A Generalised Wage Rigidity Result

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Abstract

This paper provides an alternative explanation of the empirically
observed wage rigidity in industrialized economies. We provide suffi-
cient conditions under which the negotiated wage in unionized imper-
fectly competitive industries is independent of a number of product
market features, as well as of the bargaining institution (Right-to-
Manage or Efficient Bargains), as long as negotiations are centralised
at the industry level. The wage rate turns out to be the same inde-
dependently of e.g. the number of firms, the degree of product substi-
tutability, or the intensity of market competition, and this result is

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shown to hold in a broad class of industry specifications widely used in the literature.

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1 Introduction

The empirically observed wage rigidity in most industrialized countries\footnote{See e.g. Beckerman (1986).} has led to the emergence of a number of theoretical explanations, relying on, for example, implicit contracts, efficiency wage theory, trade union models (e.g. McDonald and Solow, 1981, and Oswald, 1982) and competitive theory.\footnote{For a full taxonomy see Carruth and Oswald (1989).}

If one accepts that in addition to (real) wage inflexibility, a stylised fact is that wage-setting takes place through a process of bargaining, a natural question to ask is whether there is a link between the two. This is what some of the trade union models mentioned above study. McDonald and Solow (1981), using a constant elasticity demand, and Oswald (1982), and Carruth and Oswald (1989), with specific functional forms for the production function and the union’s objective function, show that sectorial shifts in demand and labor productivity are entirely absorbed by employment adjustments. Ulph and Ulph (1989) illustrate situations where the negotiated wage is independent of the product price. The other strand in the literature (see e.g. Dowrick, 1989) compares the effects of product market characteristics on negotiated wages under different institutional forms of bargaining. Dowrick shows that wages depend on these parameters for a constant elasticity product demand whenever bargaining is decentralized. If, however, bargaining is “centralized” (a slightly different interpretation is used by him), wages are independent of the degree of product market collusion.

In this paper we generalize the wage rigidity result derived in earlier studies to encompass not only monopoly unions and single union-firm interactions, but also to take account explicitly of different product market struct-
tures, where e.g. price is not a parameter and where firms' beliefs about other firms' actions potentially have effects on negotiated wages. Earlier studies ignored this strategic aspect of wage setting. We investigate situations in which even with this more general setting, one gets wage inflexibility. While we focus on the effect of product market structure on negotiated wages, clearly the analysis applies to any product market shocks as well.

In the context of a symmetric imperfectly competitive industry with centralized negotiations,\(^3\) sufficient conditions are derived for the wage rigidity property to hold. We consider both the Right-to-Manage model where negotiations are over wages alone (leaving employment decisions at the firm's discretion) and the Efficient Bargains model where negotiations are over employment and wages. The union's objective function depends on wages and aggregate employment and is assumed to be log-linear in employment and in a function of the wage rate.

The Generalized Nash Bargaining solution is used to obtain the negotiated wage, assuming that unions and firms take into account the consequences of their decisions for employment and product market competition. The use of the Nash solution is pervasive in the literature on union-firm bargaining (see e.g. Booth, 1995, p.125).\(^4\) Moreover, there is a well-known literature linking it with a non-cooperative bargaining structure, e.g. see

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3By this we mean that there are institutions in the market which effectively allow firms to co-ordinate on their wage decisions, e.g. employers federations, or wage advisory councils and on the other side allow unions to co-ordinate on wages. One example of the latter is an industry union but in many cases this may not be necessary and it is the co-ordination on wages that we need at the industry level, rather than the existence of a formal industry union. There is some evidence that Japan, e.g. has this kind of centralised wage setting although the bargaining structure appears to be very decentralised.

4Indeed, the prevalence of the Nash bargaining solution in the labour economics literature is itself an important motivation for our paper as it points out some important testable implications of this solution.
Binmore, Rubinstein and Wöllinsky (1986). At least in the context where the bargaining is between two parties and there are no relevant outside options that we ignore, we feel confident in assuming its adequacy in capturing the essential features of the underlying bargaining structure. In particular, the strategic approach would give the same predictions as our model with centralized negotiations, independently whether bargaining takes place over wages alone, or over wages and employment.5

Our main result is that, under some fairly general conditions, centralization or co-ordination of bargaining at the industry level causes wages to be independent of a number of product market characteristics, such as the number of firms (the measure of concentration in a symmetric industry), the degree of product differentiation, and the intensity of competition (e.g. price vs. quantity competition). Moreover, this independence property holds whether bargaining is over wages alone (Right-to-Manage Bargains) or over both employment and wages (Efficient Bargains).6 The independence of the negotiated wage implies that increases in the intensity of competition are re-

5The equivalence between the axiomatic and the strategic approach can be shown to hold also when offers and counter-offers are multi-dimensional, as e.g. in the case of wage-employment negotiations. The equivalence result goes through whenever the size of the pie to be shared between the two parties depends only on their choices, and not on external factors. For instance, the use of the Nash solution is more problematic in the case of decentralized bargaining i.e. union-firm pairs bargaining over potentially different wage rates, when outside options become important.

6Our focus is in showing the independence of wages from different institutions of bargaining. Even though there is little evidence on bargaining directly over employment, there is enough evidence that bargaining takes place indirectly over employment through manning ratios, or crew sizes (see e.g. Layard et al., 1991). Moreover in countries like Germany workers are known to have co-determination rights, i.e. at the firm level workers can influence employment decisions. Given that the union is usually industry wide, co-ordination in such bargaining, and hence implicitly industry level bargaining on employment cannot be ruled out.
flected only in increases in aggregate industry employment, hence that rents to the union increase as markets become more competitive. We illustrate our main proposition in a broad class of industry specifications used frequently both, in the labor economics and the industrial organisation literature.

While the institution of centralized bargaining between one union representing all workers in an industry and employers’ federations exists in some countries (Germany, UK, France, Italy, the Netherlands, Australia and Belgium (Calmfors and Drifill, 1988)), the model requires only that wage setting be a bargaining process where employers effectively co-ordinate on the wage and so do unions. This might happen even when the institutions do not exist – at least partly because the repeated nature of interactions between the firms and the unions may lead firms and unions to learn to co-ordinate over time.7 Moreover, sometimes contracts provide for wage adjustments in response to community wage surveys or other specified collective bargaining settlements.8 Such mechanisms may well be captured in our model.

The empirical literature, to the best of our knowledge, seems to be inconclusive on the link between wages and industry characteristics. We briefly mention some of the results. There are (i) studies on the effects of product market structure on wages and (ii) studies on the effectiveness of union rent-seeking. In the first category, Dickens and Katz (1987) detect some link between wages and industry concentration, which however is not robust to the inclusion of controls for labor quality. For the U.K., which until recently has been characterized by a large number of industries with centralized bargaining, Blanchflower (1986) finds that while concentrated industries pay higher wages, they obtain a superior quality of labor as well. Blanchflower (1986) finds that while concentrated industries pay higher wages, they obtain a superior quality of labor as well.

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7One of the stated goals of the trade union movement is to standardize wage rates for similar jobs—there is evidence that in both the USA and the UK that wage dispersion has been significantly reduced by unions (Booth, 1995, pp.179).

8See e.g. Becker (1986) Chapter 3.
flower et al. (1990) and Blanchflower and Oswald (1988) agree that wages are positively linked to financial performance. Pugel (1980), and Carruth and Oswald (1989) and Blanchflower, Oswald and Sanfey (1996) also detect some link between wage and profits. In the second category we have e.g. Hirsch and Connolly (1987), and Hirsch (1990) who find no evidence that union rent seeking is more effective in highly concentrated industries or among firms with large market share. Lewis (1986) provides evidence that union wage premiums are typically smaller in highly concentrated industries. In a sample of large British companies, Machin (1991) finds that even though unions lead to decreasing profits for these industries, their ability to capture a share of the rents is not increasing with the size of the rents available. However, the relevance of these empirical results should not be over-emphasized as we study specifically economies with centralised bargaining.

The organization of the paper is as follows. Section 2 presents the model with centralized bargaining and provides the conditions under which the wage rigidity property holds. Section 3 shows that these conditions are satisfied in a class of industry models widely used in the literature. Section 4 discusses briefly the decentralized bargaining scenario and the results therein. Section 5 concludes with some remarks.

2 The Model with Centralized Negotiations

Assume that there are \( n \) identical firms in the industry, each endowed with a log-linear one-factor (labor) technology\(^9\):

\(^9\)Our study is only indirectly related to this – their theoretical model pertains to product markets which approximate perfect competition and takes price as a parameter. Our results are not inconsistent with theirs, since we find that some determinants of profits affect wages and others do not.

\(^{10}\)More generally, (1) is the reduced form of any log-linear in labor technology when the amount of capital is fixed during the negotiations. For example, (1) with \( B \geq 1 \) stems
\[ x_i(l_i) = (A l_i)^{\frac{B}{P}} \quad i = 1, \ldots, n \]

where \( x_i \) is firm \( i \)'s output and \( l_i \) its labor input. The firms' representatives first enter into negotiations with an industry-wide union, and then the firms compete in the product market. We consider both the Right-to-Manage model (Nickell, 1982) and the Efficient Bargains model (McDonald and Solow, 1981). In the Right-to-Manage (RTM) model the representatives of the \( n \) firms and the industry union bargain over the sectoral wage alone, leaving employment decisions at each firm’s discretion. In the Efficient Bargains (EB) model the representatives of the \( n \) firms and the union bargain over both the sectoral wage and the firm-level employment. Note that, while bargaining directly over employment is hardly observed in reality, there is wide evidence that negotiations are often conducted over manning ratios or crew sizes (see Layard et al., 1991). Since we implicitly assume that the amount of capital is fixed during the negotiations, bargaining over manning ratios or crew sizes is, in fact, equivalent to negotiations over firm-level employment. The nature of market competition is not specified at this stage. For instance, firms may compete in quantities, or in prices.

The industry union’s objective is assumed to be log-linear in aggregate employment, \( L \), and in a function of the sectoral wage, \( w \),

\[ U(w, L; w_0) = u(w; w_0)L^r \]

where \( w_0 \) represents the best alternative wage (outside option) for the union’s members, \( r \geq 0 \) measures the relative importance given to employment, and from a Cobb-Douglas production function with fixed capital; and (1) with \( B = 1 \) from a Leontief technology with enough capital not to induce zero marginal returns to labor.
$u(.)$ is an increasing concave function of the sectoral wage. Note that this objective function stems from a large variety of union welfare functions used in the literature (including the insider-outsider model (see e.g. Carruth and Oswald, 1987)) after taking account of the union’s outside option.

The outcome of the negotiations between the industry union and the firms’ representatives is obtained using the generalized Nash Bargaining solution where a parameter $b$, $0 \leq b \leq 1$, represents the exogenously given bargaining power of the union. If $b = 1$, the union unilaterally sets the sectoral wage, or the wage and the per-firm employment level (Monopoly Union model), while if $b = 0$ the firms set the sectoral wage and their employment level. In the Right-to-Manage model, the negotiated wage is the solution to,

$$
Max_w \{ \Pi^*_R(w; K) \}^{1-b} \{ U(w, L^*_R(w; K)) \}^b
$$

where $\Pi^*_R(w; K)$ and $L^*_R(w; K)$ are the equilibrium industry profits and aggregate employment, resulting from the firms’ optimal choices in the subsequent employment selection and market competition stages, as a function of the sectoral wage rate and a vector of parameters, $K$, characterizing product market features. For instance, $K$ may include the number of firms, the degree of product substitutability, the intensity of market competition etc. Note that we assume, for simplicity, that fallback profits $\bar{\pi}$ are zero. This is easily justified if $\bar{\pi}$ is viewed as delay profits under alternating offers.\textsuperscript{11} In the Efficient Bargains model, the negotiated wage and the firm level employment is the solution to,

$$
Max_{(w,l_1,..,l_n)} \{ \Pi_E(w, l_1, .., l_n; K) \}^{1-b} \{ U(w, L_E(w; K)) \}^b
$$

where $\Pi_E(w, l_1, .., l_n; K)$ and $L_E(w; K) = \sum_i l_i(w; K)$ are the industry profits and aggregate employment as functions of $w$, $K$ and the vector of firm employment levels, $(l_1, .., l_n)$. As above, we assume that fallback profits are zero.\textsuperscript{11} However this assumption is not necessary, we can generalise the result to cases where the fallback profit is assumed to be the level of fixed costs whenever such costs exist.
Note that, since firms are endowed with one-factor (labor) technologies, their production capacities and thus their outputs are also determined during these negotiations. Further, as Manning (1987) pointed out, the simultaneous bargaining over wages and employment is equivalent to a sequential bargaining where in the first stage firms and the union bargain collectively over the sectoral wage and then negotiate over employment levels, provided that their bargaining powers remain the same in both stages. Therefore, the negotiated wage in the Efficient Bargains model can be viewed as a solution to,

$$\max_w \left\{ \Pi^*_E(w; K) \right\}^{1-b} \left\{ U(w, L^*_E(w; K)) \right\}^b$$

(4)

where $\Pi^*_E(w; K)$ and $L^*_E(w; K)$ are the induced (i.e. optimized with respect to the vector of firm employment levels) industry profits and aggregate employment as functions of $w$ and $K$.

Consider first the Right-to-Manage model. Since firms are endowed with identical technologies and face the same unit labor cost in the market competition stage, we shall restrict attention only to symmetric equilibria of the market game. Let $x^*_R(w; K)$ and $\pi^*_R(w; K)$ denote each firm’s equilibrium output and profits. Then industry profits are, $\Pi^*_R(w; K) = n\pi^*_R(w; K)$ and from (1) the aggregate employment is, $L^*_R(w; K) = nl^*_R(w; K) = n[x^*_R(w; K)]^B/A$.

Consider next the sequential version of the Efficient Bargains model. During the second stage negotiations over employment levels, firms with identical technologies face the same wage rate. Thus, for any given level of aggregate employment, the total number of workers have to be distributed equally across firms in order for the industry profits, and hence the Nash product to be maximized. Let $l^*_E(w; K)$ be each firm’s negotiated employment level, $x^*_E(w; K)$ its induced productive capacity and output level and $\pi^*_E(w; K)$ its induced profit level. Then induced industry profits are, $\Pi^*_E(w; K) = n\pi^*_E(w; K)$ and induced aggregate employment is, $L^*_E(w; K) = nl^*_E(w; K) = n[x^*_E(w; K)]^B/A$. 

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Given (2), the negotiated wage in both the Right-to-Manage and Efficient Bargains model is determined according to:

$$\max_w \left[ u(w) \left\{ \frac{n x_j^*(w; K)^b}{A} \right\}^b \left[ n \pi_j^*(w; K) \right]^{1-b} \right] \quad j = R, E \quad (5)$$

or equivalently,

$$\max_w b \left[ \ln u(w) + r \ln n + r B \ln x_j^*(w; K) - r \ln A \right] + (1-b) \left[ \ln n + \ln \pi_j^*(w; K) \right]$$

The first order condition is

$$\left[ \frac{u'(w)}{u(w)} + Br \frac{\partial x_j^*(w; K)}{\partial w} \right] + (1-b) \frac{\partial \pi_j^*(w; K)}{\partial w} = 0, \quad (7)$$

which can be rewritten in elasticity form as

$$\left[ \epsilon_U(w) + r \epsilon_L(w; K) \right] + (1-b) \epsilon_x(w; K) = 0 \quad (8)$$

where $\epsilon_L$ represents the wage elasticity of industry labor demand, $\epsilon_U$ the wage elasticity of the union welfare and $\epsilon_x$ the wage elasticity of the firm’s profits. Note that, given our log-linear labor technology, the wage elasticity of the firm’s output $\epsilon_x$ equals $\epsilon_L / B$. Obviously, from (2) the wage elasticity of the union welfare is independent of the market characteristics (it depends only on the wage rate). However, the wage elasticities of the industry labor demand and the firm’s profits depend, on principle, on the list of market features $K$.

A priori, we could expect the wage struck under Right-to-Manage Bargains, or under Efficient Bargains, to depend on all the factors affecting the union’s welfare or the firms’ profits. In particular, it is interesting to ask whether an increase in industry concentration, or in the firms’ market power, or a decrease in the intensity of market competition leads to a higher negotiated wage. Also, whether switching from Efficient Bargains to Right-to-Manage Bargains results in a higher negotiated wage. In what follows,
we provide conditions under which the negotiated wage is independent of a list of market parameters (such as the number of firms, the substitutability between goods, the intensity of market competition etc.) as well as the mode of negotiations (Right-to-Manage vs. Efficient Bargains). Let us make the following assumptions.

**Assumption 1R:** The firm’s (i) equilibrium output and (ii) equilibrium profits are log-linear in a function of the wage rate and a function of a list of market parameters $K$, i.e. (i) $x^*_R(w; K) = \psi_R(w)\phi_R(K)$ and (ii) $\pi^*_R(w; K) = \Psi_R(w)\Phi_R(K)$.

**Assumption 1E:** The firm’s (i) induced output and (ii) induced profits are log-linear in functions of the wage rate and a function of a list of market parameters $K$, i.e. (i) $x^*_E(w; K) = \psi_E(w)\phi_E(K)$ and (ii) $\pi^*_E(w; K) = \Psi_E(w)\Phi_E(K)$.

Our main result is then summarized in the following proposition.

**Proposition 1: The Independence Property of the Negotiated Wage:**

Let there be $n$ identical firms, each endowed with log-linear labor technology, bargaining with a single industry union whose welfare is log-linear in aggregate employment and in a function of the wage rate. Then:

(i) If assumption 1R holds, the negotiated wage emerging from the centralized wage negotiations is independent of the list of parameters $K$, and the number of firms $n$.\(^{12}\)

(ii) If assumption 1E holds, then the negotiated wage emerging from the centralized wage-employment negotiations is independent of the list of parameters $K$, and the number of firms $n$.

(iii) If both assumptions 1R and 1E hold and, moreover, $\psi_R(w) = \psi_E(w)$ and $\Psi_R(w) = \Psi_E(w)$, the negotiated wage turns out to be the same under wage negotiations (Right-to-Manage) and wage-employment negotiations.

\(^{12}\)Note that the number of firms is often included in the list $K$, as is the case in all our illustrations in section 3.
(Efficient Bargains).

**Proof:** Let assumption 1$j_j$, $j = R, E$ holds. Substituting in (7) $x^*_j(w; K) = \psi_j(w)\phi_j(K)$ and $\pi^*_j(w; K) = \Psi_j(w)\Phi_j(K)$ (assuming the second order condition is satisfied) we get,

$$b\frac{u'(w)}{u(w)} + Br\frac{\psi'_j(w)}{\psi_j(w)} + (1 - b)\frac{\Psi'_j(w)}{\Psi_j(w)} = 0 \quad (9)$$

Clearly, therefore, the solution of this equation for $w$ does not depend on $K$ or on $n$. This proves part (i) and (ii). Part (iii) is a direct consequence of (9) because, given that $\psi_R(w) = \psi_E(w)$ and $\Psi_R(w) = \Psi_E(w)$, the last two terms are the same in the Right-to-Manage and Efficient Bargains model. ◇

Assumption 1R(1E) implies that the wage elasticities of the firm’s equilibrium (induced) output and profits are independent of the market features. From (8) if these elasticities stay constant across industries, then the negotiated wage turns out not to depend on the specific industry characteristics.\textsuperscript{13}

Moreover, if the wage elasticities of the firm’s equilibrium output and profits are equal to the wage elasticities of the firm’s induced output and profits in the EB model, respectively, the negotiated wage does not depend on the mode of negotiations (wage or wage-employment bargaining) either.

The intuition behind our result can be explained in two steps. Suppose first that $b = 1$ i.e. the case of Monopoly Union. Given the industry labor demand curve, the industry union will set the wage to maximize its welfare. The wage rate is given by the tangency of the industry labor demand curve with the union’s indifference curve. An important property of the union’s indifference map is that, for a given wage rate, the marginal rate of substitution between wages and employment is inversely related to aggregate

\textsuperscript{13}The elasticity condition is not new – it is stated in Ulph and Ulph (1989) – however they do not study such market structure effects.

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employment. In fact, from (2) we have,

\[
MRS_u \equiv \frac{\partial u^u}{\partial L} = -\frac{ru(w)}{u'(w)L}
\]  

(10)

Therefore, as aggregate employment increases, the union is willing to make more concessions in terms of employment in order to achieve a higher wage level. From (10) it is easy to see that higher welfare indifference curves are iso-elastic shifts of the lower welfare ones.

A similar property holds for the slope of the industry labor demand curve if the firm's (equilibrium or induced) output is log-linear in functions of the wage rate and the list of market features \( K \). From (1) and assumption 1j, \( j = R, E \), after some manipulations we get,

\[
\frac{dw}{dL_j} = \frac{\psi_j(w)}{B\psi_j'(w)L_j^*}
\]

(11)

i.e., for a given wage rate, the slope of the (inverse) industry labor demand is inversely related to the aggregate demand level. That is, as the industry labor demand curve shifts out (e.g. due to an increase in the number of firms or in the intensity of market competition, or in the degree of substitutability among goods), the same wage increase is followed by a higher decrease in aggregate demand for labor. This is also true when we switch from wage negotiations to wage-employment negotiations in a specific industry, since the induced aggregate demand for labor under Efficient Bargains is higher than the equilibrium industry labor demand under Right-to-Manage Bargains, for any given wage rate. Note that all the shifts of the industry labor demand due to changing product market features or changes in the bargaining institution are iso-elastic (see (11)).

Consider now the family \( K \) of aggregate labor demand curves stemming from a number of industries characterized by different values of the vector of market features \( K \). If the (equilibrium or induced) firm's output is log-linear in functions of \( w \) and \( K \), the tangency between the union's indifference curve
and any one of these industry labor demand curves occurs at the same wage rate. In fact, from (10) and (11), the union’s marginal rate of substitution between wages and employment is equal to the slope of any industry labor demand curve belonging to the family $K$ if and only if,

$$\frac{ru(w)}{w^j(w)} = \frac{\psi_j(w)}{B\psi_j^2(w)} \quad j = R, E$$

Obviously, the solution to the above equation is independent of the list of market features $K$. For instance, as the number of firms increases, the (inverse) industry labor demand curve shifts out and becomes flatter. Since the union’s indifference curves become also flatter as we move out to the right, the tangency point occurs at the same wage rate and a higher level of employment (see figure 1) with the union achieving a higher level of welfare. Thus, the wage rate set by the Monopoly Union is the same in all the industries belonging to the family $K$, and is thus independent of the list of market features $K$. If, in addition, the equilibrium and the induced firm’s output are log-linear in the same function of wages, i.e. $\psi_R(w) = \psi_E(w)$, the monopoly union’s optimal wage rate is the same independently whether it sets the wage rate alone (leaving employment decisions to the firms’ discretion) or sets both the wage rate and the employment level. We have, therefore, the following corollary.

**Corollary:** Under the conditions of Proposition 1: (i) If the firm’s (equilibrium or induced) output is log-linear in functions of $w$ and $K$, the wage set by the Monopoly union is independent of the list of parameters $K$ and the number of firms $n$. (ii) If the firm’s equilibrium and induced output are log-linear in the same function of the wage rate, then the Monopoly union sets the same wage rate under Right-to-Manage and “Efficient Bargains”.

Note, in the Monopoly union case there are less requirements for the negotiated wage to be independent of the list of market features $K$. Only the firm’s output has to be log-linear in functions of $w$ and $K$, but not the firm’s.
profits as in the general case.

The second step consists in explaining why the independence property still holds in the general case of wage or wage-employment negotiations between the firms' representatives and the industry union. Let us denote the wage rate set by the Monopoly union as $w_j^U$, $j = R, E$. On the other hand, if the firms' representatives have all the bargaining power $(b = 0)$, they will set a wage rate equal to the outside option of the workers, $w_0$. Clearly, industry profits are decreasing in the unit cost of labor so that the wage set by the firms will be the lowest possible independently of the market features $K$. Note that, since the firms have all the power to set wages and employment, industry employment is given by the industry labour demand at this wage in both the Right-to-Manage and the Efficient Bargains model. The two wage rates $w_j^U$ and $w_0$ provide an upper and lower bound on the wages negotiated through the Nash Bargaining solution with varying relative bargaining strengths. For given bargaining strengths, the negotiated wage can be then expressed as a convex combination: $\lambda w_j^U + (1 - \lambda)w_0$, where the weight $\lambda$ depends, among other things, on the bargaining power of the industry union $b$. The higher is $b$, the higher is $\lambda$ and the closer is the negotiated wage to the union's most preferred wage $w_j^U$.

Clearly, if the weight $\lambda$ is independent of the list of market features $K$, the negotiated wage will not depend on any of the parameters $K$. From equation (7) (or (8)), this weight is invariant to changes in parameters $K$ whenever the wage elasticity of the firm's profits is independent of $K$; equivalently, whenever the firm's (equilibrium or induced) profits are log-linear in functions of the wage and the list of market features $K$ as equation (9) reveals. The latter condition is stated in part (ii) of assumption 1.j. Therefore, if assumption 1.j, $j = R, E$ holds, the union most preferred wage as well as its weight are independent of the market features $K$ and hence, the negotiated wage does not depend on those industry characteristics. If, in addition, the equilibrium and

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the induced firm’s output and profits are log-linear in the same functions of
the wage rate, then the union’s most preferred wage and its weight are also
independent of the mode of bargaining. Then the negotiated wage does not
depend on whether there are Right-to-Manage or Efficient Bargains either.

Insert Figure 1 here.

The interesting economic question however is what type of industries or
economies satisfy the conditions of Proposition 1 and what are the parameters
included in the list $K$. In the next section, we illustrate that some of the
widely-used in the literature models do satisfy these conditions. In addition,
we show that in these economies, the negotiated wage is not only independent
of the intensity of competition, but also of the bargaining institution. That
is, the negotiated wage is the same whether negotiations are over wages alone
(Right-to-Manage), or whether negotiations are over both employment and
wages (Efficient Bargains).

3 Some Illustrations.

3.1 Constant Elasticity Demand and Cost Function

The inverse demand function for the homogeneous good is:

\[ P(X) = X^{-\epsilon}, \text{ where } X = \Sigma x_i \]  \hspace{1cm} (12)

where $1/\epsilon$ is the constant elasticity of demand and $X$ is total output. Using
the technology assumed in (1) we have:

\[ C(x_i) = w \frac{x_i^B}{A}. \]
**Proposition 2:** Under the conditions of Proposition 1, and in addition if firms face a constant elasticity demand function, the negotiated wage emerging from centralized bargaining is independent of the number of firms, \( n \), the intensity of competition between firms, \( \alpha \), and whether firms bargain over wages or over both employment and wages.

Let us first consider Right-to-Manage Bargains and Cournot competition. The firm \( i \)'s marginal cost stemming from this technology is:

\[
C'(x_i) = \frac{B}{A} w x_i^{B-1}. 
\]

Firm \( i \) chooses its quantity to maximize its profits, \( P(X) x_i - C(x_i) \). Its first order condition can be written as:

\[
P'(X) x_i + P(X) = C'(x_i) 
\]

Adding up the first order conditions and using symmetry we get

\[
P(n x^*) (1 - \frac{\epsilon}{n}) = C'(x^*) 
\]

and thus the firm’s equilibrium output is

\[
x^*(w; n) = \left( \frac{1}{w} \right)^{\frac{1}{n-1}} \left( \frac{n^{-\epsilon} Q A}{B} \right)^{\frac{1}{n-1}} 
\]

with \( Q = (1 - \frac{\epsilon}{n}) \). Thus, \( x^* \) is log-linear in (a function of) the wage rate and (a function of) the number of firms. Further, using (13):

\[
\pi^* = \frac{C'(x^*) x^*}{1 - \frac{\epsilon}{n}} - C(x^*) 
\]

or

\[
\pi^*(w; n) = w x^* B \left( \frac{B}{Q} - 1 \right) \frac{1}{A}, 
\]

i.e. each firm’s equilibrium profits are log-linear in \( w \) and \( n \). Hence, the negotiated wage is independent of the number of firms, \( n \).
Further, it can be checked that this result is robust to different conjectural variations, and in fact that the negotiated wage is also independent of the parameter of conjectural variations. Let the intensity of competition in the industry be represented as: 

\[ a = \frac{1 + (n-1)\alpha}{n}, \]  

where \(-\frac{1}{n-1} \leq \alpha \leq 1\) is the conjectural variation parameter.\(^{14}\) Then the firm’s equilibrium output and profits are given by (14) and (15) where \(Q\) is replaced by \(Q(\alpha) = 1 - \frac{\alpha(n-1)}{n} - \frac{w}{p},\) and hence are log-linear in \(w\) and \((n, \alpha)\). (Note that \(Q = Q(0)\)). This is a generalisation of Dowrick’s (1989) Proposition 4, where with bargaining at the industry level a similar independence result is obtained but with constant marginal returns to labor.

Suppose, next, that firms’ representatives and industry union bargain over both employment and wages. As we mentioned above, our one-factor (labor) technology implies that, once the employment levels have been decided upon during the negotiations, each firm simply produces the maximum output possible with its assigned workers. That is, for a given wage, employment negotiations also determine firms’ outputs and market price. Moreover, our decreasing returns to labor technology implies that the Nash product is maximal only if identical firms are assigned the same number of workers. Therefore, the Nash product can be written as a function of a single firm’s output and wage

\[ [n(P(n)x - \frac{w}{A}x^B)]^{1-b}[u(w)(\frac{n^2x^B}{A})^b]. \]  

\(^{14}\)Note that the intensity of market competition can be viewed as a market parameter, \(\alpha\), according to the Conjectural Variations approach (Bowley, 1924). For example, in Cournot Competition, firm \(i\) perceives its rivals’ outputs to be unaffected by changes in its own output (i.e. \(\alpha = 0\)); in Bertrand Competition, firm \(i\) conjectures that, in response to a change in its own output, its rivals will adjust their outputs in a compensatory way to leave their market prices unchanged (i.e. \(\alpha = -1/(n-1)\)); perfect collusion finally corresponds to \(\alpha = 1\). See also Dowrick (1989).
The first order condition with respect to output then gives

\[ P(nx^*)x^* = \frac{Bux^* B(b + 1 - b)}{A[(1 - b)(1 - \epsilon) + Bb]}. \]

Hence, the firm’s induced output and profits are given respectively as

\[ x^*(w; n) = \left( \frac{1}{w} \right)^{\frac{b}{1 + \epsilon}} \left\{ \frac{\pi^*(w B + (1 - b)(1 - \epsilon))A}{B(b + 1 - b)} \right\} \frac{1}{w^{\frac{b}{1 + \epsilon}}}, \]

(17)

and are thus log-linear in \( w \) and \( n \) (and, as expected, independent of \( \alpha \)). Moreover, it is easy to see that both, the firm’s equilibrium and induced outputs and profits, are log-linear in the same functions of the wage rate.

Finally, the solution for the wage under both bargaining institutions, and for any conjectural variations parameter, is characterized by the same equation, i.e.

\[ \frac{1}{b^l} \left( \frac{(1 - b)(1 - \epsilon) + Bb}{B - 1 + \epsilon} \right) = \frac{wL(w)}{u(w)}, \]

which completes the proof of Proposition 2.

As an example the following graph illustrates the shifts in the industry labour demand in the case of Monopoly Union (\( b = 1 \)) when \( n \) changes from \( n = 1 \) to \( n = 2 \) and Cournot competition to \( n = 2 \) and Bertrand competition. The union’s utility is given by \( U(w, L) = (w - w_0)L \), the cost elasticity is \( B = 2 \) and the demand elasticity is \( 1/\epsilon = 2 \). In each of these cases the negotiated wage is \( w = 4w_0 \). The contract curve which gives points of tangency between the union indifference curves and iso-profit lines is a vertical line at \( L^* = (1/4w_0)^{1/2} \). It intersects the 0 iso-profit line at \( w = 4w_0 \).

All these shifts are iso-elastic shifts in industry labour demand, hence our results confirm the results of previous models like McDonald-Solow (1981) for the special case of the monopoly union, and monopoly firm, but offer an extension to different market structures and bargaining institutions.
3.2 Linear Demand-Linear Technology Economies

There are \( n \) identical firms in the market, each endowed with a linear one factor (labor) technology with constant returns to scale (given by (1) if \( B = 1 \)). Firms face symmetric linear demands, which is a generalization of Dixit (1979)\(^{15}\)

\[
P_i(x_i, x_{-i}) = a - x_i - \gamma x_{-i} \quad x_{-i} = \sum_{j \neq i} x_j \quad i, j = 1, ..., n. \tag{19}
\]

In fact, these are the demand functions of a representative consumer whose utility depends on a vector of consumption goods \( x = (x_1, x_2, ..., x_n) \) and the numeraire good \( m \). It is given by \( W(x) + m \)\(^{16}\) with:

\[
W(x) = a\left(\sum_i x_i \right) - \frac{\left(\sum_i x_i^2 + 2\gamma \sum_{i \neq j} x_i x_j\right)}{2} \quad j = 1, ..., n,
\]

\(^{15}\)This formulation of Dixit is due to Boclevy (1924, p.56)

\(^{16}\)Note that this utility function subsumes a preference for variety. It is decreasing in \( \gamma \) and increasing in the number of product varieties \( n \).
where \( \gamma \) represents the degree of substitutability between any pair of goods \( i \) and \( j \). The higher the \( \gamma \), the higher is the degree of substitutability between \( i \) and \( j \). When \( \gamma \) tends to zero, each firm virtually becomes a monopolist; when \( \gamma \) tends to one, all goods are almost perfect substitutes.

As the following proposition shows, the negotiated wage in these economies satisfies the Independence property, and furthermore it does not depend on the bargaining institution.

**Proposition 3:** Under the conditions of Proposition 1, and in addition firms face symmetric linear demands, then the negotiated wage emerging from centralized bargaining is independent of the degree of product differentiation, \( \gamma \), the number of firms, \( n \), and also of whether firms compete in prices, or quantities\(^{17}\). In addition, it is independent of whether the bargaining is over wages alone or over both wages and employment.

First, we consider Cournot competition and bargaining over wages alone. In the last stage of the game, firm \( i \) solves:

\[
Max_{x_i} (a - x_i - \gamma x_{-i})x_i - \frac{w}{A} x_i,
\]

given some wage level \( w \), and given the rival firms’ output choices \( x_{-i} \). The first order condition is:

\[
 a - 2x_i - \gamma x_{-i} = \frac{w}{A}.
\]

Then a firm’s output in the symmetric equilibrium is

\[
x^*(w; n, \gamma) = \frac{a - \frac{w}{A}}{2 + \gamma(n - 1)},
\]

\(^{17}\)In fact, it can be shown that the negotiated wage is independent of the intensity of competition (or the degree of market collusion) whenever the latter is represented by the appropriate conjectural variations parameter. See also footnote 6.
and its equilibrium profits are

$$\pi^*(w; n, \gamma) = \frac{(a - \frac{w}{A})^2}{(2 + \gamma(n - 1))^2}. \quad (23)$$

Observe that both, the equilibrium output and profits are inversely related to the degree of product differentiation, $\gamma$, and to the number of firms, $n$.

This is also true for the price-cost margin (from (21)). Note too, that the equilibrium output and profits satisfy the conditions of Proposition 1, i.e. they are log-linear in wages and the list of parameters $(\gamma, n)$. Thus, the negotiated wage is independent of $\gamma$ and $n$, as (9) applied to this case gives:

$$\frac{2(1 - b) + br}{aA - w} = \frac{bu'(w)}{u(w)}. \quad (24)$$

To illustrate, let $u(w) = w - w_0$, where $w_0$ is the best alternative wage. Then from (24) the negotiated wage is

$$w^* = \frac{aAb + [2 + b(r - 2)]w_0}{2 + b(r - 1)}. \quad (25)$$

Obviously, this wage coincides with the negotiated wage in the homogeneous $n$-firm Cournot market. It, also, coincides with the wage bargain struck between a monopoly and its union. Note, that the negotiated wage increases with the size of market $a$, the efficiency of the technology $A$, the best alternative wage $w_0$ and the union’s bargaining power $b$, while it decreases as the union cares relatively more about employment.

---

18As $\gamma$ increases, the size of all markets shrinks due to the representative consumer’s preference for variety. As $n$ increases, the demand for a firm’s good shifts in due to the availability of a larger number of substitutes. Further, as $\gamma$ increases (or $n$ increases), the intensity of competition increases. As a result, a firm’s profits decrease with both $\gamma$ and $n$. On the other hand, a firm’s output decreases with $\gamma$, because the market size effect dominates the competition effect. Also, as $n$ increases, the substitutability effect dominates the competition effect, leading to lower per firm output.
Suppose next that bargaining is over wages and employment. Again, one-factor (labor) technology implies that employment negotiations also determine firms’ outputs and market prices. Restricting attention to the case where identical firms are assigned the same number of workers, the Nash product becomes a function of a single firm’s output and the wage

$$[(a - x(1 + \gamma(n - 1)) - \frac{w}{A})nx]^{1-b}[u(w)(\frac{nx}{A})^b].$$ (26)

Then the first order condition with respect to $x$ implies that induced output is given by

$$x^*(w; n, \gamma) = \frac{(br + 1 - b)(a - \frac{w}{A})}{[2(1 - b) + br]} \frac{1}{(1 + \gamma(n - 1))}.$$ (27)

and the induced profits are

$$\pi^*(w; n, \gamma) = x^* \frac{1}{br + 1 - b}. (1 - b)(1 + \gamma(n - 1)).$$ (28)

Since both induced output and profits are log-linear in wages and parameters $(n, \gamma)$, we get by Proposition 1 the independence property. Moreover, applying (9), we obtain again equation (24), thus proving that wage is independent of the type of bargaining as well.

We turn next to a Bertrand differentiated market. Let $\gamma < 1$. Inverting the system of (inverse) demand functions in (19) we obtain the demand system

$$D_i(p_i, p_{-i}) = \frac{a(1 - \gamma) - [1 + \gamma(n - 2)]p_i + \gamma p_{-i}}{[1 + \gamma(n - 1)](1 - \gamma)}.$$ (29)

for $i = 1, 2, \ldots, n$ and $p_{-i} = \sum_{j \neq i} p_j$. Then, given the negotiated wage $w$ and its rivals’ prices $p_{-i}$, firm $i$ solves

$$\max_{p_i} (p_i - \frac{w}{A}) D_i(p_i, p_{-i}).$$

The first order condition is
\[ a(1 - \gamma) - [1 + \gamma(n - 2)]p_i + \gamma p_{-i} = (p_i - \frac{w}{A})[1 + \gamma(n - 2)]. \quad (30) \]

In the symmetric equilibrium, we get

\[ p^* = \frac{a(1 - \gamma) + [1 + \gamma(n - 2)]\frac{w}{A}}{2 + \gamma(n - 3)}. \quad (31) \]

A firm’s output in equilibrium is then

\[ x^*(w; n, \gamma) = \frac{(a - \frac{w}{A})[1 + \gamma(n - 2)]}{[1 + \gamma(n - 1)][2 + \gamma(n - 3)]} \quad (32) \]

and its equilibrium profits are

\[ \pi^*(w; n, \gamma) = \frac{x^{*2}[1 + \gamma(n - 1)](1 - \gamma)}{[1 + \gamma(n - 2)]}. \quad (33) \]

Here too, equilibrium output, profits and price-cost margin are decreasing in \( \gamma \) and in \( n \) (unless \( n = 2 \), in which case output initially decreases and then increases with \( \gamma \)).\(^{19}\) Moreover, both equilibrium output and profits are log-linear in \( w \) and \((\gamma, n)\). Hence, the negotiated wage is again independent of the number of firms \( n \), and the degree of product differentiation \( \gamma \). Finally, applying (9) the negotiated wage in the Bertrand market is determined by the same equation as in the Cournot market (equation (24)). That is, the negotiated wage is independent of the type of competition.

Finally, we consider bargaining over both wages and employment. As we said before, the one factor technology implies that employment decisions taken during the negotiations determine too firms’ outputs and prices. As a result, firms’ induced profits and outputs are independent of the type of market competition, and are given by (28) and (27), respectively. Hence, the

\(^{19}\)Similar arguments hold as in the Cournot case. See previous footnote. If, however, \( n = 2 \), as \( \gamma \) decreases, the competition effect dominates at first and then the preference for variety effect, thus producing the inverted bell shaped output curve.
independence property is again satisfied and, moreover, the negotiated wage is the same under both bargaining institutions.

3.3 The Dixit-Stiglitz Preference-for-Diversity Model

Let us consider the Dixit-Stiglitz (DS) (1977) monopolistic competition model. We shall analyze a special case of this model that has been used extensively in the literature. There are $n$ differentiated commodities, $(x_1, \ldots, x_n)$, and a numeraire good, $x_0$. A representative consumer maximizes the following Cobb-Douglas utility function:

$$U(x_0, x_1, \ldots, x_n) = x_0^{1-\gamma} \left[ \sum_{i=1}^{n} x_i^\rho \right]^{\gamma/\rho}$$

subject to a budget constraint $I = \sum_{i=0}^{n} p_i x_i$, where $p_i$ is the price of commodity $i$, $p_0$ is the price of the numeraire good (normalized to 1), and $I$ is the consumer’s income; $\gamma$ represents the share of income spent on the differentiated goods; $\sigma = 1/(1 - \rho)$ is the elasticity of substitution between varieties, where $0 < \rho < 1$. Defining the price and quantity indices $q$ and $y$ as:

$$q = \left[ \sum_{i=1}^{n} p_i^{-\sigma} \right]^{1/(1-\sigma)}$$

and

$$y = \left[ \sum_{i=1}^{n} x_i^\rho \right]^{1/\rho}$$

we have the following demand functions:

$$D_i(p_i, q) = \frac{\gamma I}{q} \left( \frac{q}{p_i} \right)^\sigma$$

and

$$D_0 = (1 - \gamma) I.$$  

Each commodity is produced by a single firm with a log-linear one factor (labor) technology (given in (1)). This is a generalization of the DS technology where the marginal cost of production was assumed to be constant. Contrary to the DS model, the number of firms, $n$, is exogenous here. This number, however, can be easily endogenized, if we assume that firms also incur an entry cost $F$. Given that this cost is sunk during the negotiations,
it plays no role in our analysis. We assume, as in Yang and Heijdra (1993),
that a firm, while setting its price, takes into account the effect of a change in
its own price on the general price index. We thus restore the strategic inter-
action among firms which was absent in the initial DS model. The following
proposition summarizes our results:

**Proposition 4:** Under the conditions of Proposition 1 and if, in addition,
the firms face the Dixit-Stiglitz demand functions and compete in prices, then
the negotiated wage emerging from centralized bargaining is independent of
the elasticity of substitution between varieties, $\sigma$, the number of firms, $n$
and the total income spent on the differentiated goods, $\gamma I$. In addition, it is
independent of whether firms bargain over wages alone, or over both wages
and employment.

First, consider the Right-to-Manage Bargains. Given the negotiated
wage, $w$, and the rival firms’ prices, firm $i$ chooses $p_i$ to maximize $p_i D_i(p_i, q) -
C(D_i(p_i, q))$ where $C(x) = wx^B / A$. Then the foc can be written as:

$$\frac{p_i - B w x_i^{B-1}}{p_i} = -\frac{1}{\epsilon_i} \frac{\partial D_i}{\partial p_i} p_i.$$

In a symmetric equilibrium, $p_i = p^*$, $x_i = x^*$ and $\epsilon_i = \epsilon^*$ for all $i$. Then from
(34) and (35), we get $\epsilon^* = -\sigma + (\sigma - 1)/n$, and $x^* = (\gamma I)/(np^*)$. Further,
from (36), and after some manipulations we obtain the firm’s equilibrium output:

$$x^*(w; \sigma, n, \gamma I) = \left( \frac{1}{w} \right)^{\frac{1}{\pi}} \left( \frac{\gamma I}{n} \right)^{\frac{1}{\pi}} \left[ \frac{(\sigma - 1)(1 - 1/n)}{\sigma - (\sigma - 1)/n} \right]^{\frac{1}{\pi}} \left( \frac{A}{B} \right)^{\frac{1}{\pi}}.$$

Thus, $x^*$ is log-linear in $w$ and $(\sigma, n, \gamma I)$. Finally, and surprisingly, the firm’s
equilibrium profits turn out to be always independent of the negotiated wage:

$$\pi^*(\sigma, n, \gamma I) = \frac{\gamma I}{n} \left[ 1 - \frac{(\sigma - 1)(1 - 1/n)}{B[\sigma - (\sigma - 1)/n]} \right].$$

(38)
(and thus are also log-linear in the same variables). This is due to that DS demands imply that firms’ revenues are independent of their cost structure in a symmetric equilibrium, and moreover that firms’ total costs are proportional to their revenues whenever the cost function is of constant elasticity-type.

We turn, next, to the Efficient Bargains. As in the previous cases, employment decisions during the negotiations determine also firms’ outputs and prices. Given our symmetric decreasing returns to scale technology, only symmetric employment allocations maximize the Nash product. This, in turn, implies that firms produce the same outputs and charge equal prices. Then (34) and (35) imply that each firm’s revenues are constant and equal to \((\gamma I)/n\). Hence, the \(n\) firms and the union choose \((x, w)\) to maximize the following (reduced) Nash product:

\[
\left[ n \left( \frac{\gamma I}{n} - w \frac{x^B}{A} \right) \right]^{(1-b)} \left[ u(w) \left( n \frac{x^B}{A} \right) ^{r-b} \right] . \tag{39}
\]

The first order condition of (39) with respect to \(x\) is:

\[
\frac{rb}{x} = (1-b)w \frac{x^{b-1}}{\left( \frac{\gamma I}{n} - w \frac{x^B}{A} \right)} .
\]

Solving for the induced output and profits we get, respectively,

\[
x^*(w; \sigma, n, \gamma I) = \left( \frac{1}{w} \right)^{\frac{1}{b}} \left( \frac{\gamma I}{n} \right)^{\frac{1}{b}} \left[ \frac{rb}{1 - b + rb} \right]^{\frac{1}{b}} A^{\frac{1}{b}} . \tag{40}
\]

and

\[
\pi^*(\sigma, n, \gamma I) = \frac{\gamma I}{n} \left[ \frac{1 - b}{1 - b + rb} \right] . \tag{41}
\]

That is, both induced output and profits are log-linear in \(w\) and \((\sigma, n, \gamma I)\). (Note that, again, profits do not depend on \(w\).) Finally, from (9) the negotiated wage is given by:

\[
\frac{uu'(w)}{u(w)} = r
\]

26
independently whether bargaining is over wages alone, or over both wages and employment. Note, further, that the negotiated wage does not depend either on the elasticity of the cost function, $B$, or the union’s bargaining power, $b$. Since profits are the same for all wage levels, it is as if the negotiated wage were set always by a “Monopoly Union” (as if the union’s bargaining power were equal to 1 while negotiating over wages). Thus, the independence of the negotiated wage from $b$. Coupling the above observation with a constant elasticity cost function, we can explain the independence of the negotiated wage from $B$.

4 Decentralized Bargaining

Let us now examine whether the wage independence property holds when firms bargain in parallel sessions with their own unions either over wages alone, or over both wages and employment. The basic model introduced in Section 2 now changes somewhat: Firms are endowed with the same log-linear one factor (labor) technology as before (1). Workers are organized in firm-specific unions. Each firm’s union is assumed to have the same objective function which is log-linear in (firm-level) employment and a function of the (firm-specific) wage rate, i.e. $U(w_i,t_i) = u(w_i;u_i)l_i$. Bargaining is decentralized, i.e. firm-union bargaining units conduct simultaneous negotiations over the firm-specific wage rate alone, or the wage rate and the firm-level employment. The outcome of negotiations between a firm and its union is again modelled as the solution to the generalised Nash bargaining problem.\footnote{The modelling of the bargaining between firm-union pairs using the Nash bargaining solution is weak to the criticism that outside options become extremely important, and hence to the criticism that a non-cooperative version of a bargaining game that gives rise to the Nash solution may not exist. However, our interest here is simply to show that even with zero threat points the independence property vanishes.}
However, as negotiations between bargaining units take place simultaneously, each firm-union pair takes the decisions of its rivals as given while conducting its own negotiations. The firm-specific negotiated wages (or negotiated wages and firm-level employment) are then determined as the Nash equilibrium of the game between firm-union bargaining units. This is the standard approach used in the literature to solve for decentralized negotiations in union-oligopoly bargaining models (see e.g., Dowrick, 1989).

In the Right-to-Manage model, the vector of negotiated wages, one for each firm-union pair is given by the solution to the system of equations, $i = 1, ..., n$,

$$Max_{w_i} \{ \pi^*_R(w_i, W_{-i}; K) \}^{1-a} \{ u(w_i) [l^*_R(w_i, W_{-i}; K)]^b \}$$

(42)

where $\pi^*_R(.)$ and $l^*_R(.)$ are firm $i$’s equilibrium profits and demand for labor, respectively, when $w_i$ is its wage rate and $W_i = (w_1, ..., w_{i-1}, w_{i+1}, ..., w_n)$ is the vector of wage rates paid by its rivals. Note that, since during the market competition stage each firm takes as given the outcome of the parallel bargaining going on between other pairs, the firm’s equilibrium output and demand for labor is a function of the whole vector of wages, rather than only their own negotiated wage. Then, given the wage bargain struck at the rival pairs’ sessions, a firm-union bargaining unit has an incentive to strategically reduce its wage in order to increase the firm’s market share as well as the union’s employment level. Due to this strategic effect, negotiated wages are lower under decentralized bargaining than under industry level negotiations. This strategic effect is also responsible for the breaking-down of the wage independence property, as our examples below demonstrate.\textsuperscript{21}

\textsuperscript{21}However, when these strategic effects are absent this may not be true, e.g. if the market is perfectly competitive, firms are price takers then the negotiated wage is independent of some market features (see e.g. Ulph and Ulph, 1989 where it is independent of market price).
Further, in the Efficient Bargaining model, the vector of negotiated wages and employment levels is the solution to:

$$Max_{(w_i, l_i)} \{ \pi(w_i, W_{-i}, l_i, L_{-i}; K) \}^{1-h} \{ u(w_i)[l_i(w_i, W_{-i}, L_{-i}; K)]^h \}$$  

(43)

where $\pi(.)$ and $l(.)$ are firm $i$’s profits and demand for labor and $L_{-i} = (l_1, ..., l_{i-1}, l_{i+1}, ..., l_n)$ is the vector of employment levels for its rivals. Each firm-union pair, while negotiating over the firm-specific wage rate and firm-level employment, takes as given the wage and employment decisions of their rivals. Obviously, there is a strategic effect in this case, too. Note that in this case, sequential bargaining over employment first and then wages is not equivalent to the simultaneous (inside each bargaining unit) wage-employment negotiations. As our examples show, the wage independence property does not hold under Efficient Bargains either.

The constant elasticity demand case with constant returns to scale technology has been analyzed by Dowrick (1989). Under Right-to-Manage Bargains, the negotiated wage depends, among other features of the market, on the number of firms in the industry and the conjectural variation parameter (Dowrick’s Proposition 3). A similar result is obtained under Efficient Bargains (Proposition 2). Contrary to the centralized bargaining case where the negotiated wage is constant, under decentralized bargaining it is decreasing in the number of firms and typically increasing in the degree of market collusion. Thus, wages are positively linked to the size of the surplus over which firms and unions bargain.

In the linear-demand-linear technology case too, the negotiated wage depends on the number of firms and the substitutability parameter. To see this, consider, first, Cournot competition with Right-to-Manage Bargains. The first order conditions (21) are as before with $w_i$ substituted for $w$. Solving the $n$ firms we get:

$$x_i^1(w_i, w_{-i}) = \frac{aA(2 - \gamma) + \gamma w_{-i} - [2 + \gamma(n - 2)]w_i}{[2 + \gamma(n - 1)](2 - \gamma)A}$$  

(44)
where \( w_{-i} = \sum_{j \neq i} w_j \). Equilibrium profits are again \( \pi_i^*(w_i, w_{-i}) = x_i^2 \), while the union's utility is given by \( u(w_i)(\frac{x_i^*}{A})^\gamma \), where \( x_i^* \) is a function of the whole vector of wages as (44) shows. Union \( i \) then bargains with its firm, and the first order conditions is,

\[
\frac{bu'(w_i)}{u(w_i)} = \frac{[br + 2(1 - b)][2 + \gamma(n - 2)]}{aA(2 - \gamma) + \gamma w_{-i} - [2 + \gamma(n - 2)]w_i}
\]

Then in the symmetric equilibrium, \( w_i^* = \ldots = w_n^* = w^* \), we have:

\[
\frac{bu'(w^*)}{u(w^*)} = \frac{[br + 2(1 - b)][2 + \gamma(n - 2)]}{(2 - \gamma)(Aa - w^*)}
\]

(45)

Hence, the negotiated wage is decreasing in the number of firms and the degree of substitutability. E.g if \( \gamma = 1, A = 1, b = 1 \), and \( U = wL \), i.e. the case of homogenous goods and monopoly unions, when \( n = 1 \), the negotiated wage is \( a/2 \) but when \( n = 2 \), negotiated wage is \( a/3 \). Similarly, if \( \gamma = 0, A = 1, b = 1 \) and \( U = wL \), and \( n = 2 \) the wage is \( a/2 \). These are shifts in the labour demand curve for each union-firm pair that are not iso-elastic. A similar result is expected with Bertrand competition when bargaining is over wages alone. Indeed, it is easily checked that the negotiated wages are dependent on the number of firms as well as the degree of substitutability. They are also smaller under Bertrand competition than under Cournot competition.

Further, if bargaining is over both wages and employment, the wage independence breaks down independently of the type of competition in the product market. The first order conditions for firm-union pair \( i \) wage rate and employment level (or alternatively, output), in this scenario are (\( x_{-i} = \sum_{j \neq i} x_j \)):

\[
\frac{bu'(w_i)}{u(w_i)} = \frac{(1 - b)}{(Aa - w_i) - Ax_i - A\gamma x_{-i}}
\]

(46)

\[
\frac{(1 - b + br)}{x_i} = \frac{(1 - b)A}{(Aa - w_i) - Ax_i - A\gamma x_{-i}}.
\]

(47)

It is easily checked that wages in the symmetric equilibrium, \( x_i^* = x^* \) and \( w_i^* = w^* \), \( i = 1, \ldots, n \), are dependent on the number of firms and the degree of product substitutability.
Finally, in the Dixit-Stiglitz Preference-for-Diversity model, if strategic effects among firms are assumed away (as in the original version of the model), the negotiated wages are independent of the number of firms even with decentralized bargaining. The proof relies on the fact that in the absence of strategic interaction between firms we can use symmetry in the firm’s prices and outputs even before solving each union-firm pair’s Nash problem, i.e. treat a pair as a representative pair. Obviously, this observation applies to our general model too. As long as we assume strategic effects away, treating a firm-union bargaining unit as a representative one, the wage independence property holds also under decentralized negotiations.\textsuperscript{22} However, if the influence of an individual price change on the general price index is not negligible, it can be checked that the negotiated wage will depend on the product market features in the Dixit-Stiglitz model too.

5 Concluding Remarks

1. In this paper we provide sufficient conditions under which the wage emerging from centralized bargaining between firms and an industry union is independent of a number of the market parameters and the institution of bargaining. We illustrate the wage independence property in a broad class of industry specifications used in the literature.

The theoretical result clearly points to centralized bargaining as being crucial for the wage rigidity—it breaks down if we introduce decentralized bargaining, in the context of oligopolistic markets where firm-union bargaining units take into account the effects of their wage increase on their rivals wages and outputs.

Our result, however, does not crucially require the institution of centralized bargaining. Although both industry unions and multi-employer bar-

\textsuperscript{22}We are grateful to an anonymous referee for pointing this out.
gaining units exist in many countries, what we require for our result is some process of bargaining where the interests of employers are joint and those of all workers are joint—this requires co-ordination between employers and between workers, but it need not always occur through a formal entity like an industry union or a formal employer co-operative. To the extent that such co-ordination occurs in many countries without an explicit industry wide structure (as in Japan, for example), the model remains applicable.

2. The wage independence result has some interesting implications for employment policy. We show that changes in market parameters that affect the intensity of competition among firms have beneficial effects on industry employment. In particular, it is possible to increase aggregate employment by encouraging the entry of new firms, e.g. through deregulation of the industry, or even subsidizing entry costs, whenever bargaining is centralized and industries are oligopolistic.

3. Some indirect support for our conclusions is given by Zweimuller and Barth (1994) who conclude that centralisation of wage bargaining is an important determinant of industry wage dispersion (they compare wage differentials in Canada and the US with those in Austria, Norway and Sweden).

Links with existing empirical work are in general difficult to establish: our results seem to be more closely linked to studies where the degree of concentration in an industry is related with the level of wages. Studies of the wage-profit link are not directly relevant as we go further into the determinants of profits.

The use of the Nash solution has been already motivated before. It may also be noted that some empirical support is provided for the Nash solution in the book by DeMenil (1971).

4. Finally, the general economic point we are making is that with most of the union objective functions used in the literature (see Carruth and Oswald, 1987, for a full taxonomy), i.e. where substitutability between wages and
employment is assumed, changes in market structure do not have as big an impact on wages as on employment. E.g. if the union had Leontief indifference curves, our result would break down. With log-linear utility, the elasticity of substitution between $u(w, w_0)$ and employment is constant at $r$, thus we have characterised conditions required for wage independence for constant elasticity of substitution union objective functions. Of course (as can be seen from the graphs) there are other union indifference curves which imply that the union will adjust wages less than employment, but they are difficult to systematically isolate. Hence a full characterization is not possible.
References


