benefits can also be tested empirically. However, caution should be exercised to take into account how taxes affect the wage-age relationship. Given the positive relationship between age and wages, it is possible that there is a second effect that implies that older workers receive larger fringe benefits. Most countries operate a progressive tax system in principle. Thus, as workers grow older the marginal tax on wages increases, implying a substitution away from wage into non-wage payments. Thus in order to identify our third intertemporal effect of fringe benefits proper care needs to be taken to disentangle this effect from the effect of the growing marginal taxation of wages with age.

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Appendix

PROOF OF LEMMA 1: note first, given wages equal severance pay, that the surplus the workers derive in the second period simplifies expression (5) to:

$$S_w = u(w_2) + u(\rho_2(F_2 + f_2)) + (1-\alpha)u(\rho_1(F_1 + f_1)) - (1-\alpha)u(\rho_1 f_1) \quad \text{(A.1)}$$

Similarly, the second-period surplus to the firm can be simplified from expression (6) to give:

$$\Pi_2 = R(N_2) - w_2 M(1 + t_w) - f_2 M(1 + t_f) - F_2 M(1 + t_f) \quad \text{(A.2)}$$

In the following we make use of expressions (A.1), (A.2) and (10). Multiply (8a) by M/N_2. Now totally differentiating the resulting expression and (8c) with respect to wages and first- and second-period fringe benefits yields the following:

$$\begin{bmatrix} C & D & E \\ F & G & H \end{bmatrix} \begin{bmatrix} dw_2 \\ \mathrm{d}f_2 \\ \mathrm{d}f_1 \end{bmatrix} = 0 \quad \text{(A.3)}$$

where:

$$C = B_{w_2w_2} = \gamma\Pi_2 u''(w_2) - u'(w_2)M\left(1 + t_w + w_2\frac{\partial t_w}{\partial w_2}\right)$$

$$-(1-\gamma)S_w M\left(2\frac{\partial t_w}{\partial w_2}\right)$$

$$D = B_{w_2f_2} = -u'(w_2)M\left(1 + t_f + (F_2 + f_2)\frac{\partial t_f}{\partial f_2}\right)$$

$$E = B_{w_2f_1} = (1-\gamma)M(1-\alpha)\rho_1[u'(\rho_1 f_1)$$

$$-u'(\rho_1 + F_1)]\left(1 + t_w + w_2\frac{\partial t_w}{\partial w_2}\right)$$

$$F = B_{f_2w_2} = -u'(w_2)M\left(1 + t_f + (F_2 + f_2)\frac{\partial t_f}{\partial f_2}\right)$$

$$G = B_{f_2f_2} = \gamma\Pi_2 u''(\rho_2(f_2 + F_2))\rho_2^2$$

$$-u'(\rho_2(f_2 + F_2))\rho_2 M\left(1 + t_f + (F_2 + f_2)\frac{\partial t_f}{\partial f_2}\right)$$

$$-(1-\gamma)S_w M\left(2\frac{\partial t_f}{\partial f_2}\right)$$

$$H = B_{f_2f_1} = (1-\gamma)M(1-\alpha)\rho_1[u'(\rho_1 f_1)$$

$$-u'(\rho_1(f_1 + F_1)]\left(1 + t_f + (F_2 + f_2)\frac{\partial t_f}{\partial f_2}\right)$$

Solving for the effects of first-period fringe benefits on second-period wages and fringe benefits yields the following:

$$\frac{\partial w_2}{\partial f_1} = \frac{1}{A}\left(\gamma\Pi_2\rho_2^2 u''(\rho_2(F_2 + f_2)) - (1-\gamma)S_w M\left(2\frac{\partial t_f}{\partial f_2}\right)\right)$$

$$\times\left(M(1-\gamma)(1-\alpha)\rho_1\{u'(\rho_1(F_1 + f_1))\right.$$

$$\left.-u'(\rho_1 f_1)\}\left(1 + t_w + w_2\frac{\partial t_w}{\partial w_2}\right)\right) \qquad \text{(A.4a)}$$

$$\frac{\partial f_2}{\partial f_1}=\frac{1}{A}\left(\gamma\Pi_2 u''(w_2)-(1-\gamma)S_w M\left(2\frac{\partial t_w}{\partial w_2}\right)\right)$$
$$\times\left(M(1-\gamma)(1-\alpha)\rho_1[u'(\rho_1(F_1+f_1))\right.$$
$$\left.-u'(\rho_1 f_1)\}\left(1+t_f+(F_2+f_2)\frac{\partial t_f}{\partial f_2}\right)\right) \qquad \text{(A.4b)}$$

where

$$A=B_{w_2w_2}B_{f_2f_2}-(B_{w_2f_2})^2>0$$

Notice that A is positive due to the familiar second-order condition for a maximum. Thus the two differentials given by (A.4a) and (A.4b) are positive. **QED.**