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Union bargaining power and innovation in the presence of subcontracting

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Abstract: We provide a reason for the positive relation between union bargaining power and innovation, which is empirically relevant but in contrast to the usual belief that higher union bargaining power reduces innovation under a right-to-manage model of labour union and ex-post bargaining. We show that if the final goods producer can subcontract production to the informal sector, higher union bargaining power increases innovation. We also show that while higher union bargaining power makes the final goods producer worse off irrespective of the effect of the union bargaining power on innovation, higher union bargaining power may increase (decrease) consumer surplus (union utility) by inducing innovation. Hence, a higher union bargaining power may either increase or decrease social welfare.

Key Words: Consumer surplus; Innovation; Union; Subcontracting

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1. Introduction

It is usually believed that higher bargaining power of the input supplier reduces the final goods producer's incentive for innovation. For example, considering labour union as the input supplier and using bargaining between a firm and a labour union, Grout (1984) shows that higher union bargaining power creates a negative impact on process innovation, which is due to the 'hold-up' problem created by the labour union. However, Ulph and Ulph (1989, 1994 and 1998) show that whether this hold-up problem remains in an oligopoly with strategic R&D competition is not immediate and may depend on the type of bargaining. If the firms and the unions engage in an ex-post (short-term) bargaining, where bargaining does not occur on the R&D investment, higher union bargaining power reduces R&D investment if bargaining is over wages alone, i.e., employing a right-to-manage model of labour union.[1] However, higher union bargaining power increases R&D investment if the bargaining takes place over wages and employment, i.e., employing efficient bargaining model of labour union, the unions are relatively risk averse and the union is weak. However, if the firms and the unions enter into an ex-ante (long-term) bargaining so that bargaining occurs on the R&D investment, wage and employment, higher union bargaining power increases (decreases) R&D investment if successful innovation increases (decreases) employment.[2]

The empirical evidence on labour union and innovation is inconclusive. Freeman and Medoff (1984) show that the effect of unionisation is ambiguous on innovation. Hirsch

[1] The right-to-manage (efficient bargaining) model of labour union stipulates that bargaining between firms and unions occurs over wage only (wage and employment).
[2] See, Menezes-Filho and Van Reenen (2003) for an excellent survey of this literature.

(1992) shows that most U.S. studies show a negative effect between union power and innovation. Using COMPUSTAT data, Bronas and Deere (1993) show that there is a significant negative relationship between firm-specific unionisation rate and innovation. Using mainly aggregative industry level data, Ulph and Ulph (1989) find a negative relation for the high-tech industries in England, while Addison and Wagner (1994) find a positive but insignificant relation. It is documented in Menezes-Filho et al. (1998) that most U.S. studies show a negative effect between union power and innovation, while the evidence from some European studies is less compelling. Menezes-Filho and Van Reenen (2003) also show strong and negative effects of unions on innovation in North America, while that is generally not the case in the UK.

As evident from the above discussion, under ex-post bargaining and the right-to-manage[3] model of labour union, the theoretical literature on labour union and innovation could not explain the empirically relevant positive relation between union bargaining power and innovation.[4] We fill this gap in the literature.

We show that a positive relation between union bargaining power and innovation occurs under ex-post bargaining and the right-to-manage model of labour union if the final goods producer can subcontract production to the informal sector, which is empirically relevant.[5] It is often be the case that firms in South Asian and Latin American countries

[3] See, Layard et al. (1991) for arguments in favour of the right-to-manage model.

[4] Since the right-to-manage model and ex-post bargaining, suggesting that bargaining occurs only on the input price, is a reasonable situation to consider when the input supplier is not a labour union but it is an intermediate goods producer, it is immediate that if the weights on the input price and the quantity of input sold are the same, this result also suggests that higher bargaining power of the input supplier reduces the final goods producer's R&D investment if the input supplier charges a linear price.

[5] It is often found, particularly in the developing countries, that the firms undertake formal in-house production and also subcontract to the informal producers within the country. According to the recent estimate provided jointly by ILO and WTO (WTO-ILO, 2009), the informality increases from 50.1% in early 1990s to 52.8% in late 1990s and then changes to 52.2% in early 2000s in Latin American economies. In Africa, this increases initially from 60.9% in early 1990s to 63.6% in late 1990s and then reduces to 55.7% in early 2000s. On the other hand, Asia accounts for higher informality and it was 78.3% in early 1990s and drops to 68.5% in late 1990s in Asia. After that, it increases to 78.2% and goes to the level that was in the early 1990s.

undertake formal in-house production and also subcontract to the informal producers (WTO-ILO, 2009 and Ulyssea, 2010). The evidence on informal production can also be found in the recent works by Schneider and Enste (2000), Boeri and Garbaldi (2005), Guha-Khasnobis and Kanbur (2006) and Mehrotra and Biggeri (2007), to name a few. As an example, Bata, a well-known shoe manufacturer in India, produces in-house and also subcontracts to outside producers in the country.

We consider a situation where a final goods producer can produce a product in-house by hiring workers from a labour union and can also subcontract production to the informal sector. We consider the right-to-manage model of labour union and no bargaining on the R&D investment. We show in this framework that higher bargaining power of the labour union increases the final goods producer's incentive for innovation. Subcontracting to the informal sector allows the final goods producer to reduce the hold-up problem due to the presence of the labour union.

We also show that while higher union bargaining power makes the final goods producer worse off irrespective of the effect of the union bargaining power on innovation, higher union bargaining power may increase (decrease) consumer surplus (union utility) by inducing innovation. It is now immediate that a higher union bargaining power may either increase or decrease social welfare, which is the sum of profit, consumer surplus and union utility.

The following two points are worth mentioning. First, our result will hold even if the input supplier is not a labour union but it is a profit maximising intermediate goods producer charging a linear price to the final goods producer. Second, subcontracting to the domestic informal sector in our analysis can be interpreted alternatively as outsourcing to another country. With this interpretation, the presence of the domestic labour union may encourage the domestic firm to outsource production to a foreign country. Thus, our paper

has a broader application than considering a problem related to labour union and innovation, and considering subcontracting to the domestic informal sector.

The remainder of the paper is organised as follows. Section 2 describes the model and derives the result. Section 3 concludes.

2. The model and the results

Assume that a monopolist producer, called firm *M*, wants to sell a product in a market with the inverse demand function $P=a-Q$, where P is the price and Q is the total output. We assume that production requires labour and firm *M*'s output can be produced in-house and/or outsourced to the informal sector.[6] For simplicity, we assume that one unit of labour is required to produce one unit of output, irrespective of in-house or informal production. However, firm *M* can reduce the labour coefficient to λ by investing F in R&D, where $\lambda \in (0,1)$.

We consider that there is a labour union which determines firm *M*'s in-house wage, w, while considering the competitive wage rate as the unionised workers' reservation wages, which are assumed to be d. The competitive wage prevails in the informal sector, thus creating different labour market institutions in the formal and informal sectors. Hence, the labour cost for informal production is d. However, it is well documented that involvement of the informal sector creates transaction and/or administrative costs (Ulyssea, 2010; Maiti and Marjit, 2011). So, the effective unit cost of production in the informal sector is the summation of competitive labour cost and the transaction and administrative costs. We assume that the constant per-unit transaction and administrative costs of informal production are x. Therefore, the effective unit cost of informal production is $c = d + x$.

[6] See, e.g., Ulyssea (2010) and Maiti and Mukherjee (2013) for works where production process involves both formal and informal sectors.

Hence, the trade-off for firm *M* is clear. Subcontracting to the informal sector helps to bypass the unionised wage, *w*, but it attracts the transaction and administrative costs, *x*, related to informal production.

In line with Crene and Davidson (2004), Mukherjee (2008) and Maiti and Mukherjee (2013), where the firms stagger output decisions among different plants, we consider that firm *M* can stagger its output decision among in-house production and subcontracting to the informal sector. More particularly, we consider that firm *M* determines its output under subcontracting before its in-house production.[7]

We consider the following game. At stage 1, firm *M* decides whether or not to invest in R&D. At stage 2, firm *M* determines the amount of subcontracting, *k*. At stage 2, the labour union and firm *M* bargains for the unionised wage, *w*. At stage 3, firm *M* determines the amount of in-house output, *q*, and the profits are realised. We solve the game through backward induction.

If firm *M* invests in R&D, i.e., reduces the labour coefficient to λ by investing *F* in R&D, given *k* and *w*, firm *M* maximises the following expression to determine its in-house production, *q*, where $Q = k + q$:

$$\underset{q}{Max}(a - q - k - \lambda w)q + (a - q - k - \lambda c)k - F . \qquad (1)$$

The equilibrium in-house production is $q^* = \frac{a - 2k - \lambda w}{2}$, which crates in-house labour demand as $L^* = \lambda q^*$. The in-house production is positive if $(a - 2k - \lambda w) > 0$, which is assumed to hold.

Given k and $q^* > 0$, if bargaining between firm *M* and the labour union is successful, the profit of firm *M* is $\pi_m = \frac{a^2 - 4ck\lambda - 2a\lambda w + \lambda w(4k + \lambda w)}{4}$ and utility of the

union is $U=(w-d)\lambda q^*$, where d is reservation wage. However, given k, if bargaining between firm M and the labour union beaks down, the profit of firm M is $\overline{\pi_m}=(a-k-\lambda c)k$ and the union utility is $\overline{U}=0$, since $q^*=0$. Hence, the equilibrium in-house wage is determined by maximising the following expression:

$$\underset{w}{Max}[(w-d)\lambda q^*]^{\beta}\left[\pi_m-\overline{\pi_m}\right]^{(1-\beta)}, \tag{2}$$

where β (resp. $(1-\beta)$) is the bargaining power of the labour union (resp. Firm M).

The equilibrium wage is $w^*=\frac{(a-2k-d\lambda)\beta+2d\lambda}{2\lambda}$. Since the equilibrium in-house unionised wage, w^*, cannot be less than d, it implies that $(a-2k-\lambda d)>0$ whenever $q^*>0$, i.e., $(a-2k-\lambda w^*)>0$. We get that $\frac{\partial w^*}{\partial\beta}=\frac{a-2k-\lambda d}{2\lambda}>0$ and $\frac{\partial^2 w^*}{\partial\beta\partial\lambda}=-\frac{a-2k}{2\lambda^2}<0$, suggesting that if bargaining power of the labour union increases, it increases the equilibrium wage for a given λ (i.e., $\frac{\partial w^*}{\partial\beta}>0$) and as λ falls, this increase in wage due to higher union bargaining power increases (i.e., $\frac{\partial^2 w^*}{\partial\beta\partial\lambda}<0$). This result suggests why the previous work on union bargaining power and innovation (e.g., Grout, 1984) implies that higher union bargaining power reduces the incentive for R&D.

However, there is another effect that we can find from w^*. We get that $\frac{\partial w^*}{\partial k}=-\frac{\beta}{\lambda}<0$, i.e., higher amount of subcontracting to the informal sector reduces the in-house unionised wage, since it reduces the in-house labour demand, and $\frac{\partial^2 w^*}{\partial k\partial\lambda}=\frac{\beta}{\lambda^2}>0$,

[7] We will discuss later on why this sequence of output choice is beneficial for firm M.

i.e., the reduction in the unionised wage following higher amount of subcontracting increases with a lower λ.

Inserting w^* and q^* in (1) and maximising that expression with respect to *k*, we find the equilibrium amount of subcontracting to the informal sector as $k^* = \frac{(a-\lambda d)}{2} - \frac{2x\lambda}{(4-\beta)\beta}$. We get that $k^* > 0$ if $x < \frac{(4-\beta)\beta(a-\lambda d)}{4\lambda}$, which is assumed to hold. It is intuitive that there is no incentive for subcontracting to the informal sector if the cost of subcontracting is high. We get that $\frac{\partial k^*}{\partial \beta} = \frac{4x\lambda(2-\beta)}{(4-\beta)^2\beta^2} > 0$, suggesting that higher union bargaining power increases the amount of subcontracting to the informal sector, since subcontracting to the informal sector helps to reduce rent extraction by the union. Given $k^* > 0$, we get that $w^* = d + \frac{2x}{4-\beta} < (d+x)$, i.e., the marginal cost of in-house production is lower than the marginal cost of subcontracting to the informal sector, and $q^* = \frac{(2-\beta)x\lambda}{(4-\beta)\beta} > 0$ for $x > 0$ and $\lambda > 0$, suggesting that the in-house output is positive.

The above discussion gives the following result immediately.

Proposition 1: *If* $0 < x < \frac{(4-\beta)\beta(a-\lambda d)}{4\lambda}$ *and* $\lambda \in (0,1)$, *we get* $k^* > 0$ *and* $q^* > 0$, *i.e., firm M's in-house production and subcontracting to the informal sector are positive.*

The reason for the above result is as follows. Subcontracting to the informal sector allows firm *M* to reduce the in-house labour demand, which reduces the in-house unionised wage. Unless the cost of subcontracting is very high, firm *M* prefers to subcontract certain amount of outputs to reduce rent extraction by the union through wage. Hence, if the cost

of outsourcing is not very high, firm *M* subcontracts to the informal sector and also produces in-house.

It is now worth mentioning why firm *M* deals with the informal sector prior to its dealing with the in-house labour union. If firm *M* deals with the in-house labour union prior to its dealing with the informal sector, it could reduce the union wage up to $c = d + x$. However, as shown above, firm *M* could reduce the union wage below *c* by contracting with the informal sector prior to bargaining with the labour union.

We consider in the following analysis that subcontracting is always an equilibrium outcome. It is trivial that if subcontracting does not occur in our analysis, i.e., $x > \frac{(4-\beta)\beta(a-\lambda d)}{4\lambda}$, the effects of a higher union bargaining power will be similar to the effects shown in the existing literature without the possibility of subcontracting production to the informal sector. Hence, if subcontracting is not an equilibrium outcome in our analysis, higher union bargaining power will reduce the incentive for innovation.

2.1. The effects of higher union bargaining power on innovation

Given the equilibrium values of *k*, *w* and *q*, we get the equilibrium profit of firm *M* under innovation as

$$\pi_m^I = \frac{1}{4}\left[a^2 - 2a\lambda(d+x) + \lambda^2\left(d^2 + 2dx + \frac{4x^2}{(4-\beta)\beta} \right)\right] - F \,. \tag{3}$$

If firm M does not innovate, we have $\lambda = 1$ and $F = 0$. Hence, it is immediate from (3) that the profit of firm *M* under no innovation is

$$\pi_m^{NI} = \frac{1}{4}\left[a^2 - 2a(d+x) + \left(d^2 + 2dx + \frac{4x^2}{(4-\beta)\beta} \right)\right]. \tag{4}$$

It follows from (3) and (4) that firm *M* innovates if $\pi_m^I > \pi_m^{NI}$ or $F < \overline{F}(\lambda)$ where

$$\overline{F}(\lambda) = \frac{(1-\lambda)\left[2a(4-\beta)\beta(d+x) - (4(d+x)^2 - 2(2-\beta)^2(d+x)d + (2-\beta)^2 d^2)(1+\lambda)\right]}{4(4-\beta)\beta},$$

which shows firm *M*'s maximum willingness to invest in innovation. A higher (lower) $\overline{F}(\lambda)$ implies that firm *M*' maximum willingness to invest in innovation increases (decreases), i.e., firm *M*'s incentive for innovation increases (decreases).

Proposition 2: *Assume* $0 < x < \frac{(4-\beta)\beta(a-\lambda d)}{4\lambda}$ *and* $\lambda \in (0,1)$, *i.e.,* $k^* > 0$ *and* $q^* > 0$. *We get that higher union power increases firm 1's incentive for innovation.*

Proof: We get that $\frac{\partial \overline{F}(\lambda)}{\partial \beta} = \frac{2(2-\beta)x^2(1-\lambda^2)}{(4-\beta)^2\beta^2} > 0$, suggesting that higher union bargaining power increases firm *M*'s incentive for innovation. ■

As discussed in the introduction, it is believed that higher union bargaining power reduces a final goods producer's incentive for innovation under a right-to-manage model of labour union and ex-post bargaining. This is due to the hold-up problem created by the labour union. In contrast, Proposition 2 shows that if the final goods producer can subcontract production to the informal sector it can reduce the hold-up problem created by the labour union, and higher union bargaining power increases the final goods producer's incentive for innovation.

As shown above, given the amount of subcontracting, higher union bargaining power increases the equilibrium wage and this increase is higher with innovation. However, higher union bargaining power increases the amount of subcontracting, which tends to reduce the in-house unionised wage and this reduction in the unionised wage is

higher with innovation. Thus, higher union bargaining power creates a trade-off on firm *M*'s incentive for innovation, which is due to firm *M*'s ability to subcontract production to the informal sector. We find that the latter effect dominates the former and higher union bargaining power increases firm *M*'s incentive for innovation.

2.2. The effects of higher union bargaining power on the profit of firm M

The profits of firm *M* under innovation and no innovation are given by (3) and (4) respectively. We get that higher union bargaining power reduces both (3) and (4), i.e., if firm *M* either always innovates or never innovates, higher union bargaining power reduces its profit.

Now consider the situation where higher union bargaining power induces innovation. Assume that innovation does not occur if the union bargaining power is *t*, which occurs for $\overline{F}(t) < F$. The profit of firm *M* in this situation is given by (4). If the union bargaining power increases from *t* to, say, *z*, and the higher union bargaining power induces innovation, which occurs for $\overline{F}(t) < F < \overline{F}(z)$, the net profit of firm *M* is given by (3). Subtracting (4) from (3) and evaluating this difference at $\overline{F}(t)$, we get that the difference is $-\frac{x^2\lambda^2(z-t)(4-t-z)}{(4-t)t(4-z)z} < 0$, suggesting that the net profit of firm *M* is lower under higher bargaining power.

The following result summarises the above discussion.

Proposition 3: *Higher union bargaining power reduces the profit of firm M, irrespective of the effect of the union bargaining power on innovation.*

Higher union bargaining power increases wage and tends to reduce the profit of firm *M*. Even if higher union bargaining power tends to increase production efficiency by inducing innovation, the wage effect is stronger than the production efficiency effect, thus making firm *M* worse off under higher union bargaining power.

2.3. The effects of higher union bargaining power on consumer surplus

While higher union bargaining power tends to reduce total output by increasing wage, it tends to increase total output by increasing innovation. The following diagram shows that higher union bargaining power may make the consumers better off by inducing innovation.

Since the consumer surplus in our analysis is $\frac{(q^* + k^*)^2}{2}$, we show how the total output is affected by higher union bargaining power. For a given labour coefficient, the total output is $Q^*(\lambda) = q^*(\lambda) + k^*(\lambda) = \frac{a - \lambda d}{2} - \frac{x\lambda}{4 - \beta}$, which decreases with higher β. Hence, total output decreases with higher union bargaining power if firm *M* either always innovates or never innovates. We also find that for a given β, the total output increases with lower λ. Figure 1 plots these information.

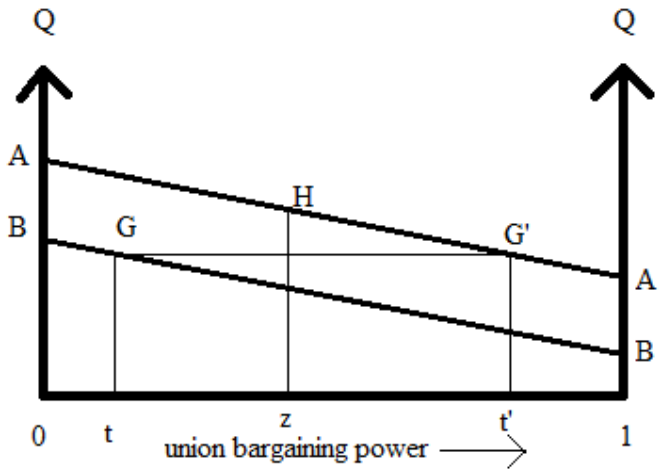

Figure 1: The effects of higher union bargaining power on the total output

The lines *AA* and *BB* in Figure 1 show how higher union bargaining power affects the total output. *BB* corresponds to the labour coefficient *1*, while *AA* corresponds to a labour coefficient λ. We draw the lines straight for simplicity. Let us consider a union bargaining power *t*. Assume that innovation does not occur if the union bargaining power is *t*, which occurs for $\overline{F}(t) < F$. The corresponding total output is *G*. If the union bargaining power increases from *t* to, say, *z*, and higher union bargaining power induces innovation, which occurs for $\overline{F}(t) < F < \overline{F}(z)$, the total output is *H*. Hence, higher union bargaining power increases total output and therefore, consumer surplus, by inducing innovation. If the initial union bargaining power is *t* and innovation does not occur at this union bargaining power, higher union bargaining power increases consumers surplus if the higher union bargaining power is less than t' and innovation occurs at this higher union bargaining power.

On one hand, higher union bargaining power tends to reduce the total output by increasing wage, for a given labour coefficient. However, if higher union bargaining power induces innovation, it tends to increase the total output by increasing production efficiency.

If the latter effect is stronger than the former effect, which occurs if a relatively small increase the union bargaining power induces innovation, higher union bargaining power increases the total output.

The following result is immediate from the above discussion.

Proposition 4: *Higher union bargaining power may increase the total output if it increases innovation.*

2.4. The effects of higher union bargaining power on union utility

Now consider the effects of higher union bargaining power on union utility. For a given labour coefficient, union utility is $U = \frac{2(2-\beta)x^2\lambda^2}{(4-\beta)^2\beta}$, which decreases with higher β, irrespective of innovation by firm *M*. We also find that for a given β, union utility decreases with lower λ. Figure 2 plots these information.

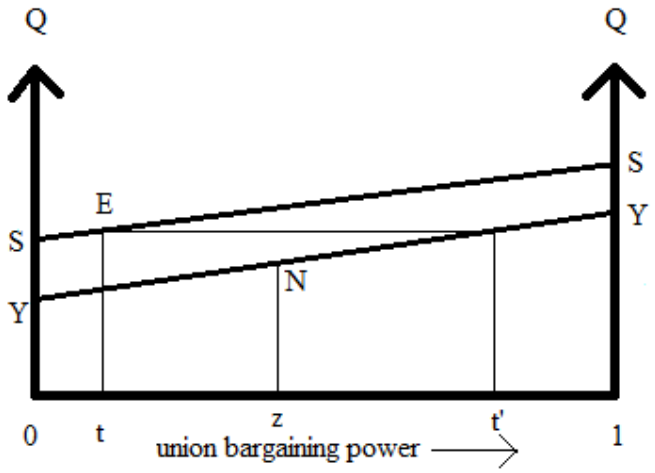

Figure 2: The effects of higher union bargaining power on union utility

The lines *SS* and *YY* in Figure 2 show how higher union bargaining power affects union utility. *SS* corresponds to the labour coefficient *1*, while *YY* corresponds to a labour coefficient $\lambda \in (0,1)$. We draw the lines straight for simplicity. Assume that innovation does not occur if the union bargaining power is *t*, which occurs for $\overline{F}(t) < F$. The corresponding union utility is *E*. If the union bargaining power increases from *t* to, say, *z*, and the higher union bargaining power induces innovation, which occurs for $\overline{F}(t) < F < \overline{F}(z)$, the union utility is *N*. Hence, higher union bargaining power decreases union utility by inducing innovation.

On one hand, higher union bargaining power tends to increase the union utility by increasing wage, for a given labour coefficient, although it increases subcontracting to the informal sector. However, if higher union bargaining power also reduces labour coefficient by inducing innovation, our result suggests that this loss of labour coefficient along with higher amount of subcontracting may outweigh the upward pressure on the unionised wage, thus creating lower union utility following an increase in the union bargaining power.

The following result is immediate from the above discussion.

Proposition 5: *Higher union bargaining power may decrease union utility if it increases innovation.*

Due to the results in Subsections 2.2, 2.3 and 2.4, it is now immediate that a higher union bargaining power may either increase or decrease social welfare, which is the sum of profit, consumer surplus and union utility.

3. Conclusion

Although it is empirically observed that higher power of the labour union increases the incentive for innovation, the right-to-manage model of labour union could not explain this phenomenon so far while considering ex-post bargaining, where bargaining between the firm and the union does not occur over the R&D investment. We fill this gap in the literature. Considering a right-to-manage model of labour union and ex-post bargaining, we show that higher union bargaining power increases the final goods producer's incentive for innovation if the final goods producer can subcontract production to the informal sector, which is an empirically observed phenomenon in today's world. We also show that while higher union bargaining power makes the final goods producer worse off irrespective of the effect of the union bargaining power on innovation, higher union bargaining power may increase (decrease) consumer surplus (union utility) by inducing innovation. Hence, a higher union bargaining power may either increase or decrease social welfare, which is the sum of profit, consumer surplus and union utility.

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