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**Abstract:** Although empirical evidence shows that higher product market competition increases unionized wage, the theoretical literature did not pay much attention to this aspect. We show that the positive relation between product market competition and unionized wage may occur in the presence of external economies of scale. In this respect, the labor productivity and the effects of the external economies of scale may play important roles.

**Key Words:** Competition; External economics of scale; Unionized wage

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# Product market competition, external economies of scale and unionized wage

## 1. Introduction

What is the effect of product market competition on unionized wage? In an influential paper, Dowrick (1989) shows that more firms in an industry reduces unionized wage in the presence of decentralized or firm-specific union-firm bargaining. Even if the theoretical work of Dowrick (1989) shows a negative relation between product market competition and unionized wage, the empirical evidence on this issue is mixed. Many studies on the US have found that decreased product market competition reduces unionized wage (Bloch and Kuskin, 1978 and Freeman and Medoff, 1981). Abowd and Tracy (1989) show that the relation between four firm concentration of sales and the unionized wage is positive at low levels of concentration, but the relation is negative at high levels of concentration. Bratsberg and Ragan (2002) show that the effect of deregulation on the union wage premium vary considerably across industries. Stewart (1983), Macpherson and Stewart (1990) and Van Reenen (1996) show mixed evidences on the UK industry.

Inspired by the empirical evidences, Bastos et al. (2010) provide open-shop union, where the union density is less than one, as a reason for the positive relation between product market competition and unionized wage. Considering a move from monopoly to duopoly, they show that the unionized wage is higher under the latter product market structure compared to the former if the union density is positive but very low. Thus, they conclude that the previous theoretical result showing a negative relation between competition and unionized wage is due to the assumption that union density is one, i.e., all workers are union members.

We show in this paper that, if there are external economies of scale, the relation between competition and unionized wage may either increase or decrease even if the union density is one. In this respect, the labor productivity and the effects of the external economies of scale may play important roles. Thus, we provide a *new* reason for the positive relation between competition and unionized wage, and suggest that open-shop union is not a necessary condition for creating the positive relation between higher competition and unionized wage.

External economies of scale create a negative relation between the number of firms and a firm's cost of production by affecting labor productivity. Hence, as competition increases, on the one hand, it tends to reduce the unionized wage by reducing the labor demand, but, on the other hand, it tends to increase the unionized wage by increasing labor productivity. As the effects of the external economies of scale increase, it strengthens the latter effect, thus increasing the possibility of a higher unionized wage following higher product market competition.

The consideration of external economies of scale has clear empirical relevance. Caballero and Lyons (1990) show the evidence of external economies of scale in the manufacturing industries of Belgium, France, the UK and former West Germany. Their study suggests that external economies of scale are more prominent than internal economies of scale. Broadberry and Marrison (2002) show the evidence of external economies of scale in the UK cotton industry. The presence of externalities created by external economies of scale is also acknowledged by Choi and Yu (2002), Grossman and Rossi-Hansberg (2010) and several references therein.[1]

The remainder of the paper is organized as follows. Section 2 describes the model and shows the results. Section 3 concludes.

[1] See, Mukherjee (2010) for a recent theoretical work showing the welfare effects of entry in the presence of external economies of scale.

## 2. The model and the results

Assume that there are $n$ unionized firms in an industry competing like Cournot oligopolists with homogeneous products. For simplicity, all firms require only labor for production. Assume that each firm requires $\lambda$ workers to produce one unit of the output. Hence, $\frac{1}{\lambda}$ is the labor productivity. However, there are external economies of scale. As the number of firm increases, it reduces each firm's labor requirement. We consider that $\lambda = \lambda(n)$ with $\frac{\partial \lambda}{\partial n} \equiv \lambda' < 0$ and $\frac{\partial^2 \lambda}{\partial n^2} \equiv \lambda'' > 0$. Hence, in increases in $n$ reduces the labor requirement at a decreasing rate. Although we feel that $\lambda'' > 0$ is a reasonable assumption, it is not necessary for our results, but it helps to show our results in the simplest way.

We assume that wages are determined by bargaining between the firms and the firm-specific unions. We consider the right-to-manage model of labor union, as in Bughin and Vannini (1995), Vannini and Bughin (2000), López and Naylor (2004), Mukherjee (2008) and Bastos et al. (2010), to name a few, where the union-firm bargaining determines wage and the firms hire workers according to their requirements.[2] We assume for simplicity that the reservation wages of the workers are zero. Further, all workers are union members. Thus, we eliminate the effects of the open-shop unions, as shown in Bastos et al. (2010).

We consider the following game. Given the number of firms, at stage 1, firms and unions bargain over wages. At stage 2, the firms hire workers according to their need and produce like Cournot oligopolists. We solve the game through backward induction.

[2] See, Layard et al. (1991) for arguments in favor of the right-to-manage models.

We assume that the inverse market demand function is $P = a - q$, where $P$ is price and $q$ is the total output.

Given the wage, $w_i$, for firm $i$, $i = 1, 2..., n$ the $i$th firm maximizes the following expression to determine its output:

$$\underset{q_i}{Max}(a - q - \lambda w_i)q_i \,. \tag{1}$$

The equilibrium output of the $i$th firm is

$$q_i = \frac{a - n\lambda w_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} \lambda w_j}{n+1} \,. \tag{2}$$

Now we are in position to determine the unionized wage. We assume that the union utility is

$$U_i = w_i^{\theta}(\lambda q_i)^{(1-\theta)} = w_i^{\theta}\left(\frac{\lambda(a - n\lambda w_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} \lambda w_j)}{n+1}\right)^{(1-\theta)} \,, \tag{3}$$

where $\theta$ (resp. $(1-\theta)$) shows the union's preference over wage, $w_i$ (resp. employment, $\lambda q_i$). As $\theta$ reduces, it increases the union's preference for employment. If $\theta = 0$, the union cares about employment only, and it approximates the situation where the union acts as a price taker in a competitive labor market. If $\theta = 0.5$, the union is like a rent maximizing union. Although, in principle, we can consider $\theta \in [0,1]$, it seems more responsible to consider that unions pay more attention to employment than wage. Hence, we restrict our attention to $\theta \in [0, 0.5]$.

The $i$th union bargains with the $i$th firm to determine $w_i$, $i = 1, 2, \ldots, n$. We assume that bargaining powers of all unions are $\beta$ and that of all firms are $(1-\beta)$. If $\beta = 1$, the union has full bargaining power. However, if $\beta = 0$, the firm has the full bargaining power, and this situation creates the outcome similar to the competitive labor market. We consider $\beta \in [0,1]$. Therefore, $w_i$ is determined by maximizing the following expression:

$$\underset{w_i}{Max}\left(U_i - \overline{U_i}\right)^{\beta} (\pi_i - \overline{\pi_i})^{1-\beta}, \tag{4}$$

In the case of disagreement, the utilities of the unions and the profits of the firms are zero. Since all workers are union members, there is no production in the *i*th firm in the case of disagreement, thus creating $\overline{U_i} = \overline{\pi_i} = 0$.

Due to the symmetry of the firms and the unions, we get that the equilibrium wage maximizing (4) with $\overline{U_i} = \overline{\pi_i} = 0$ as

$$w_i^* = \frac{a\beta\theta}{\lambda[n(2-\beta-\beta\theta)+\beta\theta]}. \tag{5}$$

It follows from (5) that if $\lambda$ does not depend on *n*, an increase in *n* reduces the equilibrium unionized wage, since $(2-\beta-\beta\theta) > 0$ for $\theta \in [0, 0.5]$ and $\beta \in [0,1]$. This is in line with the existing works suggesting that higher competition reduces the unionized wage in the case of firm specific unions if the union density is one. However, if $\lambda$ falls with higher *n*, it creates a counter force, and tends to increase the equilibrium unionized wage. Therefore, the net effect of an increase in *n* on the equilibrium unionized wage depends on the strengths of the two opposing effects.

Straightforward calculation from (5) gives that $\frac{\partial w_i^*}{\partial n} \gtreqless 0$ if

$$-\lambda' \gtreqless \frac{\lambda(2-\beta-\theta\beta)}{n(2-\beta)+\beta\theta(1-\beta)}. \tag{6}$$

Since the second order condition for maximizing (4) implies $n(2-\beta)+\beta\theta(1-\beta) > 0$, left hand side (LHS) and right hand side (RHS) of (6) are positive.

Condition (6) suggests that if the effects of external economies of scale are sufficiently strong (i.e., $\lambda' < 0$ and sufficiently high), higher competition increases the unionized wage. Since RHS of (6) is negatively related to both $\theta$ and $\beta$, it suggests that higher values of $\theta$ (i.e., unions' higher preference for wage) and higher values of $\beta$ (i.e., higher bargaining power of the unions) increase the possibility of higher unionized wage following higher competition.

Re-writing (6), we get that $\frac{\partial w_i^*}{\partial n} \underset{<}{\geq} 0$ if

$$n \underset{<}{\geq} \frac{\lambda(2-\beta-\beta\theta)}{-(2-\beta)\lambda'} - \frac{(1-\beta)\beta\theta}{(2-\beta)} \equiv Z(n). \tag{7}$$

It follows from (7) that the relation between the LHS of (7) and RHS of (7) depends on the factors such as the effects of the external economies of scale (i.e., $\lambda'$), the labor coefficient (i.e., $\lambda$), the unions' preference for wage and employment (i.e., $\theta$) and the unions' bargaining power (i.e., $\beta$). We will show in the following analysis that LHS of (7) can be higher or lower than RHS of (7). However, whether the former is higher than the latter for higher or lower values of $n$ is not immediate.

Straightforward calculation shows that $\frac{\partial Z(n)}{\partial n} = \frac{(2-\beta-\beta\theta)(2-\beta)\left[-\left(\lambda'\right)^2 + \lambda\lambda''\right]}{\left[-(2-\beta)\lambda'\right]^2} > 0$. However, $\frac{\partial Z(n)}{\partial n} \underset{>}{\leq} 1$ if $\frac{(2-\beta-\beta\theta)\left[-\left(\lambda'\right)^2 + \lambda\lambda''\right]}{(2-\beta)\left(\lambda'\right)^2} \underset{>}{\leq} 1$. Since $\frac{2-\beta-\beta\theta}{2-\beta} < 1$, a sufficient condition for $\frac{\partial Z(n)}{\partial n} < 1$ is $\lambda\lambda'' < 2\left(\lambda'\right)^2$, i.e., if the effects of external economies of scale are strong (i.e., $\lambda'$ is high), the labor coefficients are small (i.e., $\lambda$ is small) and the effect of $n$

on the effects of external economies of scale is small (i.e., $\lambda''$ is small). However, $\frac{\partial Z(n)}{\partial n} > 1$ *only if* $\lambda\lambda'' > 2(\lambda')^2$.

To show our point in the easiest way, we will consider two separate cases in the following analysis: (i) where $\frac{\partial Z(n)}{\partial n} < 1$ for $n > 1$, and (ii) where $\frac{\partial Z(n)}{\partial n} > 1$ for $n > 1$. We acknowledge that the function $\lambda = \lambda(n)$ may be such that $\frac{\partial Z(n)}{\partial n} \lesseqgtr 1$ depending on *n*. Since this complication will not add much new insight to our analysis, we ignore this complication.

### *2.1. The case of* $\frac{\partial Z(n)}{\partial n} < 1$

First, consider the case of $\frac{\partial Z(n)}{\partial n} < 1$. We draw LHS of (7) and RHS of (7) in Figures 1 and 2. While Figure 1 considers the case of $Z|_{n=1} > 1$, Figure 2 considers the case of $Z|_{n=1} < 1$. In both the diagrams, we consider $\frac{\partial Z(n)}{\partial n} < 1$ for $n > 1$, which can occur, as shown in the examples below, and for simplicity, we draw RHS of (7) as a straight line.

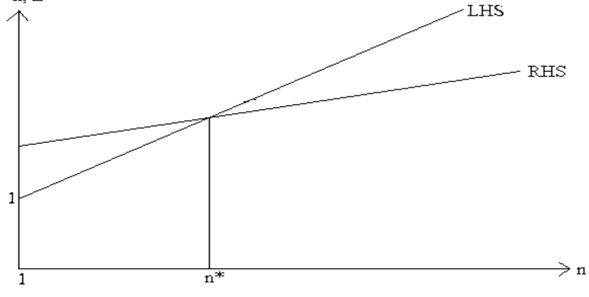


Figure 1: Condition (7) for $\frac{\partial Z(n)}{\partial n} < 1$ and $Z|_{n=1} > 1$.

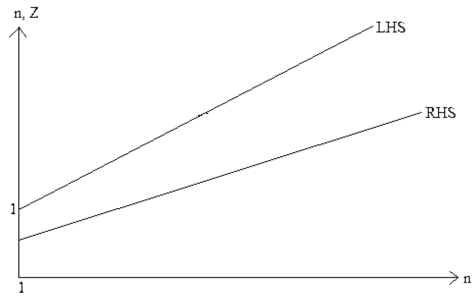


Figure 2: Condition (7) for $\frac{\partial Z(n)}{\partial n} < 1$ and $Z|_{n=1} < 1$.

Since $Z$ is positively sloped and $\frac{\partial Z(n)}{\partial n} < 1$, the curves LHS and RHS intersect in Figure 1[3] while there is no intersection between LHS and RHS in Figure 1.

It follows from Figure 1 (where $Z|_{n=1} > 1$) that higher competition (i.e., higher values of *n*) increases (decreases) the unionized wage for $n > n^*$ ($n < n^*$). Note that $Z|_{n=1} > 1$ occurs if $\lambda$ is sufficiently high compared to $-\lambda'$ at *n = 1*, i.e., the labor coefficient in the absence of external economies of scale (which is the case for *n = 1*) is sufficiently high compared to the effects of the external economies of scale at the beginning. Hence, for low values of *n* (i.e., if the initial product market competition is low), the effects of the external economies of scale are dominated by the competition effect and the increase in competition reduces the unionized wage. However, as competition increases, the effects of competition on labor demand tend to fall due to the fall in the labor coefficients. Hence, after a critical level of competition, the effects of the external economies of scale start dominating the effects of competition, thus

[3] It is easy to see that LHS of (7) can intersect RHS of (7) for larger *n*. For example, this happens if the effects of the external economies of scale are such that $\lambda$ is sufficiently small for a large but finite *n*.

increasing the unionized wage following higher competition if the competition is sufficiently high.

However, Figure 2 shows the situation for $Z|_{n=1} < 1$, which implies that $\lambda$ is sufficiently low compared to $-\lambda'$ at *n = 1*, i.e., the labor coefficient in the absence of external economies of scale (which is the case for *n = 1*) is sufficiently low compared to the effects of the external economies of scale at the beginning. Hence, from the beginning, the effects of competition on the labor demand are weak compared to the effects of the external economies of scale. Therefore, as competition increases, the latter effect always dominates the former effect and creates higher unionized wage following higher competition.

The above discussion is summarized in the following proposition.

**Proposition 1:** *Consider the case of* $\frac{\partial Z(n)}{\partial n} < 1$.

*(i) If* $Z|_{n=1} > 1$*, higher competition increases (decreases) the unionized wage for* $n > (<) n^*$*, where* $n = Z(n)$ *at* $n^*$.

*(ii) If* $Z|_{n=1} < 1$*, higher competition increases the unionized wage for* $n > 1$.

Let us now consider two examples to show the cases shown in Figures 1 and 2. First, consider the case where $\lambda(n) = \frac{1}{1+n}$. This situation will correspond to the case of Figure 1. In this situation, we get that $\lambda' = -\frac{L}{(1+n)^2} < 0$, $\lambda'' = \frac{2L}{(1+n)^3} > 0$, $Z(n) = 1 + n + \frac{(n-2+\beta)\beta\theta}{(2-\beta)}$, $\frac{\partial Z(n)}{\partial n} < 1$ and $Z|_{n=1} > 1$. We get that $n \underset{<}{\geq} Z(n)$ for

$n \underset{<}{\geq} \frac{(2-\beta)(1-\beta\theta)}{\beta\theta} \equiv n^*$, where $n^* > 1$ for $\theta \in [0, 0.5]$ and $\beta \in [0,1)$, suggesting that higher competition increases (decreases) the unionized wage for $n > (<) n^*$.

Now consider the case where $\lambda(n) = \frac{\lambda}{n}$. This situation will correspond to the case of Figure 2. We get that $\lambda' = -\frac{L}{n^2} < 0$, $\lambda'' = \frac{2L}{n^3} > 0$, $Z(n) = n - \frac{(1+n-\beta)\beta\theta}{(2-\beta)}$, $\frac{\partial Z(n)}{\partial n} < 1$ and $Z\big|_{n=1} < 1$. Hence, $n > Z(n)$ for $n > 1$, suggesting that higher competition increases the unionized wage for $n > 1$.

2.2. *The case of* $\frac{\partial Z(n)}{\partial n} > 1$

Let us now consider the case of $\frac{\partial Z(n)}{\partial n} > 1$, i.e., the case of

$$\frac{(2-\beta-\beta\theta)\left[-(\lambda')^2 + \lambda\lambda''\right]}{(2-\beta)(\lambda')^2} > 1.$$

Following the argument of the previous subsection, it is easy to understand that higher competition reduces the unionized wage for $n > 1$ if $\frac{\partial Z(n)}{\partial n} > 1$ and $Z\big|_{n=1} > 1$, since, in this situation, RHS of (7) is higher than LHS of (7) for $n > 1$. However, higher competition may increase the unionized wage if $\frac{\partial Z(n)}{\partial n} > 1$ and $Z\big|_{n=1} < 1$, which is shown in Figure 3. In Figure 3, we consider $\frac{\partial Z(n)}{\partial n} > 1$ for $n > 1$, which can occur, as shown in the example below. For simplicity, we draw RHS of (7) as a straight line.

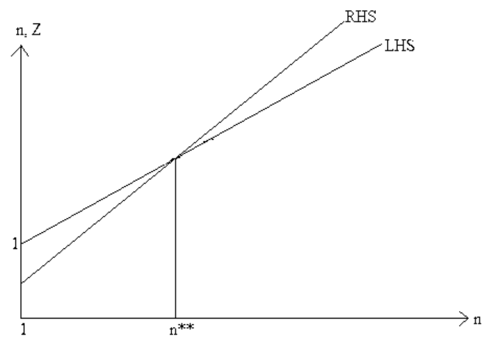


Figure 3: Condition (7) for $\frac{\partial Z(n)}{\partial n} > 1$ and $Z|_{n=1} < 1$.

It follows from Figure 3 that higher competition increases (decreases) the unionized wage for $n < n^{**}$ ($n > n^{**}$).[4] Hence, in contrast to Figure 1, where higher competition increases (decreases) the unionized wage for higher (lower) values of *n*, here higher competition increases (decreases) the unionized wage for lower (higher) values of *n*.

The discussion for the case of $\frac{\partial Z(n)}{\partial n} > 1$ is summarized in Proposition 2.

**Proposition 2:** *Assume* $\frac{\partial Z(n)}{\partial n} > 1$.

*(i) If* $Z|_{n=1} > 1$*, higher competition reduces the unionized wage for* $n > 1$.

*(ii) If* $Z|_{n=1} < 1$*, higher competition increases (decreases) the unionized wage for* $n < (>) n^{**}$*, where* $n = Z(n)$ *at* $n^{**}$.

We know from the above discussion that $\frac{\partial Z(n)}{\partial n} > 1$ provided $\lambda\lambda''$ is sufficiently higher than $2(\lambda')^2$, which can occur if, ceteris paribus, $\lambda$ is sufficiently

[4] It is evident from our example below that the curves in Figure 3 can intersect.

high. Moreover, if $\lambda$ is sufficiently high compared to $\lambda'$, we get $Z|_{n=1} > 1$. This implies that if the labor productivity is very low (i.e., labor coefficient is very high) to start with and the effects of the external economies of scale are not very strong, the effect of competition always dominates the effects of the external economies of scale to reduce the unionized wage following higher competition. This is because higher competition reduces the labor demand significantly due to the high labor coefficient, and this loss is not compensated by the positive effects of the external economies of scale.

If the labor coefficient is high to create $\frac{\partial Z(n)}{\partial n} > 1$ but it is not high enough compared to $\lambda'$, we get $Z|_{n=1} < 1$. In this situation, we can get that higher competition increases (deceases) the unionized wage for if the competition is low (high), i.e., *n* is low (high). This happens for the following reason. Relatively stronger effect of the external economies of scale initially compensates the loss of labor demand due to higher competition. Hence, an increase in competition increases the unionized wage if competition is low. However, as competition increases, the effects of the external economies of scale reduce significantly if the diminishing returns on the external economies of scale are high (i.e., $\lambda''$ is high). Hence, if competition is very high, the effects of the external economies of scale fade out and reduce the unionized wage following higher competition.

Now consider an example for the case of Figure 3. Assume that $\lambda(n) = 1 + \frac{10}{n}$ and $\beta = \theta = 0.5$. We get that $\lambda' = -\frac{10}{n^2} < 0$, $\lambda'' = \frac{20}{n^3} > 0$, $Z(n) = \frac{(-1 + 10n + n^2)}{12}$, $\frac{\partial Z(n)}{\partial n} > 1$ for $n > 1$ and $Z|_{n=1} < 1$. We get that $n \gtrless Z(n)$ for $n \gtrless (1 + \sqrt{2}) \equiv n^{**}$, suggesting that higher competition increases (decreases) the unionized wage for $n < (>) n^{**}$.

It may worth noting that if we change the above example and consider $\lambda(n) = 1 + \frac{1}{n}$, $\beta = \theta = 0.5$, we get that $\lambda' = -\frac{1}{n^2} < 0$, $\lambda'' = \frac{2}{n^3} > 0$, $Z(n) = \frac{(-1 + 10n + 10n^2)}{12}$ and $\frac{\partial Z(n)}{\partial n} > 1$ for $n > 1$. However, we get $Z\big|_{n=1} > 1$ in this situation, suggesting that higher competition decreases the unionized wage for $n > 1$.

## 3. Conclusion

The influential theoretical work of Dowrick (1989) shows that higher product market competition reduces unionized wage in the presence of firm-specific union-firm bargaining. We show that this is not necessarily the case in the presence of external of economies of scale, which can be found in several industries. Higher competition may increase the unionized wage under external economies of scale. In this respect, the labor productivity and the effects of the external economies of scale may play important roles. Thus, in contrast to the current explanation for the positive relation between competition and unionized wage based on the open-shop union (Bastos et al., 2010), where the union density is less than one, we provide a new rationale for the empirically found positive relation between competition and unionized wage.

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