Wage Independence in Symmetric Oligopolistic Industries

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Abstract

This paper provides su±cient conditions under which the negotiated wage in unionized oligopolistic industries with centralized negotiations is independent of a number of product market features (such as the number of ¯rms, the degree of product substitutability, or the type of market competition). This wage independence property is shown to hold in a broad class of industry speci¯cations widely-used in the literature, both when negotiations are conducted over wages alone (Right-to-Manage), and over wages and employment (E±cient Bargains). In particular, it holds for the Dixit-Stiglitz preference-for-diversity model, the symmetric linear demands-linear one factor (labor) technology model, and the constant elasticity demand and cost functions model. In these models the negotiated wage is independent of the bargaining institution, too. Unions are then better-o® as the market becomes more competitive since aggregate employment increases. (JEL L13, J31, J51)

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1 Introduction

There is a popular conception of unions as entities that attempt to extract rents available in the industry[1]. Restricting attention to imperfectly competitive industries which are presumed to create rents, a natural question to ask is if and how the size of these rents (measured e.g. by the concentration in the industry, the degree of product differentiation, or the intensity of competition) affects the negotiated wage. The dependence of wages on product market features, like prosperity and market power, has been a topic widely researched in the labor economics literature both empirically and theoretically, with differing conclusions.

To illustrate a few of the empirical results for the US and UK: There is evidence of substantial wage differentials among industries that appear to be stable over time (Krueger & Summers (1988)). Layard et al. (1991) attribute these differentials mainly to firm specific factors (such as the size of firms, their productivity and profitability),and these factors seem to be equally important when bargaining is centralized, or when product markets are more competitive. Dickens & Katz (1987) detect some link between wages and industry concentration, which however is not robust to the inclusion of controls for labor quality. Hirsch & Connolly (1987), and Hirsch (1990) 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. 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. Stewart (1990) concludes that wage differentials are positive in industries with market power, but zero in perfectly competitive markets. Blanchflower et al. (1990) and Blanchflower & Oswald (1988) agree that wages are positively linked to financial performance. Pugel (1980), and Carruth & Oswald (1989) also detect some link between wage and profits. In a sample of large British companies, Machin (1991) finds that, even though unions lead to decreasing profits for these industries, their

[1] E.g. see Ashenfelter and Layard (1986), and Layard, Nickell, and Jackman (1991).

ability to capture a share of the rents is not increasing with the size of the rents available. Hence, the existing evidence seems to be inconclusive on the link between product market features and wages.

In the theoretical literature there have been mainly two strands: The ¯rst strand is concerned with wage rigidity to product market shocks. McDonald & Solow (1981), using a constant elasticity demand, and Oswald (1982), and Carruth & Oswald (1989), with speci¯c functional forms for the production function and the union's objective, show that sectorial shifts in demand and labor productivity are entirely absorbed by employment adjustments. Moreover, Ulph & 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 e®ects of product market characteristics on negotiated wages under di®erent 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, wages are independent of the degree of product market collusion.

In this paper we generalize the wage independence result derived in the earlier studies. The emphasis is given on the independence of the negotiated wage from the product market features, rather than on the wage rigidity to product market shocks. In the context of a symmetric imperfectly competitive industry with centralized negotiations, su±cient conditions are derived for the wage independence property to hold. We consider both, the Right-to-Manage model where negotiations are over wages alone (leaving employment decisions at the ¯rm's discretion), and the E±cient Bargains model where negotiations are both over employment and wages. The union's objective function depends on both wages and aggregate employment and is assumed to be log-linear in employment. The Generalized Nash Bargaining solution is used to obtain the negotiated wage, assuming that unions and ¯rms take into account the consequences of their decisions for employment and product market competition.

Our main result is that, under some fairly general conditions, centralization of bargaining at the industry level causes wage to be independent of a number of product market characteristics, such as the number of ¯rms (the measure of concentration in a symmetric industry), the degree of product di®erentiation, 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). The independence of the negotiated wage implies that increases in the intensity of competition are reflected 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. In addition, in these industry models the negotiated wage is shown to be independent of whether the bargaining institution is Right-to-Manage or Efficient Bargains.

The organization of the paper is as follows. Section 2 presents the model with centralized bargaining and provides the conditions under which the wage independence 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 and discusses the necessity of our assumptions for the main result.

2 Centralized Bargaining

There are n identical firms, each endowed with a log-linear one factor (labor) technology[2]:

$$x_i(l_i) = (A.l_i)^{\frac{1}{B}} \qquad i = 1; \ldots; n \tag{1}$$

$$A > 0; \quad B \geq 1$$

where x_i is firm i's output and l_i its labor input. Firms first enter into negotiations with an industry-wide union, and then compete in the product market. We consider both the Right-to-Manage model (Nickell, (1982)) where the n firms and the union collectively bargain over the wage alone, leaving employment decisions at each firm's discretion, as well as the Efficient Bargains model (McDonald & Solow (1981)) where the n firms and the

[2] 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 larger than 1 stems 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.

union bargain collectively over both employment and wages. The nature of market competition is not specified at this stage. For instance, firms may compete in quantities, or in prices.

The union's objective is to maximize a function of the wage, w, and the aggregate employment, L, given the reference wage w_0 (interpreted as the best alternative wage):

$$U(w; L; w_0) = u(w; w_0).L^r \tag{2}$$

where $r \in \Re_+$ measures the relative importance given to employment, and $u(.)$ is an increasing concave function of the wage. This objective stems from a large variety of union welfare functions used in the literature after taking account of the union's outside option.

The negotiated wage 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. In the limit as $b = 1$, the union unilaterally sets the wage, while if $b = 0$ firms set the wage. Let $\Pi^*(w; K)$, and $L^*(w; K)$, represent the firms' aggregate "indirect" profits, and the aggregate employment level, respectively, for a given negotiated wage, w, with K being a list of parameters characterizing the market. Under Right-to-Manage Bargains, $\Pi^*(w; K)$ and $L^*(w; K)$ are the equilibrium aggregate profits and employment, resulting from the firms' optimal choices in the subsequent product market game. Under Efficient Bargains, $\Pi^*(w; K)$ and $L^*(w; K)$ are the "reduced" aggregate profits and employment after taking into account both the vector of employment levels agreed upon during the negotiations[3], as well the firms' optimal choices in the subsequent market game. A generalized Nash Bargain over the wage then solves[4]:

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

Restricting attention to symmetric market equilibria (and employment choices), we have: $\Pi^*(w; K) = n\pi^*(w; K)$, and $L^*(w; K) = nl^*(w; K)$, where $\pi^*(w; K)$, and $l^*(w; K)$, are an individual firm's equilibrium profits, a-

[3] Note that maximizing the Nash product with respect to both the vector of employment levels and the wage is equivalent to first maximizing it with respect to the vector of employment levels and then with respect to the wage.

[4] We assume that fallback profits $\bar{\pi}$ are identically 0. This is easily justified if $\bar{\pi}$ is viewed as delay profits under alternating offers.

nd employment, respectively. Log-linear technology (1) then implies that $l^*(w,K) = (x^*(w,K))^B/A$, where $x^*(w,K)$ is a firm's output in equilibrium. Given (2), the negotiated wage is determined according to:

$$Max_w[u(w)\{nx^*(w,K)^B/A\}^r]^b[n\pi^*(w,K)]^{1-b} \qquad (3)$$

A priori, we could expect the wage emerging from this maximization exercise 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 leads to a higher negotiated wage. The following proposition gives the conditions under which the negotiated wage is independent of a list of market parameters.

Proposition 1: The Independence Property:

Let there be n identical firms, each with log-linear one factor (labor) technology, bargaining with a single industry-wide union. If a firm's equilibrium output and "indirect" profits [5] are multiplicatively separable (m-separable) in wages and a list of parameters K, and if the union's objective function is m-separable in wages and in employment and is log-linear in employment, then the negotiated wage emerging from centralized bargaining is independent of the list of parameters K, and the number of firms, n.

Proof: Let a firm's equilibrium output and "indirect" profit functions be represented as:

$$x^*(w,K) = \psi(w)\phi(K) \qquad (4)$$

$$\pi^*(w,K) = \Psi(w).\Phi(K) \qquad (5)$$

Note, that (3) is equivalent to

$$Max_w\, b[\ln u(w) + r\ln n + rB\ln x^*(w,K) - r\ln A] + (1-b)[\ln n + \ln \pi^*(w,K)]$$

Substituting for $\pi^*(w,K)$ and $x^*(w,K)$, and taking the first order condition (assuming the second order condition is satisfied), we get:

[5] We make the standard assumptions to ensure that these functions are differentiable.

$$\frac{b.u'(w)}{u(w)} + \frac{Bbr\psi'(w).}{\psi(w)} + \frac{(1-b).\Psi'(w)}{\Psi(w)} = 0 \tag{6}$$

Clearly, therefore, the solution of this equation for w does not depend on K or on n.

$\diamondsuit$

The intuition behind this result is as follows. The Generalized Nash bargaining solution requires that the negotiated wage be such that the percentage decrease in the firms' "indirect" profits due to a wage increase, weighted by the firms' bargaining power, is equal to the percentage increase in union's welfare, weighted by its bargaining power . Given the form of union's objective (2), the latter can be decomposed into the percentage increase of wage-related welfare, $u(w)$; and the percentage decrease of employment-related welfare, L^r. Clearly, the percentage increase of wage-related union welfare is independent of the number of firms and the list of parameters, K. On the other hand, our separability assumption ensures that the percentage decrease in aggregate profits, $n\pi^*(w;K)$, and the percentage decrease of employment-related union's welfare, $(nl^*(w;K))^r = (n[x^*(w;K)]^B/A)^r$; are also independent of n and K. This in turn implies that the negotiated wage does not depend on the number of firms, n, or the list of parameters, K.

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 industry models do satisfy these conditions. In addition, we show that in these economies, the negotiated wage is not only independent of the type 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 demand function is represented as:

$$P(X) = X^{-\varepsilon}; \text{ where } X = \Sigma x_i \tag{7}$$

Using the technology assumed in (1) we have:

$$C(x_i) = w\frac{x_i^B}{A}$$

Proposition 2: Let there be n identical firms, with log-linear one factor (labor) technology, bargaining with a single union. If firms face a constant elasticity demand function, and if the union's objective function is m-separable in wages and aggregate employment and is log-linear in employment, then the negotiated wage emerging from centralized bargaining is independent of the number of firms, n; the kind of competition between firms, α; and whether firms bargain over wages or over both employment and wages.

Let us first consider Right-to-Manage Bargains and Cournot competition. The marginal cost for this technology is:

$$C'(x_i) = \frac{B}{A}wx_i^{B-1}$$

Firm i chooses its quantity to maximize its profits, $P(X)x_i - C(x_i)$. Its foc can be written as:

$$P'(X).x_i + P(X) = C'(x_i)$$

Using symmetry we get:

$$P(nx^*)(1 - \frac{\epsilon}{n}) = C'(x^*) \tag{8}$$

and thus:

$$x^*(w;n) = (\frac{1}{w})^{\frac{1}{B-1+\epsilon}}\{\frac{n^{-\epsilon}QA}{B}\}^{\frac{1}{B-1+\epsilon}} \tag{9}$$

with $Q = (1 - \frac{\epsilon}{n})$. Thus, x^* is m-separable in wages and number of firms. Further, using (8):

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

or:

$$\pi^*(w;n) = w.x^{*B}\{\frac{B}{Q} - 1\}.\frac{1}{A}, \tag{10}$$

i.e. each firm's "indirect" profits are m-separable in w and 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 competitiveness of industry parameter be represented as: $a = \frac{1+(n-1)\alpha}{n}$; where $-\frac{1}{n-1} \le \alpha \le 1$ is the conjectural variation parameter[6]. Then optimal output and "inderect" profits are given by (9) and (10) where Q is replaced by $Q(\alpha) = 1 - \frac{\alpha(n-1)\varepsilon}{n} - \frac{\varepsilon}{n}$; and hence are m-separable in w and $(n;\alpha)$: (Note that $Q = Q(0)$). This is a generalisation of Dowrick's (1989) Proposition 4, where with industry level bargaining a similar independence result is obtained but with constant marginal returns to labor.

Suppose, next, that firms and union bargain over both employment and wages. 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:

$$[n(P(nx)x - \frac{w}{A}x^B)]^{1-b}[u(w)(\frac{nx^B}{A})^r]^b \tag{11}$$

The foc with respect to output then gives:

$$P(nx^*)x^* = \frac{Bwx^{*B}(br+1-b)}{A[(1-b)(1-\varepsilon)+Bbr]}$$

Hence, optimal output and "reduced" profits are given respectively as:

$$x^*(w;n) = (\frac{1}{w})^{\frac{1}{B-1+\varepsilon}}\{\frac{n^{-\varepsilon}(brB+(1-b)(1-\varepsilon))A}{B(br+1-b)}\}^{\frac{1}{B-1+\varepsilon}} \tag{12}$$

[6]Note that the type of market competition can be viewed as a market parameter, α, according to the Conjectural Variations approach (Bowley (1924)). For example, in Cournot Competition a 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)

$$\pi^*(w;n) = w{:}x^{*B}\left\{\frac{(1-b)(B-1+\epsilon)}{brB+(1-b)(1-\epsilon)}\right\}{:}\frac{1}{A}; \qquad (13)$$

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

$$\frac{1}{b}\left[\frac{(1-b)(1-\epsilon)+Bbr}{B-1+\epsilon}\right] = \frac{wu'(w)}{u(w)}$$

which completes the proof of Proposition 2.

3.2 Linear Demand-Linear Technology Economies

There are n identical firms in the market, each endowed with a linear one factor (labor) technology (given by (1) if $B = 1$). Firms face symmetric linear demands, which is a generalization of Dixit (1979) :

$$P_i(x_i; x_{-i}) = a - x_i - \gamma x_{-i} \qquad x_{-i} = \Sigma_{j\neq i}x_j \quad i;j = 1;\ldots;n \qquad (14)$$

In fact, these are the demand functions of a representative consumer whose utility depends on a vector of consumption goods $x = (x_1; x_2; \ldots; x_n)$ and the numeraire good m. It is given by $W(x) + m$[7] with:

$$W(x) = a\left(\sum_i x_i\right) - \frac{\left(\sum_i x_i^2 + 2\gamma \sum_{i\neq j} x_i x_j\right)}{2} \qquad j = 1;\ldots;n$$

where γ represents the degree of substitutability between any pair of goods i and j. The higher the γ; the higher is the degree of substitutability between i and j. When γ tends to zero, each firm virtually becomes a monopolist; when γ 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:

[7] Note that this utility function subsumes a preference for variety. It is decreasing in γ and increasing in the number of product varieties n.

Proposition 3: Let there be n identical firms, with linear one factor (labor) technology, and facing symmetric linear demands, bargaining with a single union. If the union's objective is m-separable in wages and employment and is log-linear in employment, then the negotiated wage emerging from centralized bargaining is independent of the degree of product differentiation, γ, the number of firms, n; and also of whether firms compete in prices, or quantities[8]. 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:

$$Max_{x_i}(a - x_i - \gamma x_{-i})x_i - \frac{w}{A}x_i \tag{15}$$

given some wage level w; and given the rival firms' output choices x_{-i}. The first order condition are:

$$a - 2x_i - \gamma x_{-i} = \frac{w}{A} \tag{16}$$

Then a firm's output in the symmetric equilibrium is:

$$x^*(w; n; \gamma) = \frac{a - \frac{w}{A}}{2 + \gamma(n - 1)} \tag{17}$$

and its equilibrium profits are:

$$\pi^*(w; n; \gamma) = \frac{(a - \frac{w}{A})^2}{(2 + \gamma(n - 1))^2} \tag{18}$$

Observe that both, the optimal output and "indirect" profits, are inversely related to the degree of product differentiation, γ, and to the number of firms, n[9]. This is also true for the price-cost margin (from (16)). Note too, that the equilibrium output and profits satisfy the conditions of Proposition

[8] In fact, it can be shown that the negotiated wage is independent of the type of competition (or the degree of market collusion) whenever the latter is represented by the appropriate conjectural variations parameter. See also footnote 6

[9] As γ 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 γ increases (or n increases), the intensity of competition increases. As a result, a firm's profits decrease with both,

1, i.e. they are m-separable in wages and the list of parameters $K = (\gamma; n)$: Thus, the negotiated wage is independent of γ and n; as (6) applied to this case gives:

$$\frac{2(1-b)+br}{aA-w} = \frac{bu'(w)}{u(w)} \tag{19}$$

To illustrate, let $u(w) = w - w_0$; where w_0 is the best alternative wage: Then from (19) the negotiated wage is:

$$w^* = \frac{aAb + [2 + b(r-2)]w_0}{2 + b(r-1)} \tag{20}$$

Obviously, this wage coincides with the negotiated wage in the homogenous 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.

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:

$$[(a - x(1+\gamma(n-1)) - \frac{w}{A})nx]^{1-b}[u(w)(\frac{nx}{A})^r]^b \tag{21}$$

Then the foc with respect to x implies that optimal output is given by:

$$x^*(w; n; \gamma) = \frac{(br+1-b)(a-\frac{w}{A})}{[2(1-b)+br]}\frac{1}{(1+\gamma(n-1))} \tag{22}$$

and the "reduced" profits are:

$$\pi^*(w; n; \gamma) = x^{*2}\frac{(1-b)(1+\gamma(n-1))}{br+1-b} \tag{23}$$

γ and n. On the other hand, a firm's output decreases with γ; 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.

Since both optimal output and "reduced" profits are m-separable in wages and parameters $(n;\gamma)$; we get by Proposition 1 the independence property. Moreover, applying (6), we obtain again equation (19), 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 (14) we obtain the demand system:

$$D_i(p_i;p_{-i}) = \frac{a(1-\gamma) - [1+\gamma(n-2)]p_i + \gamma p_{-i}}{[1+\gamma(n-1)](1-\gamma)} \tag{24}$$

for $i = 1;2;...;n$ and $p_{-i} = \Sigma_{i \neq j} p_j$. 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 conditions are:

$$a(1-\gamma) - [1+\gamma(n-2)]p_i + \gamma p_{-i} = (p_i - \frac{w}{A})[1+\gamma(n-2)] \tag{25}$$

In the symmetric equilibrium, we get:

$$p^* = \frac{a(1-\gamma) + [1+\gamma(n-2)]\frac{w}{A}}{2+\gamma(n-3)} \tag{26}$$

A firm's output in equilibrium is then:

$$x^*(w;n;\gamma) = \frac{(a-\frac{w}{A})[1+\gamma(n-2)]}{[1+\gamma(n-1)][2+\gamma(n-3)]} \tag{27}$$

and its indirect profits are:

$$\pi^*(w;n;\gamma) = \frac{x^{*2}[1+\gamma(n-1)](1-\gamma)}{[1+\gamma(n-2)]} \tag{28}$$

Here too, optimal output, indirect profit and price-cost margin are decreasing in γ and in n (except if $n = 2$; in which case output initially decreases and then increases with γ)[10]. Moreover, both output and profit functions satisfy the m-separability condition of Proposition 1.Hence, the negotiated wage

[10] Similar arguments hold as in the Cournot case. See previous footnote. If, however, $n = 2$; as γ decreases, the competition effect dominates at first and then the preference for variety effect, thus producing the inverted bell shaped output curve.

is again independent of the number of firms n; and the degree of product differentiation γ. Finally, applying (6) the negotiated wage in the Bertrand market is determined by the same equation as in the Cournot market (equation (19)). 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' "reduced" profits and outputs are independent of whether firms compete in prices or quantities in the market, and are given by (23) and (22), respectively. Hence, the 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, $(x_1, ..., x_n)$; and a numeraire good, x_0. A representative consumer maximizes the following Cobb-Douglas utility function:

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

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; γ 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:

$$q = \left[\sum_{i=1} p_i^{1-\sigma} \right]^{1/(1-\sigma)} \quad \text{and } y = \left[\sum_{i=1} x_i^{\rho} \right]^{1/\rho} \tag{29}$$

we have the following demand functions:

$$D_i(p_i, q) = \frac{\gamma I}{q} \left(\frac{q}{p_i} \right)^{\sigma} \quad \text{and } D_0 = (1-\gamma) I \tag{30}$$

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 interaction among firms which was absent in the initial DS model. The following proposition summarizes our results:

Proposition 4: Let there be n identical firms, with log-linear one-factor (labor) technology, bargaining with a single industry-wide union. If the firms face the Dixit-Stiglitz demand functions and compete in prices, and if the union's objective is m-separable in wages and employment and is log-linear in employment, then the negotiated wage emerging from centralized bargaining is independent of the elasticity of substitution between varieties, σ; the number of firms, n, the total income spent on the differentiated goods, γI. 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:

$$\frac{p_i - \frac{B}{A} w x_i^{B-1}}{p_i} = -\frac{1}{\epsilon_i} \text{ with } \epsilon_i = \frac{\partial D_i}{\partial p_i}\frac{p_i}{D_i} \tag{31}$$

In a symmetric equilibrium, $p_i = p^*$, $x_i = x^*$ and $\epsilon_i = \epsilon^*$ for all i. Then from (29) and (30), we get $\epsilon^* = -\sigma + (\sigma - 1)/n$, and $x^* = (\gamma I)/(np^*)$. Further, from (31), and after some manipulations we obtain the optimal output:

$$x^*(w; \sigma; n; \gamma I) = \left(\frac{1}{w}\right)^{\frac{1}{B}} \left(\frac{\gamma I}{n}\right)^{\frac{1}{B}} \left[\frac{(\sigma - 1)(1 - 1/n)}{\sigma - (\sigma - 1)/n}\right]^{\frac{1}{B}} \left(\frac{A}{B}\right)^{\frac{1}{B}} \tag{32}$$

Thus, x^* is m-separable in w and $(\sigma; n; \gamma I)$. Finally, and surprisingly, "indirect" profits turn out to be always independent of the negotiated wage:

$$\pi^*(\sigma; n; \gamma I) = \frac{\gamma I}{n}\left[1 - \frac{(\sigma - 1)(1 - 1/n)}{B\,[\sigma - (\sigma - 1)/n]}\right] \tag{33}$$

(and thus are also m-separable 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 (29) and (30) 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:

$$\left[n\left(\frac{\gamma I}{n} - w\frac{x^B}{A}\right)\right]^{(1-b)}\left[u(w)\left(\frac{nx^B}{A}\right)^r\right]^b \tag{34}$$

The foc of (34) with respect to x is:

$$\frac{rb}{x} = \frac{(1-b)wB\frac{x^{B-1}}{A}}{\frac{\gamma I}{n} - w\frac{x^B}{A}}$$

Solving for the optimal output and "reduced" profits we get, respectively,

$$x^*(w; \sigma; n; \gamma I) = \left[\left(\frac{1}{w}\right)^{\frac{1}{B}}\left(\frac{\gamma I}{n}\right)^{\frac{1}{B}}\frac{rb}{1 - b + rb}\right]^{\frac{1}{B}} A^{\frac{1}{B}} \tag{35}$$

$$\pi^*(\sigma; n; \gamma I) = \frac{\gamma I}{n}\left[\frac{1 - b}{1 - b + rb}\right] \tag{36}$$

That is, both optimal output and "reduced" profits are m-separable in w and $(\sigma; n; \gamma I)$. (Note that, again, profits do not depend on w). Finally, from (6) the negotiated wage is given by:

$$\frac{wu'(w)}{u(w)} = r$$

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. It is shown that whenever there is strategic interaction between firm/union pairs, the negotiated wage typically is dependent on all product market features. Since our interest lies in showing conditions under which the opposite is true, this section will briefly discuss some cases where bargaining is decentralized to emphasize the difference that centralized bargaining makes.

The constant elasticity demand case 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 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 (decreasing in the former and increasing in the latter). To see this, consider, first, Cournot competition with Right-to-Manage Bargains. The first order conditions (16) are as before with w_i substituted for w: Solving the n focs we get:

$$x_i^* = \frac{2+\gamma(n-2)}{2[2+\gamma(n-2)]-\gamma^2(n-1)}\left[a\frac{2-\gamma}{2+\gamma(n-2)}+\frac{\gamma}{A(2+\gamma(n-2))}w_{-i}-\frac{w_i}{A}\right] \tag{37}$$

where $w_{-i} = \sum_{j \neq i} w_j$. Equilibrium profits are again x_i^{*2}; while the union's utility is given by $u(w)\cdot(\frac{x_i^*}{A})^r$; where x_i^* is a function of the whole vector of wages as (37) shows. Each union then bargains with its firm, and the first order conditions for the symmetric equilibrium are:

$$\frac{bu'(w)}{u(w)} = \frac{(br+2(1-b))(2+\gamma(n-2))}{(2-\gamma)(Aa-w)} \tag{38}$$

Hence, the negotiated wage is decreasing in the number of firms and increasing in the degree of substitutability. 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.

Also, 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 wage and employment, respectively, in this scenario are:

$$\frac{bu'(w)}{u(w)} = \frac{(1-b)}{(Aa-w)-Ax[1+\gamma(n-1)]} \tag{39}$$

$$\frac{(1-b+br)}{x} = \frac{(1-b)A}{(Aa-w)-Ax[1+\gamma(n-1)]} \tag{40}$$

It is easily checked that wages in the symmetric equilibrium are dependent on the number of firms and the degree of product differentiation.

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 decentralised 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). However, if the influence of an individual price change on the general price index is not negligible, we can expect as in the Bertrand case mentioned above, that wage will depend on the product market features.

5 Concluding Remarks

1. In this paper we provide sufficient conditions under which the wage emerging from centralized bargaining between firms and an industry-wide union is independent of a number of the market parameters. We illustrate the wage independence property in a broad class of industry specifications widely-used in the literature, where moreover the negotiated wage is shown to be independent from the institution of bargaining. Note however that most of our examples consider a partial equilibrium model where unions especially are not concerned with the effects of higher wages on the price index.

Some of the assumptions turn out to be crucial for our results: Centralization of negotiations, constant elasticity in labor technology (with fixed capital) and the form of the union's objective function. As for the symmetry assumption, although it seems to be important for technical simplicity, we conjecture that it can be relaxed, and that our result still holds in an asymmetric technology scenario where firms are replicated according to the initial distribution of technologies. Centralization of negotiations is an indispensable assumption as the previous section shows. This seems to be also the case for our assumption on technology. Finally, we provide an example to show the necessity of assuming a union objective function of the form (2). Let:

$$U(w; L) = w(1 + \frac{L}{2})$$

Assume a Bertrand differentiated goods industry. Then the negotiated wage solves:

$$Max:_w[(x^*(w)^2 X(\gamma; n)]^{1-b}[w(1 + \frac{L^*(w)}{2})]^b$$

where $x^*(w)$ is given in (27). This is equivalent to maximizing:

$$(1 - b)[2 \ln x^*(w) + \ln X(\gamma; n)] + b[\ln w + \ln\{1 + \frac{nx^*(w)}{2A}\}]$$

where $X(\gamma; n) = \frac{[1+\gamma(n-1)](1-\gamma)}{1+\gamma(n-2)}$. Let $Y(\gamma; n) = \frac{1+\gamma(n-2)}{[1+\gamma(n-1)][2+\gamma(n-3)]}$. Then the first order condition is:

$$-\frac{2(1 - b)}{aA - w} + \frac{b}{w} = \frac{b}{2A^2/nY(\gamma; n) + (aA - w)} \quad (41)$$

The LHS of (41) is decreasing, while the RHS is increasing, in w. Further, the LHS is independent of, while the RHS shifts with, ° and n. Hence, the negotiated wage depends on both, the product substitutability °, and the number of ¯rms n: Finally, it can be easily checked that the negotiated wage depends on the type of competition, too.

2. The wage independence result has some interesting implications for employment policy. We show that changes in market parameters that a®ect the level of competition among ¯rms have bene¯cial e®ects on industry employment. In particular, it is possible to increase aggregate employment by encouraging the entry of new ¯rms, e.g. through deregulation of the industry, or even subsidizing entry costs, whenever bargaining is centralized.

3. A number of testable hypotheses can emerge from our theoretical results. First is the wage independence property. The latter is supported by Hirsch & Connolly (1987), and Hirsch (1990) who ¯nd no evidence that union rent seeking is more e®ective in highly concentrated industries, or among ¯rms with large market shares. Second, the independence property further suggests that union/non-union di®erentials are independent of market parameters (such as substitutability among goods, industry concentration, and the intensity of competition), if non-union wage is to be taken as the best alternative wage. So far, evidence is mixed on the issue. According to Lewis (1986), union wage premiums are typically smaller in highly concentrated industries. However, Stewart (1990) concludes that wage di®erentials are positive in industries with market power, but zero in perfectly competitive markets. Third, the union e®ect on pro¯ts is more deleterious among ¯rms with low market shares. This is in accordance with Clark (1984). Fourth, the union e®ect on price-cost margin is less negative in highly concentrated industries. This is along the lines of Domowitz et al. (1986) who ¯nd little evidence that price-cost margins are more negative in highly concentrated industries. Finally, there is no link between wages and pro¯ts. This is in contrast to Pugel (1980), and Carruth & Oswald (1989) who detect some link between wage and pro¯ts. Machin (1991) provides some estimates of the impact of unions on pro¯ts in a sample of large British companies. While he ¯nds that unions lead to decreasing pro¯ts for industries, the ability to capture a share of the rents does not increase with the size of the rent available.

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 di®erentials in Canada and the US with those in Austria, Norway and Sweden).

4. It is known that the negotiated wage in a Bertrand homogenous market with identical ¯rms and constant marginal costs is indeterminate, pro¯ts for the ¯rms being 0 for any wage rate. We propose that a reasonable way to solve this indeterminacy is that the negotiated wage of the homogenous market be the limit of the wage of a di®erentiated market as the degree of substitutability goes to one. The independence property discussed above then implies that the negotiated wage in the homogenous Bertrand market coincides with that of the di®erentiated market, if the ¯rms, in addition, face linear symmetric demands.

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