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The Effects of Entry in Oligopoly with Bargained Wages *

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Abstract

We show that a firm's profits under Cournot oligopoly can be increasing in the number of firms in the industry if wages are determined by decentralised bargaining in unionised bilateral oligopoly. The intuition for the result is that increased product market competition following an increase in the number of firms is mirrored by increased labour market rivalry which induces (profit-enhancing) wage moderation. Whether the product or labour market effect dominates depends both on the extent of union bargaining power and on the nature of union preferences. An incumbent monopolist will have an incentive to accommodate entry if the labour market effect dominates. We also show that this incentive is stronger if the incumbent anticipates that, post entry, it will be able to act as a Stackelberg leader.

Keywords: Oligopoly, wage bargaining, profits and entry.

JEL classification: D43, J50, L13.

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1 Introduction

In the standard Cournot model of oligopoly, each firm's profits decrease as the number of firms competing in the product market increases. This fundamental result in microeconomics was formally established by Seade (1980a).[1] One important implication, for example, is that incumbent firms have an unambiguous incentive to deter entry by new firms. In this paper, we show that when firms' costs (wages) are determined by decentralised bargaining between (downstream) firms and (upstream) labour unions in unionised bilateral oligopoly, then the relationship between profits-per-firm and the number of firms depends on relative bargaining power and on union preferences. If unions are relatively powerful and place sufficient weight on wages relative to employment, then an increase in the number of firms in the market can raise the profits of each firm, reversing the standard Cournot result. The intuition for the result is that increased product market competition following an increase in the number of firms is mirrored by increased labour market rivalry which induces (profit-enhancing) wage moderation. The greater the bargained wage, the greater the wage moderation effect. There is no wage moderation effect under centralised bargaining, as in that case there is no labour market rivalry. The basic model we develop considers decentralised bargaining between a firm and an organised labour union. As Booth (1995) and others have argued, the bargaining model is likely to be relevant wherever workers can exert bargaining power, whether or not they are formally organised into labour unions. For example, as Lindbeck and Snower (1988) have shown, 'insider' power is likely to prevail even in the absence of organised unions.

One implication of this result is that firms in unionised bilateral oligopoly do not necessarily have incentives to deter entry: a duopolist's profits can exceed those of a monopolist, for example. A corollary of this is that the presence of unions might be associated with an increase rather than a decrease in product market competition. Thus, the model identifies a mechanism to counter that analysed in the classic model of Williamson (1968), according to which unions are associated with inhibiting product market competition. We also show that if a firm has a first-mover advantage in the Stackelberg sense, the result is strengthened: any marginal benefit of entry is greater if the incumbent firm is, post entry, able to act as a Stackelberg leader. Hence, in our framework, a Stackelberg leadership may be associated with an enhanced willingness to accommodate entry. A second corollary of our model is that when the bilateral oligopoly is characterised by upstream profit-maximising firms – rather than by utility-maximising labour unions – the profits of each downstream firm are necessarily falling in the number of firms, as in the standard model. This is because the firm-firm bilateral oligopoly can be characterised as a special case of the union-firm bilateral oligopoly, in which we can show that the upstream agent's preferences are such that the implicit weight on the bargained

[1] Early work by Bain (1956) and Sylos-Labini (1962) sparked an interest in the broader topic of the effects of entry. The first formal attempts to directly study these effects are, to the best of our knowledge, found in Frank (1965), Okuguchi (1973) and Ruffin (1971).

price is not sufficient to cause profits to increase with entry.

Our finding that each Cournot firm's profit can increase with the number of firms may also arise in different environments. Recently, Matsushima and Mizuno (2012) consider a simple Cournot model where downstream firms engage in process R&D. They find that the profits of upstream input suppliers may increase with entry since more upstream suppliers leads downstream firms to engage in more R&D, correctly anticipating a fall in the input price which comes about from entry in the upstream market. Mukherjee and Zhao (2009) have shown that profits of some incumbent firms may increase if they are relatively cost efficient relative to other incumbent firms and relative to Stackelberg followers.[2] Their finding is, unlike ours, independent of the vertical structure.[3] Naylor (2002) shows conditions under which industry profits are increasing with the number of firms in the market, but does not address the issue of the individual firm's profit level. It is less surprising that industry profits can increase with the number of firms as such a result is anyway consistent with falling profits-per-firm. In the related literature on unionised oligopoly, Dowrick (1989) develops a framework in which unions act as the upstream agent and shows how the bargained wage varies with market size, but does not focus on the relationship between profits and the number of firms. Horn and Wolinsky (1988) examine a differentiated oligopoly with upstream agents (unions) and downstream firms, but assume a duopolistic market.[4] In the literature on unions and entry deterrence, the usual approach builds on Williamson's (1968) insight that incumbent firms might collude with unions to enforce industry-wide wage premia in order to deter entry. Unions are seen as an employer instrument to preserve product market power. In the model we outline below, it emerges that in the presence of unions firms might have reduced incentives to deter entry: indeed, in contrast to the Williamson insight, unions might have a pro-competitive impact within an imperfectly competitive product market. In a related literature, Bughin (1999) compares firms' and unions' preferences over bargaining scope and finds that entry deterrence is an influence on the choice of bargaining agenda.

The rest of this paper is organized as follows. In Section 2, we outline the basic model and in Section 3 we examine how firms' profits vary with the number of firms. Section 4 augments the basic model to the case of a Stackelberg leader. Section 5 addresses the issue of firm-firm rather than union-firm bilateral oligopoly. Section 6 examines the sensitivity of the results to assumptions regarding the level at which wage bargaining takes place. Section 7 closes the paper with conclusions and further remarks.

[2] The requirements for their result to hold are rather specific. In fact, all of the following must be satisfied: there must be a large number of cost inefficient incumbents relative to cost efficient incumbents and entrants, and the cost difference between the incumbents, and that between the efficient incumbents and entrants must also be large.

[3] Similar papers which demonstrate a positive relationship between firm profits and entry due to a vertical structure include: Tyagi (1999), Matsushima (2006) and Mukherjee et al. (2009).

[4] Similarly, Naylor (1999) considers unionised oligopoly in the context of international trade and economic integration, but does not allow the number of firms to vary.

2 The Model

We model upstream agents as firm-specific trade unions bargaining with downstream firms over the wage rate. We analyse a non-cooperative two-stage game in which n identical firms produce a homogeneous good. In the first stage (the labour market game), each firm independently bargains over its wage with a local labour union: bargaining is decentralised. The outcome of the labour market game is described by the solution to the n union-firm pairs' sub-game perfect best-reply functions in wages. In the second stage (the Cournot product market game), each firm sets its output - given pre-determined wage choices from stage 1 - to maximize profits. We proceed by backward induction.

(i) *Stage 2: the product market game*

Let linear product market demand be written as:

$$p = a - bX, \tag{1}$$

where $X = \sum_{i=1}^{n} x_i$. Profit for the representative firm i can be written as:

$$\pi_i = \left[a - b \sum_{i=1}^{n} x_i - w_i \right] x_i \tag{2}$$

where w_i is the outcome of the wage bargain for union-firm pair i. In this short-run analysis, we exclude non-labour costs. We also assume a constant marginal product of labour, and set this as a numéraire.

Under the Cournot-Nash assumption, differentiation of (2) with respect to x_i yields the first-order condition for profit maximisation by firm i, from which it is straightforward to derive firm i's best-reply function in output space as:

$$x_i = \frac{1}{2b} \left[a - w_i - b \sum_{\substack{j=1 \\ j \neq i}}^{n} x_j \right]. \tag{3}$$

Solving across the n first-order conditions, the n best-reply functions can be re-written as sub-game perfect labour demand equations. From Equation (3) for example, the expression for firm i's labour demand is:

$$x_i = \frac{1}{(n+1)b} \left[a - nw_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} w_j \right]. \tag{4}$$

It is useful to express firm i's profits in terms of the vector of all firms' wages. Substituting (4) in (2), we obtain,

$$\pi_i = \frac{1}{(n+1)^2 b} \left[a - nw_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} w_j \right]^2. \tag{5}$$

From (5), it follows that in symmetric equilibrium, with $w_i = w$,

$$\pi_i = \frac{1}{(n+1)^2 b}[a - w]^2, \quad \forall \quad i, \tag{6}$$

where w is the outcome of the Stage 1 wage-bargaining game. We note that if w is set exogenously at the competitive level, $\overline{w}$, or if unions have no bargaining power, then, with $w = \overline{w}$ in (6), the firm's profits are falling in n, the number of firms in the industry, as

$$\frac{d\pi_i}{dn} = -\frac{2}{(n+1)^3 b}[a - \overline{w}]^2 < 0, \tag{7}$$

which is the standard Cournot oligopoly result.

(ii) *Stage 1: the labor market game*

We assume that the representative trade union i bargaining with firm i, has the objective described by the Stone-Geary utility function:

$$U_i = [w_i - \overline{w}]^{2\alpha} x_i^{2(1-\alpha)}, \tag{8}$$

where $\overline{w}$ denotes the wage which would obtain in a competitive non-unionised labour market. We choose the quadratic form for the Stone-Geary utility as this captures the special case of rent maximisation if $\alpha = 1/2$.[5] Under the assumption of a right-to-manage model of Nash-bargaining over wages, we write the maximand as:

$$B_i = U_i^{\beta} \pi_i^{1-\beta}, \tag{9}$$

where we assume that disagreement payoffs are zero. β represents the union's Nash-bargaining power in the asymmetric wage bargain.

Substituting (4), (6) and (8) into (9) yields,

$$B_i = \frac{1}{(n+1)^{2(1-\alpha\beta)} b^{1+\beta-2\alpha\beta}} [w_i - \overline{w}]^{2\alpha\beta} \left[a - nw_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} w_j \right]^{2(1-\alpha\beta)} \tag{10}$$

The first order condition derived from the Nash maximand, (10), is

$$\begin{aligned} \frac{\partial B_i}{\partial w_i} = & \frac{2[w_i - \overline{w}]^{2\alpha\beta-1}}{(n+1)^{2(1-\alpha\beta)} b^{1+\beta-2\alpha\beta}} \left[a - nw_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} w_j \right]^{1-2\alpha\beta} \\ & \times \left\{ \alpha\beta \left[a - nw_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} w_j \right] - (1-\alpha\beta) n [w_i - \overline{w}] \right\} = 0, \end{aligned} \tag{11}$$

[5] This form will be convenient for comparison with the case of firm-firm bilateral oligopoly considered in Section 5 below.

from which it follows that, in symmetric sub-game perfect equilibrium,

$$w = w_i = \overline{w} + \frac{\alpha\beta}{\alpha\beta + n(1-\alpha\beta)}[a - \overline{w}]. \tag{12}$$

From substitution of (12) in (4), we can represent symmetric equilibrium output by

$$x_i = x = \frac{n(1-\alpha\beta)}{(n+1)b[\alpha\beta + n(1-\alpha\beta)]}[a - \overline{w}]. \tag{13}$$

Substituting (12) in (6) gives equilibrium firm profits of

$$\pi_i = \pi = \frac{n^2(1-\alpha\beta)^2}{(n+1)^2 b[\alpha\beta + n(1-\alpha\beta)]^2}[a - \overline{w}]^2. \tag{14}$$

It follows from Seade (1980a, 1980b) that the Cournot product market equilibrium characterised in (13) and (14) satisfies sufficient conditions for stability. For the linear demand case considered here, the sufficient conditions are that $b > 0$ and $n > 0$. The difference between our model and that of Seade (1980a) is that in our model costs are not exogenous, but are the result of strategic bargaining in the Stage 1 game. In the next section of the paper, we consider comparative static properties of the model.

3 Firm profits and the number of firms

We now investigate how the profits of each firm in sub-game perfect Nash equilibrium vary with the number of firms in the market. We establish Proposition 1.

Proposition 1. *Profits-per-firm increase in the number of firms if and only if unions care sufficiently about wages and have sufficient bargaining power.*

Proof. Differentiating (14) with respect to n, we obtain

$$\frac{\partial \pi_i}{\partial n} = \frac{2(1-\alpha\beta)^2 n}{(n+1)^3[\alpha\beta + n(1-\alpha\beta)]^3 b}[\alpha\beta - n^2(1-\alpha\beta)][a - w]^2, \tag{15}$$

which is non-negative – implying that firm profits are non-decreasing in the number of firms – if and only if the following condition is satisfied:

$$\frac{\alpha\beta}{1-\alpha\beta} \geq n^2 \tag{16}$$

□

From (16), it is clear that firm profits are more likely to be increasing in the number of firms the larger are both α and β and the smaller is n. If the product of α and β is close to unity – for example, if wages are set by monopoly unions ($\beta = 1$) with an objective function close to wage rate maximisation – then the value of

n over which firm profits are increasing in the number of firms is potentially large. We proceed by re-writing (14) as

$$\pi_i = \pi = \frac{n^2(1-\delta)^2}{(n+1)^2 b[\delta + n(1-\delta)]^2}[a - \overline{w}]^2, \tag{17}$$

where δ denotes the product of α and β. Evaluating (17) for various values of n yields:

$$\text{For } n = 1, \qquad \pi_{i|n=1} = \left\{ \frac{(1-\delta)}{2} \right\}^2 \frac{[a-\overline{w}]^2}{b}. \tag{18}$$

$$\text{For } n = 2, \qquad \pi_{i|n=2} = \left\{ \frac{2(1-\delta)}{3[2-\delta]} \right\}^2 \frac{[a-\overline{w}]^2}{b}. \tag{19}$$

$$\text{For } n = 3, \qquad \pi_{i|n=3} = \left\{ \frac{3(1-\delta)}{4[3-2\delta]} \right\}^2 \frac{[a-\overline{w}]^2}{b}. \tag{20}$$

$$\text{For } n = 4, \qquad \pi_{i|n=4} = \left\{ \frac{4(1-\delta)}{5[4-3\delta]} \right\}^2 \frac{[a-\overline{w}]^2}{b}. \tag{21}$$

From comparison of (18) and (19), it follows that the profits of each duopolist exceed those of a monopolist if $\delta > \frac{2}{3}$. That is,

$$\pi_{i|n=2} > \pi_{i|n=1} \text{ if and only if } \delta > \hat{\delta}_2 = \frac{2}{3}, \tag{22}$$

where $\hat{\delta}_2$ is the critical value of δ such that the profit of each of two firms under n-firm Cournot oligopoly (with $n = 2$) is just equal to the profit level associated with the case of monopoly, in which $n = 1$. Similarly, we can show by successive pair-wise comparisons of (19), (20) and (21) that

$$\pi_{i|n=3} > \pi_{i|n=2} \text{ if and only if } \delta > \hat{\delta}_3 = \frac{6}{7}, \tag{23}$$

and that

$$\pi_{i|n=4} > \pi_{i|n=3} \text{ if and only if } \delta > \hat{\delta}_4 = \frac{12}{13}. \tag{24}$$

Indeed, it can be demonstrated that the critical level of δ is always less than one: implying that for sufficiently high δ, an increase in n always leads to an increase in firm profits. We can show this by evaluating (17) at the value of $n = N$ and at the value of $n = N + 1$ and comparing. It is straightforward to show that the value of the individual firm's profits when $n = N + 1$ exceeds profits when $n = N$ if and only if

$$\delta > \hat{\delta}_{N+1} = \frac{N(N+1)}{N(N+1)+1}, \tag{25}$$

where $\hat{\delta}_{N+1}$ is strictly less than unity $\forall\ N$. In reality, however, δ is unlikely ever to be sufficiently high that firm profits increase in n over and above the values considered explicitly in conditions (22) through (24). The implication of this is that profits-per-firm will be maximised when the oligopolistic industry consists of only a small number of firms. The novelty of our result is that this number is not necessarily equal to one.

Figure 1: Profits-per-firm against $\delta = \alpha\beta$, for selected n

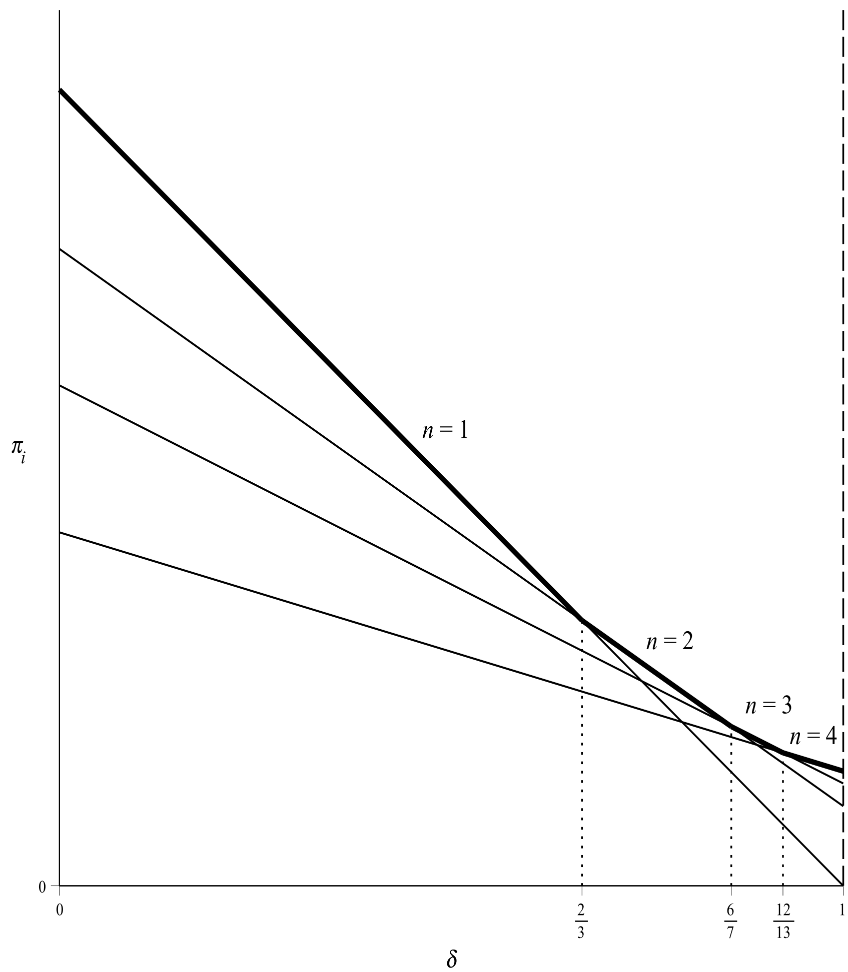
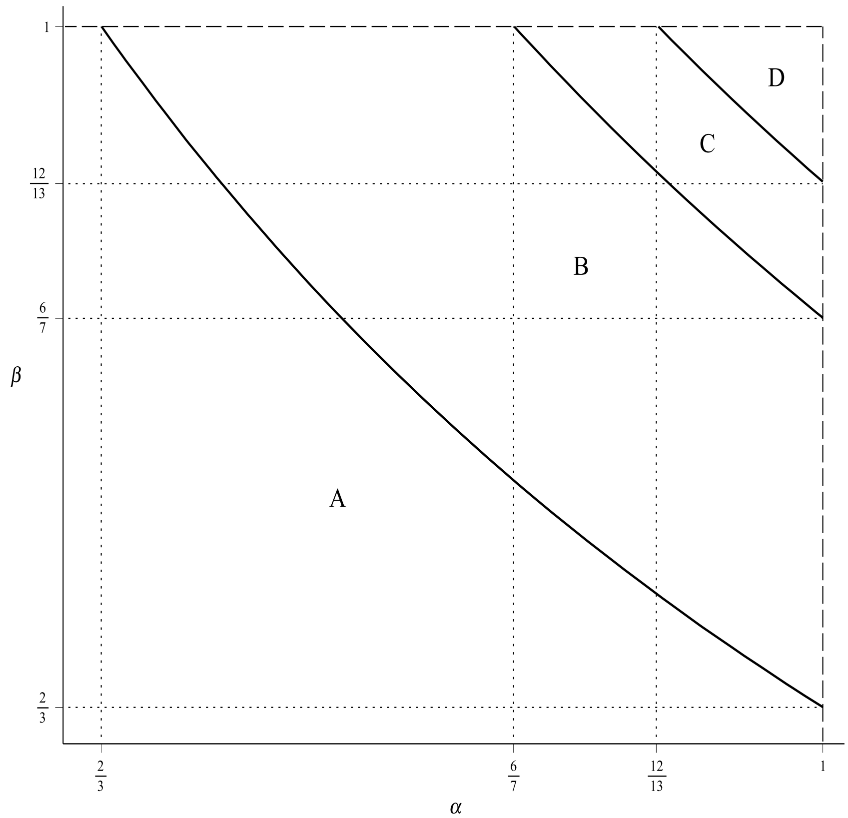


Figure 1 plots (18) through (21) in (π_i, δ)-space and uses (22) through (24) to demonstrate the critical values of δ at which the maximal values of profits-per-firm shift with the number of firms. Consider now Figure 2 which represents (22) through (24) in (α, β)-space to depict the combinations of α and β which produce iso-profit contours for successive increments in the value of n. In Region A, for example, all combinations of α and β lie below the iso-profit schedule which satisfies (18) and (19) simultaneously. In this region, then, a monopolist's profits always dominate the profits-per-firm associated with any alternative value of n, $n > 1$. Conversely, in Region B, each firm in a duopoly market earns profits which exceed those of the monopolist. Finally, Region C represents combinations of α and β such that profits-per-firm are maximised when there are three firms competing in the Cournot oligopoly, and Region D when there are four or more firms.

Figure 2: Iso-profits curves for successive increments in n



What is the intuition for our result that profits-per-firm increase in the number of firms in the market if $\delta = \alpha\beta$ is sufficiently high and n sufficiently low? In the standard oligopoly model, an increase in the number of firms unambiguously reduces profits-per-firm through increased product market competition which reduces product price. We can see this mechanism working in the model of bilateral oligopoly developed in this paper. We substitute (4) in (1) and solve for the equilibrium price. This gives:

$$p = \frac{1}{n+1}(a + nw), \tag{26}$$

where w is given by (12). From (26), it follows that

$$\frac{dp}{dn} = \frac{n}{n+1}\frac{dw}{dn} - \left[\frac{a-w}{(n+1)^2}\right]. \tag{27}$$

Assuming that $\frac{dw}{dn} \leq 0$, as we demonstrate below, it follows from (27) that $\frac{dp}{dn}$ must be negative: an increase in n leads to a fall in product price.

In addition to the profit-reducing effect of the fall in product price, however, the increase in the number of firms competing in the market also induces unions to moderate their wage demands. We can see the result simply by differentiating (12) with respect to n, which yields

$$\frac{dw}{dn} = -\frac{\delta(1-\delta)}{[\delta + n(1-\delta)]^2}(a - \overline{w}) \leq 0. \tag{28}$$

Furthermore, this wage moderation effect captured in (28) is increasing in the product $\delta = \alpha\beta$. It is readily shown from (28) that $\frac{d^2w}{dnd\delta} < 0$. At one extreme, for example if $\alpha\beta = 0$, then there is no wage moderation effect associated with an increase in the number of firms: that is, there can be no wage moderation effect if unions exert no influence on the wage, as is implied by $\alpha\beta = 0$.

Thus, the presence of unions with influence over wages induces a (profit-enhancing) wage moderation effect to accompany the (profit-damaging) price-reducing effect of an increase in n. Which effect dominates depends both on the product $\alpha\beta$ – as shown in (28) – and on the size of n itself. To see this, consider (27) once more. As n becomes very large, the fraction $\frac{n}{n+1}$ tends to one, implying that $\frac{dp}{dn}$ tends to equal $\frac{dw}{dn}$ minus the diminishing but positive term in square brackets. Hence, for sufficiently large n the absolute size of the price effect dominates that of the wage effect. For small enough n, however, the fraction $\frac{n}{n+1}$ in (27) is sufficiently less than one that $\frac{dw}{dn}$ exceeds $\frac{dp}{dn}$ and the wage moderation effect dominates, causing an increase in n to raise profits-per-firm for sufficiently high values of α and β.

3.1 Entry deterrence incentives

Following Williamson (1968), unions have been characterised as a potential instrument with which incumbent firms can deter further market entry. In the standard Cournot oligopoly model, with profits-per-firm unambiguously decreasing in the number of firms in the market, there is an unambiguous incentive for firms to attempt to restrict entry. This was the explicit focus of the analysis of Seade (1980a) in establishing the nature of the relationship between the number of firms and profits-per-firm in the standard Cournot oligopoly model. But in the unionised bilateral oligopoly framework we have developed in the current paper, the very presence of unions with influence over wages leads to the possibility that, at least for small n, profits-per-firm increase with n. Thus, if (decentralised) unions have sufficient influence over wages, a single-firm monopolist might have incentives to encourage rather than to deter entry by one or more firms. If this were the case, a potential monopolist might accommodate that number of Cournot rivals which maximise profits per firm. Alternatively, the presence of influential unions might induce an incumbent monopolist toward a multi-divisional structure with distinct plants operating *as if* in competition with one another.

In the current paper, we analyse the effects of entry in the presence of labour unions following the standard assumption that firms are identical. As Seade (1980a) observes, with a non-homogeneous industry, entry cannot be interpreted simply as an increase in firm numbers: it becomes necessary to model the nature of the marginal firm and its entry/exit decision. In the next section, we model one type of industry non-homogeneity, one that gives an incumbent firm a first-mover advantage in the industry.

4 Firm profits with a Stackelberg leader

Thus far we have studied the effects of entry when all firms compete à la Cournot, without consideration of any structural advantages due to incumbency. In this section, we examine how the Stackelberg first-mover advantage of an incumbent firm affects the basic results in the previous section. This analysis is somewhat more complicated due to the asymmetric nature of the game played by, on the one hand, the Stackelberg leader and its union, and on the other, that of the follower firms and their unions. In equilibrium, unlike in the Cournot case, labour costs will differ across bargaining pairs in a way which depends on the firms' order of moves. Denote by x_l the output of the Stackelberg leader, by x_k the output of follower $k = 1, .., m$, and by $X_{-l} = \sum_{k=1}^{m} x_k$ the aggregate output of the m followers, which are assumed to be identical to each other. Profits of the leader and that of a typical follower, respectively, can be written as:

$$\pi_l = [a - bX - w_l]\, x_l \quad \text{and} \quad \pi_k = [a - bX - w_k]\, x_k, \tag{29}$$

where $X = x_l + X_{-l}$ denotes the aggregate output of all firms. The game now has the following stages: in the first, each firm independently bargains over its wage with a local labour union; in the second, the Stackelberg leader decides how much to produce; and in the final stage, m Stackelberg followers make their output decisions. The Stone-Geary utility functions representing the preferences of the union in the Stackelberg firm, and that representing workers in all of the m symmetric followers, respectively, are:

$$U_l = [w_l - \overline{w}]^{2\alpha} x_l^{2(1-\alpha)} \quad \text{and} \quad U_k = [w_k - \overline{w}]^{2\alpha} x_k^{2(1-\alpha)} \quad \forall \quad k. \tag{30}$$

The maximands for the two types of firms, respectively, are:

$$B_l = U_l^{\beta} \pi_l^{1-\beta} \quad \text{and} \quad B_k = U_k^{\beta} \pi_k^{1-\beta} \quad \forall \quad k. \tag{31}$$

Since the solution procedure for this game is similar to the Cournot game described in the previous section, we restrict the formal derivation to Appendix A, where we show that the output produced by the Stackelberg leader with m followers is:

$$x_l = \frac{(1-\delta)(\delta + 2m + 1)}{b\{2m + 1 + \delta[1 - m(1+\delta)]\}}(a - \overline{w}). \tag{32}$$

The expression for the leader's profits can also be solved as:

$$\pi_l = \frac{1}{(m+1)4b} \frac{(1-\delta)^2(\delta + 2m + 1)^2}{\{2m + 1 + \delta[1 - m(1+\delta)]\}^2}(a - \overline{w})^2. \tag{33}$$

We note that evaluating (33) for different values of m would give us the critical values of δ which are the counterparts of the expressions derived in (18)-(21) for the Cournot case.

We now investigate how entry affects the profits of the Stackelberg leader. Denote by $\pi_l(M)$ the Stackelberg leader's profits when there are M followers, and by $\Delta_M \pi_l$ the difference between the leader's profits with M followers and its monopoly rents, $\Delta_M \pi_l = \pi_l(M) - \pi_l(0)$. Using (33) we obtain:

$$\Delta_M \pi_l = \pi_l(M) - \pi_l(0) = \frac{(1-\delta)^2(a-\overline{w})^2}{4b(M+1)} \left[\frac{[\delta + 2M + 1]^2 - (M+1)\left[2M + 1 + \delta[1 - M(1+\delta)]\right]^2}{\left[2M + 1 + \delta[1 - M(1+\delta)]\right]^2} \right]. \quad (34)$$

Similarly, denote by $\Delta_{N+1}\pi$ the difference between a Cournot firm's profits with N competitors in the market and its monopoly profits. We can write the expression for $\Delta_{N+1}\pi$ using (17):[6]

$$\Delta_{N+1}\pi = \pi(N+1) - \pi(0) = \frac{(1-\delta)^2(a-\overline{w})^2}{4b} \left[\frac{4(N+1)^2 - (N+2)^2[\delta + (N+1)(1-\delta)]^2}{(N+2)^2[\delta + (N+1)(1-\delta)]^2} \right]. \quad (35)$$

Proposition 2 concerns the relative magnitudes of $\Delta_M \pi_l$ and $\Delta_{N+1}\pi$:

Proposition 2. *The marginal increase in the profits of an incumbent monopolist is greater if, post entry, the firm is able to act as a Stackelberg leader rather than as one of a number of Cournot oligopolists: $\Delta_M \pi_l > \Delta_{N+1}\pi$. It follows that the range of δ for which profits per firm increase with entry is greater under Stackelberg competition. Hence, entry is more likely in environments favourable to Stackelberg leadership.*

Proof. See Appendix B □

The extent to which the Stackelberg leader benefits at the margin from entry exceeds the equivalent marginal benefit accruing to firms under Cournot competition. There are two mechanisms at work. First, the Stackelberg leader's response to entry is always more aggressive at the margin relative to the equivalent Cournot firm for all values of δ. In other words, the Stackelberg leader always increases output by an amount greater than an incumbent firm competing á la Cournot. The latter increases output in response to entry only for values of δ where profits-per-firm are increasing in entry, but it never increases output by an amount greater than a Stackelberg firm. The aggressive output response on the part of the Stackelberg leader is particularly beneficial for high values of δ where the competition-induced benefits from wage moderation dominate the price reducing effects, and hence, through this channel a Stackelberg firm captures a greater share of the net benefits from entry. Second, since the Stackelberg leader is the largest employer in its market, it will also exert a greater downward pressure on its bargained wage, thereby increasing its net gain relative to a Cournot firm. These effects are formally established in Proposition 3:

Proposition 3. *A firm with a first-mover advantage responds more aggressively to entry than a firm competing á la Cournot through its output choice. Moreover, the Stackelberg firm exerts greater downward pressures on its negotiated wage for high values of δ.*

Proof. See Appendix C □

[6] Note that $m = 0$ describes the case of monopoly, a leader with no followers, which corresponds to the case of $n = 1$ in Section 3 on Cournot oligopoly. Similarly, $m = 1$ corresponds to $n = 2$ etc.

5 Firms as upstream agents

Suppose that the upstream agent is not a utility-maximising trade union but is a profit-maximising firm with the objective function

$$\pi_{Ui} = (w_i - \overline{w})x_i, \tag{36}$$

where $\overline{w}$ represents the upstream firm's fixed input price and w_i now denotes the price of the intermediate product sold by upstream firms to their downstream firm pair. Bargaining is still assumed to be locally decentralised with an equal number of upstream and downstream agents.[7] Then the firm-firm Nash bargain over the intermediate product price solves

$$B_i^F = \pi_{Ui}^{\beta}\pi_i^{1-\beta}. \tag{37}$$

Formally, this problem is equivalent to that described in equations (10) through (14) above, with the implicit value of α set at one-half. Hence, even in the extreme case in which upstream firms have all the bargaining power, so that $\beta = 1$, the implicit value of the product $\delta = \alpha\beta$ is never greater than one-half. Hence, it is always less than the critical value, $\hat{\delta}_2$, above which profits-per-duopolist exceed those of a monopolist. Proposition 3 follows.

Proposition 4. *Profits-per-firm in the downstream industry are never higher than in the case of monopoly when upstream and downstream agents are both characterised as profit-maximising firms.*

Proof. From condition (22) – see also the graphic representations in Figures 1 and 2 – it follows that the critical threshold value of $\hat{\delta}_2$, exceeds the maximum of δ associated with the case in which upstream agents are profit-maximising firms. □

6 Centralisation of wage bargaining

In the basic union-firm model outlined in Section 3, we assumed explicitly that wage bargaining occurs at the decentralised level of the individual union-firm pair. The extent to which wage bargaining is decentralised or is centralised at either the industry or economy-wide level varies across countries and over time. The classic macroeconomic work of Calmfors et al. (1988) has exploited variation across countries in the level at which wage bargaining takes place in order to infer the nature of a relationship between the level of centralisation and a country's macroeconomic performance. It has been argued that industry-level wage bargaining produces the worst possible outcome because it fails to internalise potential adverse externalities

[7]This assumption is more plausible in the union-firm case where the existence of the union can be thought of as arising as an institutional response to the existence of the firm. A similar story to explain a one-to-one matching between the number of upstream and downstream agents in the case of firm-firm bargaining is less convincing

associated with union-firm wage bargaining. In contrast, it is argued that both fully decentralised bargaining and fully centralised bargaining force bargaining agents to internalise wage externalities and hence yield efficient outcomes. Consider the basic Cournot model of Section 3, but incorporating the assumption that all unions and firms negotiate jointly over the level of wages. Then the Nash maximand defined in (9) becomes

$$B^C = \left(\sum U\right)^{\beta} \left(\sum \pi\right)^{1-\beta}, \tag{38}$$

where $\sum \pi$ is the sum of the individual firms' profits - given by (6) - and $\sum U$ is the sum over the unions' utility functions - given by (8). In the Nash maximand, it is assumed that all bargained wages will be equal: thus, $w_i = w$ by assumption. Substituting this and the sum over (4), (6)) and (8) in (38) yields the Nash centralised wage-bargaining maximand:

$$B^C = \frac{n}{(n+1)^{2(1-\alpha\beta)} b^{1+\beta-2\alpha\beta}} [w - \overline{w}]^{2\alpha\beta} [a - w]^{2(1-\alpha\beta)}. \tag{39}$$

The first order condition derived from the centralised-bargaining Nash maximand is then

$$\frac{\partial B^C}{\partial w} = \frac{2n[w - \overline{w}]^{2\alpha\beta}[a - w]^{1-2\alpha\beta}}{(n+1)^{2(1-\alpha\beta)} b^{1+\beta-2\alpha\beta}} \times \left[\alpha\beta \left[\frac{a - w}{w - \overline{w}}\right] - (1 - \alpha\beta)\right]. \tag{40}$$

Setting this first order condition equal to zero and solving for w yields:

$$w = w_i = \overline{w} + \alpha\beta(a - \overline{w}). \tag{41}$$

This establishes Proposition 5.

Proposition 5. *Under centralised bargaining, the wage is independent of n, the number of firms in the industry.*

It follows from Proposition 5 that in the case of centralised bargaining, there is no wage moderation effect associated with an increase in n. This lies behind Calmfors et al. (1988) and related analyses (see also Moene et al., 1993) . It also follows from (41) that with perfect competition and decentralised bargaining, unions have no effect on wages: all wage externality effects are internalised. To see this within our model, let n become very large: then the bargained wage given by (12) tends to the competitive non-union level, w. With centralised (industry-level) bargaining, in contrast, even with large n, the wage will be set above the competitive level, as shown in (41). Under decentralised bargaining, a wage externality arises only with the introduction of imperfect competition, represented by a falling and finite value of n. Increasing n is associated with increasingly internalising the negative wage externality: which is just an alternative interpretation of what we have previously referred to as the wage moderation effect of increasing the number of firms in competition.

7 Conclusions

In this paper, we have developed a simple model of a unionised oligopoly in order to demonstrate that the standard cornerstone Cournot result that profits-per-firm are falling in the number of firms in the product market is not necessarily valid when firms' input prices are determined endogenously through bargaining with upstream agents (labour unions). We have shown that if wage bargaining is decentralised (that is, firm-specific), then profits-per-firm will increase with the number of competing firms if unions care sufficiently about wages, relative to employment, and possess sufficient bargaining power. One corollary of this result is that if unions do possess sufficient influence over wages, it is no longer clear that incumbent firms will have an incentive to deter market entry. Wage bargaining in the model is interpreted as firm-specific bargaining with labour unions. To the extent that non-union labour also possesses bargaining power, the model is likely to be of wider significance.

The intuition for our result is that when wages are determined endogenously through bargaining, an expansion in the number of firms has a wage moderation effect which offsets the detrimental effect on firm profits associated with competitive reductions in product price. The more workers care about wages and the more powerful they are in bargaining, the greater is this wage moderation effect. We have shown that the conditions necessary for unions (as the upstream agent) to have the (unintended) effect of translating an increase in firm numbers into an increase in firm profits are not satisfied when the upstream agents are profit-maximising firms. We have also shown that the result holds only if union-firm bargaining is decentralised. Under centralised (industry-wide) bargaining, there is no wage moderation effect associated with an increase in the number of firms: this is because the bargained wage is independent of firm numbers under industry bargaining. Finally, we have looked beyond the Cournot case to a setting in which an incumbent monopolist becomes a Stackelberg leader in the event of entry. We find that such a firm is more likely to gain from entry than a firm which anticipates facing Cournot competition post entry.

Appendix A

As usual, the Stackelberg game is solved backwards so we begin by determining the output of the followers. Maximising the profits of follower k in (29) yields:

$$x_k = \frac{1}{2b}\left[a - w_k - b\sum_{\substack{j=1\\ j\neq k}}^{m} x_j - bx_l\right]. \tag{42}$$

Solving these m reaction functions for x_k and X_{-l} yields:

$$x_k = \frac{1}{(m+1)b}\left[a - mw_k + \sum_{\substack{j=1 \\ j \neq k}}^{m} w_j - bx_l\right]; \tag{43}$$

$$X_{-l} = \frac{1}{(m+1)b}\left[ma - \sum_{k=1}^{m} w_k - mbx_l\right]. \tag{44}$$

The output of the Stackelberg leader can now be found by maximising its profits in (29) using (44). This yields:

$$x_l = \frac{1}{2b}\left[a - w_l(m+1) + \sum_{k=1}^{m} w_k\right]. \tag{45}$$

Substituting (45) back into (43) and (44) yields the following expression for output of follower k and aggregate output of all followers:

$$x_k = \frac{1}{(m+1)2b}\left[a - (2m+1)w_k + (m+1)w_l + \sum_{\substack{j=1 \\ j \neq k}}^{m} w_j\right]; \tag{46}$$

$$X_{-l} = \frac{1}{(m+1)2b}\left[ma - (m+2)\sum_{k=1}^{m} w_k + n(m+1)w_l\right]. \tag{47}$$

Now substituting (45) and (47) into (1) gives an expression for the common equilibrium price:

$$p = \frac{1}{2(m+1)}\left[a + (m+1)w_l + \sum_{k=1}^{m} w_k\right]. \tag{48}$$

Using this expression for the price we can derive profits of the Stackelberg leader and a follower, respectively, as:

$$\pi_l = \frac{1}{(m+1)4b}\left[a - (m+1)w_l + \sum_{k=1}^{m} w_k\right]^2; \tag{49}$$

$$\pi_i = \frac{1}{(m+1)^2 4b}\left[a - (2m+1)w_k + (m+1)w_l + \sum_{\substack{j=1 \\ j \neq k}}^{m} w_j\right]^2. \tag{50}$$

The bargained wage rate for a particular firm is derived from the labour market game described in the previous section. To solve for the wage of the leader and a typical follower, respectively, we substitute (45) and (46) into the expressions for U_l and U_k in (30), and then substitute the resulting expressions into the maximands in (31). This yields, respectively,

$$B_l = \frac{1}{b^{1+\beta-2\alpha\beta} 2^{2\beta(1-\alpha)} [4(m+1)]^{1-\beta}} [w_l - \overline{w}]^{2\alpha\beta} \times \left[a - w_l(m+1) + \sum_{k=1}^{m} w_k\right]^{2(1-\alpha\beta)}, \tag{51}$$

and,

$$B_i = \frac{1}{b^{1+\beta-2\alpha\beta}(m+1)^{2(1-\alpha\beta)}2^{2\beta(1-\alpha)}4^{1-\beta}}[w_l - \overline{w}]^{2\alpha\beta} \times \left[a - (2m+1)w_k + (m+1)w_l + \sum_{\substack{j=1 \\ j\neq k}}^{m} w_j\right]^{2(1-\alpha\beta)}. \tag{52}$$

Maximising (51) and (52) with respect to w_l and w_k yields the expression for wages of a leader and a follower, respectively:

$$w_l = \frac{a\delta[2m+1+\delta] + \{(2m+1)(m+1) - \delta[\delta + m(m+2+\delta(m+1))]\}\,\overline{w}}{(2m+1)(m+1) + \delta[1 - m(m+\delta+m\delta)]}, \tag{53}$$

$$w_k = \frac{a\delta(1+\delta) + \{2m+1-\delta[\delta+m(1+\delta)]\}\,\overline{w}}{2m+1+\delta[1-\delta(m+1)]}, \tag{54}$$

where symmetry of followers, $k = 1, .., m$ has been imposed. Equilibrium output and profit for the Stackelberg leader, respectively, can now be obtained by substituting (54) into (45) and (49). This yields the expressions in (32) and (33).

Appendix B

Proof of Proposition 2. Subtracting (34) from (35) for $M = N$:

$$\Delta_M \pi_l - \Delta_{N+1}\pi = \frac{N^2(1-\delta)^2(a-\overline{w})^2}{4b(N+1)(N+2)^2\,[2N+1+\delta[1-N(1+\delta)]]^2\,[N(1-\delta)+1]^2} \times \{4N^4(1-\delta)^2 + 4N^3(1-\delta)\left(3+\delta^2(2+\delta)-4\delta\right) + N^2\left(13-11\delta^4+40\delta-42\delta^2\right) + 2N\left(7\delta^3-4\delta^4+11\delta^2-13\delta+3\right) + (\delta+1)\left(8\delta^2-7\delta+1\right)\}. \tag{55}$$

This expression is non-negative if and only if the term in $\{\cdot\}$ is non-negative. The first three terms in the expression are non-negative, whereas the last two can be positive or negative. Evaluating $\{\cdot\}$ at $N = 1$ yields:

$$32 - 2\delta - 13\delta^2 - 15\delta^4 + 4\delta^3 > 0. \tag{56}$$

It is easy to see from (55) that the expression in $\{\cdot\}$ is increasing in N. Hence, $\Delta_M\pi_l \geq \Delta_{N+1}\pi$. Proposition 2 also claims that the range of δ for which the Stackelberg firm gains from the entry of M followers is larger than for the equivalent Cournot firm facing N competitors. This claim follows from the fact that the Stackelberg firm's profit gain (loss) from entry is greater (smaller). □

Appendix C

Proof of Proposition 3. Evaluating (32) at $m = M =$ and $M = 0$ yields:

$$q_l(M) - q_l(0) = \Delta_M q_l = \frac{M\delta(1-\delta)(1+\delta)(a-\overline{w})}{2b\left[2M+1+\delta[1-N(1+\delta)]\right]}. \tag{57}$$

Similarly, evaluating (13) at $n = N+1$ and $n = 0$ yields:

$$q(N+1) - q(0) = \Delta_N q = \frac{N(1-\delta)(a-\overline{w})\left[\delta(N+2)-(N+1)\right]}{2b(N+2)(N(1-\delta)+1)}. \tag{58}$$

Subtracting (57) from (58) for $M = N$:

$$\Delta_M q_l - \Delta_N q = \frac{N(1-\delta)(a-\overline{w})\left[3N+1+\delta+\delta^2 N-2N\delta(N+1)\right]}{2b(N+2)(2N+1+\delta[1-N(1+\delta)])(N(1-\delta)+1)} \geq 0, \tag{59}$$

which is clearly non-negative. This proves the first part of the proposition.

Evaluating (54) at $M = 1$ and $M = 0$ yields:

$$w_l(M) - w_l(0) = \Delta_M w_l = -\frac{M\delta(1-\delta)[(1+\delta)(M+1)+M](a-\overline{w})}{(M+1)[2M+1+\delta(1-M(1+\delta))]}. \tag{60}$$

Similarly, evaluating (12) at $n = N+1$ and $n = 0$ yields:

$$w(M) - w(0) = \Delta_M w = -\frac{N\delta(1-\delta)(a-\overline{w})}{N(1-\delta)+1}. \tag{61}$$

Subtracting (60) from (61) for $M = N$:

$$\Delta_M w_l - \Delta_N w = -\frac{(N\delta)^2(1-\delta)(a-\overline{w})}{(N+1)[2N+1+\delta(1-N(1+\delta))][N(1-\delta)+1]} \leq 0, \tag{62}$$

which is unambiguously non-positive. This proves the second part of the proposition. □

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