Economics Bulletin

Volume 35, Issue 3

Welfare analysis of civil servants' wage bargaining in a mixed-duopoly approach

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Abstract

This research examines how wage regulation can be Pareto-improving. We demonstrate the wage regulation of public firms by relaxing the assumption of substitution between private and public goods. In other words, we admit a complementary relationship between private and public goods. Relaxing this assumption provides results both additional to and different from those produced by other models. We find that wage regulation can be Pareto-improving under a moderately strong complementary relationship between private and public goods.

I would like to thank Akira Konakayama, Noriaki Matsushima and Yukihiro Nishimura for his valuable comments and suggestions. I gratefully acknowledge the financial support from the Japanese Ministry of Education, Culture, Sports, Science and Technology (Grant-in-Aid for Scientific Research(C)) (No. 23530381).

Citation: Kazuki Hiraga, (2015) "Welfare analysis of civil servants' wage bargaining in a mixed-duopoly approach", *Economics Bulletin*, Volume 35, Issue 3, pages 1734-1743

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Submitted: December 26, 2014. **Published:** August 12, 2015.

1. Introduction

Many countries have mixed markets, where state-owned public firms compete against private firms, for example, aircrafts, banks, railroads, and electric utility industries. In the standard mixed-duopoly model, public firms are assumed to maximize social welfare, and private firms are assumed to maximize their profits. Public firms may, however, instead maximize their own utility, for example, employee (civil servant) attitude if their intentions are not benevolent. If the goal of civil servants is not social welfare, the government must regulate their behavior. Ishida and Matsushima (2009) formulate a mixed-duopoly model in which a welfare-maximizing public firm competed against a profit-maximizing private firm and examined the regulatory framework of public institutions, focusing on wage regulation imposed on the public firm. Ishida and Matsushima (2009) conclude that the overall welfare effects were ambiguous and any regulations could not be Pareto dominant when the welfare provided by private firm was substituted for that produced by the public firm.

Contrary to Ishida and Matsushima's (2009) findings, several studies estimated the complementary or substitute relationships between private and government consumption (e.g., Karras, 1996; Evans and Karras, 1994) and empirically demonstrated that government consumption (i.e., a public firm) has a complementary relationship with private consumption (i.e., a private firm). Similarly, public banks often serve as a signal for private banks in assessing the firms they consider safer to lend to. This effect is called the "cowbell effect," whereby private banks loan to firms that receive loans from the Japanese Development Bank, which is Japan's largest public bank, as a herd of cows follow the one wearing the cowbell. Horiuchi and Sui (1993) empirically demonstrated this effect, suggesting that public and private firms may have a complementary relationship.

This paper investigates the welfare comparison between two wage regulations for public servants: wage bargaining by the public firm's union versus a regulated, pre-determined wage-setting rule such as the "equal pay for equal work" principle. We demonstrate that the wage regulation can be Pareto-improving under a moderately strong complementary relationship between private and public goods because the complementarity enhances both goods' demand and increases both firms' output and wages.

This paper proceeds as follows: Section 2 briefly outlines the models and initiates the equilibrium. Welfare analysis follows in Section 3, and Section 4 concludes the paper.

2. The model

2.1. The (Representative) Consumer's Utility

Similar to Ishida and Matsushima (2009), we formulate a mixed-oligopoly model in which a welfare-maximizing public firm (firm 0) competes against a profit-maximizing private firm (firm 1). The basic structure of the model follows a standard productive differential. The utility of the representative consumer is shown as follows:

$$U = x_0 + x_1 - \frac{x_0^2 + 2\gamma x_0 x_1 + x_1^2}{2}, \qquad (1)$$

where x_0 and x_1 represent the quantity of public and private goods, respectively, and $\gamma \in (-1,1)$ represents the degree of product differentiation. Unlike Ishida and Matsushima (2009), we allow complementarity between the two goods. This specification implies the following inverse demand function: for positive demands and i=0,1[a]:

$$p_i = 1 - x_i - \gamma x_j, \quad i \neq j. \qquad (2)$$

Eq. (2) means that the prices of public goods (p_0) and that of private goods (p_1), which are equal to the marginal costs of them, are equal to marginal utilities with respect to each goods (x_0 and x_1).In Eq. (2), the strategic substitutes (complements) are satisfied if $\gamma \in (0,1)$ and ($\gamma \in (-1,0)$).

The firms are heterogeneous with respect to their productivity. Each firm has a constant-return-to-scale technology where one unit of labor produces one unit of the final firm output. The wage paid by firm *i* is denoted by w_i.

[a] The representative consumer maximizes her consumer surplus (CS) as follow:

$$\max_{x_0, x_1} CS = x_0 + x_1 - \frac{x_0^2 + 2\gamma x_0 x_1 + x_1^2}{2} - p_0 x_0 - p_1 x_1.$$

Solving above problem, we obtain Eq. (2).

2.2. Wage Setting

The private firm is unionized, and its wage is determined by Nash bargaining between the firm and its union. Let $\overline{w}$ denote the competitive wage. Taking this as the reservation wage, the union sets the wage w_1 to maximize the following utility function:

$$u_1 = (w_1 - \overline{w})^{\theta} x_1, \theta > 0, \quad (3)$$

where θ is the weight the union attaches to the wage level. For simplicity, we restrict our attention to the case where θ = 1. We also set $\overline{w} = 0$, as its level is qualitatively inconsequential.

Although the public firm's wage is determined by collective bargaining, we consider two distinct wage-setting systems for the public firm. One system imposes no regulation on the public firm so that its union (union 0) can bargain collectively. Because the public firm is unionized in the same manner as the private firm, the union sets the wage w_0 to maximize:

$$u_0 = \left(w_0 - \overline{w}\right)^{\theta} x_0. \quad (4)$$

We set $\theta = 1$ and $\overline{w} = 0$ following Ishida and Matsushima (2009).

On the other hand, in the other system, the public firm's union is prohibited from collective bargaining. In the absence of collective bargaining, the wage w0 is determined according to a wage-setting rule such as the "equal pay for equal work" principle. Specifically, the public firm's wage is given by the following wage-setting rule:

$$w_0 = k w_1, \quad (5)$$

where k is an exogenous given variable that determines how closely w_0 should follow w_1.

2.3. Timing of Wage Setting

Similar to Ishida and Matsushima (2009), we consider a two-stage game. The timing of this game is as follows:

(1) The upstream the market

If the public firm's union is allowed to collectively bargain, each union simultaneously determines its wage w_0. Otherwise, only the private firm's union sets the wage w_1, whereas the wage-setting rule (Eq. (5)) determines w_0.

(2) The downstream the market
Each firm simultaneously selects its quantity of output, x_i, to maximize its objectives.

2.4. Output Market

The public firm maximizes the social welfare objective as follows:

$$W = (U - p_0x_0 - p_1x_1) + (\pi_0 + \pi_1) + (u_0 + u_1), \tag{6}$$

where π_0 and π_1 represent profits of firm 0 and firm 1 which calculate as follow:

$$\pi_i = (p_i - w_i)x_i, \qquad i = 0,1.$$

Similar to Ishida and Matsushima (2009), we assume that the public firm (firm 0) maximizes the social welfare subjected to $\pi_0 = (p_0 - w_0)x_0$ given w_0, and the private firm (firm 1) maximizes her profit as follow:

$$\max_{x_1} \pi_1 = (p_1 - w_1)x_1 = (1 - x_1 - \gamma x_0 - w_1)x_1$$

where w_1 is given for firm 1. Similar to Ishida and Matsushima (2009), we assume $\pi_0 \geq 0$.

2.5. Market Equilibrium

Solving the maximization problems of both unions (u_0, u_1), we obtain the market equilibrium both cases in unregulated and regulated the public firm. The equilibrium wage and output levels under the case in unregulated public firm, denoted as w_i^N and x_i^N, are given by:

$$\begin{aligned} w_0^N &= \frac{2\theta(1+\theta) - \theta\gamma - \theta^2\gamma^2}{2(1+\theta) - \theta^2\gamma^2}, \quad w_1^N = \frac{2\theta(1+\theta) - 2\theta\gamma - \theta^2\gamma^2}{2(1+\theta) - \theta^2\gamma^2}, \\ x_0^N &= \frac{2\left(2(1+\theta) - \gamma - \theta\gamma^2\right)}{\left(2-\gamma^2\right)\left(2(1+\theta) - \theta^2\gamma^2\right)}, \quad x_1^N = \frac{2(1+\theta) - 2\gamma - \theta\gamma^2}{\left(2-\gamma^2\right)\left(2(1+\theta) - \theta^2\gamma^2\right)}. \end{aligned} \tag{7}$$

On the other hand, the equilibrium wage and output levels under the case in unregulated public firm, denoted as w_i^R and x_i^R, are given by:

$$\begin{aligned} w_0^R &= \frac{k\theta(1-\gamma)}{(1+\theta)(1-\gamma k)}, \quad w_1^R = \frac{\theta(1-\gamma)}{(1+\theta)(1-\gamma k)}, \\ x_0^R &= \frac{2(1+\theta) - \gamma - \theta\gamma^2 - \left(2\theta + 2\gamma - (1+\theta)\gamma^2\right)k}{(1+\theta)(1-\gamma k)\left(2-\gamma^2\right)}, \quad x_1^R = \frac{1-\gamma}{(1+\theta)\left(2-\gamma^2\right)}. \end{aligned} \tag{8}$$

3. Re-examining the Propositions

We analyze the welfare difference between two wage settings for public servants, comparing them with the results of Ishida and Matsushima's model (2009).
First, we establish that the wage regulation either increases or decreases the wage, depending on γ.

Proposition 1: There exists a threshold $\overline{w}_0(\gamma)$ such that the wage regulation raises union 0's wage; i.e., $\overline{w}_0^R > \overline{w}_0^N$ for $k > \overline{w}_0(\gamma)$. Similarly, there exists a threshold $\overline{w}_1(\gamma)$ such that the wage regulation raises union 1's wage; i.e., $\overline{w}_1^R > \overline{w}_1^N$ for $k > \overline{w}_1(\gamma)$.
Proof: See the proof of Proposition 1 in Ishida and Matsushima (2009).

Next, we examine the conditions under which each union is better off under the wage regulation.

Proposition 2: There exists a threshold $\overline{u}_0(\gamma)$ such that the wage regulation makes union 0 better off for $k > \overline{u}_0(\gamma)$, and a threshold $\overline{u}_1(\gamma)$ such that the wage regulation makes union 1 better off for $k < \overline{u}_1(\gamma)$ when $\gamma \in (-1,0)$.
Proof: Using Eqns. (A. 7) and (A. 8) in Ishida and Matsushima (2009), we demonstrate in P. 1 that the wage regulation makes union 1 better off if

$$k < \frac{1}{\gamma}\left[1 - \frac{(1-\gamma)^2(8-\gamma^2)^2}{4(4-2\gamma-\gamma^2)^2}\right] = \overline{u}_1(\gamma) \quad if \quad \gamma \in (-1,0). \tag{P.1}$$

For the condition of $\overline{u}_0(\gamma)$, see Ishida and Matsushima (2009).

Q.E.D

The wage regulation decreases the public servants' wage and increases the quantity of good 0. If good 0 is substituted for good 1, the wage regulation never makes union 1 better off, as demonstrated in Ishida and Matsushima (2009). However, if good 0 is complementary to the 1, the wage regulation may make union 1 better off because increasing the demand for good 0 increases the demand for good 1. If the complementarity is sufficiently large, the wage regulation makes union 1 better off.

Both public and private firms seek to maximize profit, and so we investigate whether the wage regulation increases their profits, as demonstrated in Proposition 3.

Proposition 3: The wage regulation increases firm 1's profit at $\gamma \in (-1,0)$ and lowers firm 1's profit at $\gamma \in (0,1)$.
Proof: Using Eqns. (A. 9) and (A. 10) in Ishida and Matsushima (2009), we demonstrate that the wage regulation raises firm 1's profit if

$$\begin{aligned} &\pi_1^R > \pi_1^N \Leftrightarrow \gamma(\gamma^2 + \gamma - 4) > 0, \\ &\Rightarrow \frac{-1-\sqrt{17}}{2} < \gamma < 0, \quad or \quad \gamma > \frac{-1+\sqrt{17}}{2}, \end{aligned} \tag{P.2}$$

where π_1^N and π_1^R are denoted as profit of firm 1 under unregulated public firm and that under regulated public firm. Therefore, we observe in (P. 2) that the wage regulation increases firm 1's profit at $\gamma \in (-1,0)$.

For the case in $\gamma \in (0,1)$, see the proof of Proposition 3 in Ishida and Matsushima (2009).

Q.E.D

The wage regulation increases the demand for good 1 when it is complementary to good 0 because firms decrease the cost of wages and increase the production of their goods. Thus, firm 1's profit increases when good 0 is complementary to good 1.
The following two propositions (4 and 5) are similar to Ishida and Matsushima's (2009) results.

Proposition 4: There exists a threshold CS(γ), which is equal to $U - p_0 x_0 - p_1 x_1$, such that the wage regulation enhances consumer surplus if k<CS(γ).
Proof: See the proof of Proposition 4 in Ishida and Matsushima (2009).

Proposition 5: There exists a threshold W(γ) such that the wage regulation is efficient (enhances social welfare) if k<W(γ).
Proof: See the proof of Proposition 5 in Ishida and Matsushima (2009).

Unlike Ishida and Matsushima (2009), we can obtain the crucial result that the wage regulation can be Pareto-improving, as Proposition 6 demonstrates.

Proposition 6: Wage regulation can be Pareto-improving when public goods are moderately complementary to private goods.

Proof: Using proofs of Propositions 2, 4, and 5 in Ishida and Matsushima (2009) and the proof of Proposition 2' in the present study, we can compute the values of each k and present these values in Fig. 1. The wage regulation tends to be welfare-improving when γ is in the range from roughly −0.8 to zero. Because firm 1's profit increases in the range of negative γ, the wage regulation is Pareto-improving in this range.

Q.E.D

We can interpret Proposition 6 as follows. The wage regulation decreases both public and private wages, as shown in Fig. 2, in the range satisfying Proposition 6'. However, decreasing wages (i.e., firm costs) allow firms to produce more goods and increase their profits. According to the social welfare and consumer surplus theories, increasing both private and public goods increases both production and profits. To demonstrate the explanation, we provide a numerical example. We set $\gamma = 0.5$, $k = 0.9$, and $\theta = 1$. Table 1 reports the values of u_0, u_1, π_1,W, and CS under wage regulation and absent regulation. We can easily observe that all agents' utilities under the wage regulation are larger than those without it.

4. Conclusion

This study investigates the welfare comparison between two wage regulations for public servants: wage bargaining by the public firm's union versus a regulated, pre-determined wage-setting rule such as the "equal pay for equal work" principle. We demonstrate that the wage regulation can be Pareto-improving under a moderately strong complementary relationship between private and public goods because the complementarity enhances both goods' demand and increases both firms' output and wages. In this model, the wage regulation that decreases the wage of public servants causes Pareto improvement. Decreasing public servants' wages increases the production of public goods because of cost reduction. Increasing the demand for and supply of public goods increases the demand for private goods because of its complementarity. Thus, the Pareto improvement occurs in the presence of a moderately strong degree of complementarity.

We can apply this model to several extensions, such as mixed-oligopoly markets between several private firms and one public firm, and introducing an endogenous wage-setting rule, as found in Ishida and Matsushima (2009). Future studies will address these extensions.

References

P. Evans and G.Karras. (1994) "Are government activities productive? Evidence from a panel of U.S. states" *Review of Economic Statistics* 76: 1–11

A. Horiuchi and Q. Sui. (1993) "Influence of the Japanese Development Bank loan on corporate investment behavior" *Journal of the Japanese and International Economies* 7: 441–465

J. Ishida, N. Matsushima. (2009) "Should civil servants be restricted in wage bargaining? A mixed-duopoly approach" *Journal Public Economics* 93: 534–545

G.Karras. (1996) "The optimal government size: Further international evidence on the productivity of government services" *Economic Inquiry* 34: 193–203

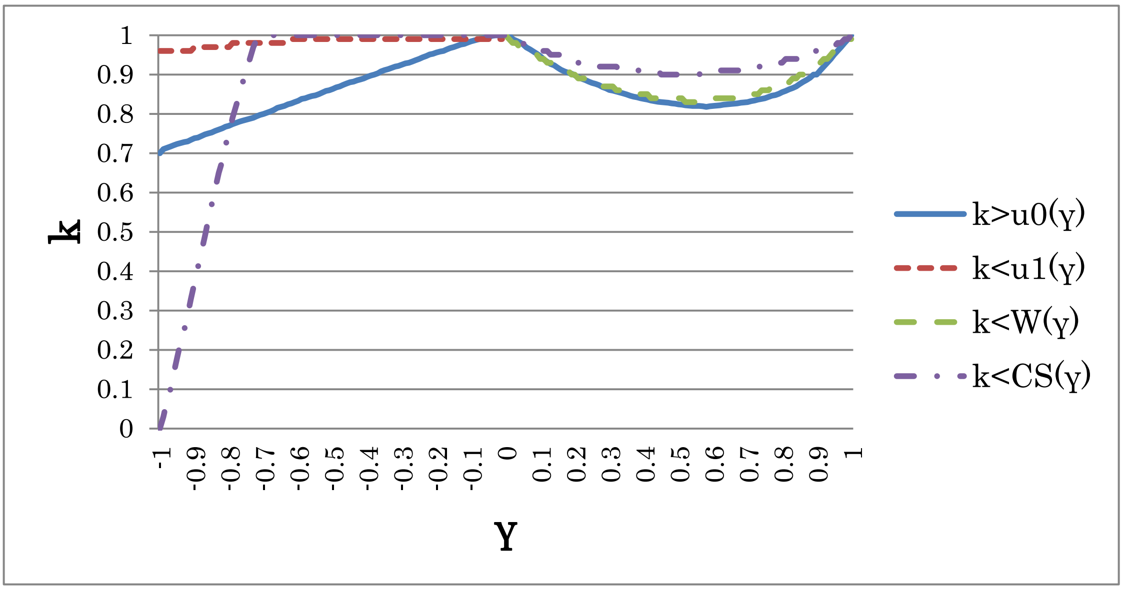

Fig 1 Public and private firm's unions, consumer surplus, and social welfare

Note:

There is no region at $\gamma \in (0,1)$ where the wage regulation enhances u_1.

The wage regulation always improves W at $\gamma \in (-1,0)$ and CS at $\gamma \in (-0.71,0)$.

The wage regulation enhances (u_0, u_1, W, CS) if $\left(k > \bar{u}_0(\gamma), k < \bar{u}_1(\gamma), k < \overline{W}(\gamma), k < \overline{CS}(\gamma)\right)$.

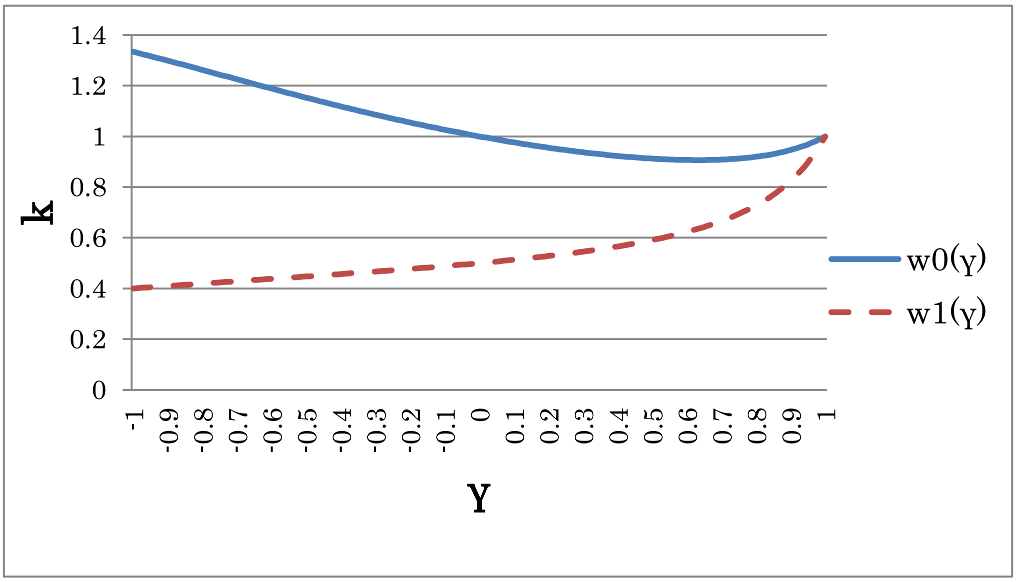

Fig. 2 Wages $\overline{w}_0(\gamma)$ and $\overline{w}_1(\gamma)$

Note: The wage regulation raises w_0 if $k > \overline{w}_0(\gamma)$.

The wage regulation raises w_1 if $\begin{matrix} k > \overline{w}_1(\gamma) & if & \gamma \in [0,1) \\ k < \overline{w}_1(\gamma) & if & \gamma \in (-1,0) \end{matrix}$.

Table 1 Numerical comparison with and without wage regulation.

Note: $\gamma = -0.5$, k = 0.9, and $\theta = 1$.

Variables	The value with wage regulation	The value without wage regulation
u_0	**0.347538**	0.34369
u_1	**0.221675**	0.214657
π_1	**0.183674**	0.108943
W	**0.965626**	0.828983
CS	**0.211714**	0.161694