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Efficiency wages and union-firm bargaining with private information

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Abstract. We consider efficiency wage effects in a union-firm bargaining model with private information. We show that an increase in the efficiency wage effects does not necessarily increase the wage level at equilibrium, even when the wage bargaining with private information is close to one with complete information. However, if it is commonly known that the firm is stronger than the union and the demand is sufficiently elastic, then an increase in the efficiency wage effects increases for sure the wage at equilibrium.

JEL Classification J41, J50, J52

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1 Introduction

Clearly, it is likely that when firms bargain with workers over wages they are also influenced by efficiency wage considerations.[1] Models of union bargaining with efficiency wages have been used to inquire into several considerations. Layard et al. (1991) have shown in a general equilibrium framework that unionization aggravates the unemployment due to efficiency wages. Recently, Garino and Martin (2000) have confirmed an original insight of Summers (1988) that efficiency wage effects lead to higher wages and result in lower employment. But all the previous

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[1] See Campbell (1993) or Konings and Walsh (1994).

studies have considered a complete information framework so that delays (strikes or lockouts) and inefficiencies cannot occur in equilibrium.

The purpose of this note is to provide a theoretical study of how efficiency wage effects will affect the outcome of wage negotiations in presence of private information. To describe the wage bargaining process, we adopt Rubinstein's (1982) alternating-offer bargaining model with two-sided incomplete information, which allows the occurrence of strikes at equilibrium. We show that an increase in the efficiency wage effects do not necessarily increase the wage level at equilibrium, even when the wage bargaining with private information is close to one with complete information. This result suggests that the impact of efficiency wage effects is not robust to a change in the information structure. Thereby economic policies supported by results within a complete information framework have to be taken cautiously. However, if it is commonly known that the firm is stronger than the union and the product demand is sufficiently elastic, then an increase in the efficiency wage effects still increases the equilibrium wage.

The note is organized as follows. In Sect. 2 the model under complete information is presented. Section 3 is devoted to the case with private information. In Sect. 4 the wage bargaining with almost complete information is studied.

2 The union-firm bargaining model

We consider a wage determination model with incomplete information between a firm and a union. The firm is risk neutral and profit-maximizer. Firm's technology is characterized by a production function $Q = (EL)^{\alpha}$ with $0 < \alpha \leq 1$, where L is the level of employment and E is the effort per worker. The firm faces a demand function $Q = P^{-\varepsilon}$ with constant elasticity of demand ε, where P is output price. Firm's profits are given by $\Pi = P \cdot (EL)^{\alpha} - WL$, where W is the wage level. There is a continuum of identical risk-neutral workers who supply each one unit of labor with no disutility. We denote by $\overline{W}$ the expected income of a worker who loses his job. It may be interpreted as the unemployment benefit or the wage elsewhere. Workers are represented in the wage bargaining process by a utilitarian union. The continuum of workers who supply labor is normalized to unity. Hence, the union's utility is given by $U = L \cdot W + (1 - L) \cdot \overline{W}$.

We adopt Summers (1988) and Layard et al. (1991) functional form of efficiency wage effects,[2]

$$E = \left(\frac{W - \overline{W}}{\overline{W}} \right)^{\lambda}, \text{ with } \lambda < 1 \tag{1}$$

where E measures the effort put forth by workers which depends of the wage paid by the firm relative to the wage workers expect to earn elsewhere, and λ measures the productivity enhancing effects of paying higher wages. If $\lambda = 0$, efficiency wage

[2] Distinct microeconomic approaches that justify the relation between wages and productivity have been provided: shirking models, labor-turnover models, adverse selection, sociological models. See Yellen (1984) and Layard et al. (1991).

considerations are absent. As λ increases, they become more important. Interactions between the output and price decision, and the wage level are analyzed according to the following structure. First, wages are determined by negotiations between the firm and the union. Second, the firm chooses employment, output and price. The model is solved backwards.

Taking as given the wage level, the output and the employment levels that maximize the profits of the firm are

$$Q^* = \left[\left(\frac{\varepsilon}{\varepsilon-1}\right)\frac{W}{\alpha E}\right]^{\frac{-\varepsilon\alpha}{\alpha+\varepsilon(1-\alpha)}} \text{ and } L^* = \frac{1}{E}\left[\left(\frac{\varepsilon}{\varepsilon-1}\right)\frac{W}{\alpha E}\right]^{\frac{-\varepsilon}{\alpha+\varepsilon(1-\alpha)}}, \quad (2)$$

respectively. The firm and the union negotiate the wage level foreseeing perfectly the effect of wages on output and employment levels. The negotiation proceeds as in Rubinstein's (1982) alternating-offer bargaining model. The firm and the union make alternatively wage offers, with the firm making offers in odd-numbered periods and the union making offers in even-numbered periods. The negotiation ends when one of the negotiators accepts an offer. No limit is placed on the time that may be expended in bargaining and perpetual disagreement is a possible outcome. The union is on strike in every period until an agreement is reached. Both negotiators are assumed to be impatient: the firm and the union have time preferences with constant discount rates $r_f > 0$ and $r_u > 0$, respectively.

As the interval between offers and counteroffers is short and shrinks to zero, the alternating-offer model has a unique limiting subgame perfect equilibrium, which approximates the Nash bargaining solution to the bargaining problem (see Binmore et al., 1986). Thus the predicted wage is given by

$$W^* = \arg\max\,[U - U_0]^{\gamma} \cdot [\Pi - \Pi_0]^{1-\gamma} \quad (3)$$

where $U_0 = \overline{W}$ and $\Pi_0 = 0$ are, respectively, the disagreement payoffs of the union and the firm, and $\gamma \in (0,1)$ is the union bargaining power which is equal to $\frac{r_{\mathrm{f}}}{r_{\mathrm{u}}+r_{\mathrm{f}}}$. Simple computation gives us

$$\begin{aligned} W^* &= \overline{W} \cdot \left[\frac{\alpha(\varepsilon-1)(1-\gamma)+\varepsilon\gamma}{\alpha(\varepsilon-1)(1-\lambda)}\right] \\ &= \overline{W} \cdot \left[\frac{\alpha(1-\gamma)+\phi\gamma}{\alpha(1-\lambda)}\right], \end{aligned} \quad (4)$$

where $\phi = \frac{\varepsilon}{\varepsilon-1}$ is the mark-up of price over marginal cost. This is the wage expression Garino and Martin (2000) obtained and it tells us that, in complete information, the wage is increasing with the union bargaining power (γ) and the efficiency wage effects (λ), but is decreasing with the elasticity of demand (ε). Notice that the efficiency wage effects on the wage outcome W^* are increasing with the union bargaining power $\gamma : \frac{\partial^2 W^*}{\partial\lambda\partial\gamma} > 0$.

Then, from (4) one can easily obtain the equilibrium employment level as well as the equilibrium payoffs, which are denoted by $U^*(\gamma)$ and $\Pi^*(\gamma)$. However, both the asymmetric Nash bargaining solution and the Rubinstein's model predict efficient outcomes of the bargaining process (in particular agreement is settled immediately). This is not the case once we introduce incomplete information into the wage bargaining, in which the first rounds of negotiation are used for information transmission between the two negotiators.

3 Wage bargaining with private information

The main feature of the negotiation is that both negotiators have private information. Each negotiator does not know the impatience (or discount rate) of the other party. It is common knowledge that the firm's discount rate is included in the set $[r_f^{\mathrm{P}}, r_f^{\mathrm{I}}]$, where $0 < r_f^{\mathrm{P}} \leq r_f^{\mathrm{I}}$, and that the union's discount rate is included in the set $[r_u^{\mathrm{P}}, r_u^{\mathrm{I}}]$, where $0 < r_u^{\mathrm{P}} \leq r_u^{\mathrm{I}}$. The superscripts "I" and "P" identify the most impatient and most patient types, respectively. The types are independently drawn from the set $[r_i^{\mathrm{P}}, r_i^{\mathrm{I}}]$ according to the probability distribution p_i, for $i =$u,f. We allow for general distributions over discount rates. This uncertainty implies bounds on the union bargaining power which are denoted by $\underline{\gamma} = r_f^{\mathrm{P}} \cdot \left[r_u^{\mathrm{I}} + r_f^{\mathrm{P}}\right]^{-1}$ and $\overline{\gamma} = r_f^{\mathrm{I}} \cdot \left[r_u^{\mathrm{P}} + r_f^{\mathrm{I}}\right]^{-1}$.

Lemma 1. *Consider the wage bargaining with incomplete information in which the distributions p_f and p_u are common knowledge, and in which the period length shrinks to zero. For any perfect Bayesian equilibria (PBE), the payoff of the union belongs to $\left[U^*(\underline{\gamma}), U^*(\overline{\gamma})\right]$ and the payoff of the firm belongs to $\left[\Pi^*(\overline{\gamma}), \Pi^*(\underline{\gamma})\right]$.*

This lemma follows from Watson's (1998) analysis of Rubinstein's alternating-offer bargaining model with two-sided incomplete information.[3] Lemma 1 is not a direct corollary to Watson's (1998) Theorem 1 because Watson's work focuses on linear preferences, but the analysis can be modified to handle the present case. Translating Watson (1998) Theorem 2 to our framework completes the characterization of the PBE payoffs.

Lemma 2. *Consider the wage bargaining with incomplete information in which the period length shrinks to zero. For any $\widetilde{U} \in [U^*(\underline{\gamma}), U^*(\overline{\gamma})]$, $\widetilde{\Pi} \in [\Pi^*(\overline{\gamma}), \Pi^*(\underline{\gamma})]$, there exists distributions p_u and p_f, and a PBE such that the PBE payoffs are $\widetilde{U}$ and $\widetilde{\Pi}$.*

In other words, whether or not all payoffs within the intervals given in Lemma 1 are possible depends on the distributions over types. As Watson (1998) has stated, Lemma 1 and Lemma 2 establish that "each player will be no worse than he would be in equilibrium if it were common knowledge that he were his least patient type and the opponent were his most patient type. Furthermore, each player will be no better

[3] Watson (1998) characterized the set of PBE payoffs which may arise in Rubinstein's alternating-offer bargaining game and constructed bounds (which are met) on the agreements that may be made. The bounds and the PBE payoffs set are determined by the range of incomplete information and are easy to compute because they correspond to the SPE payoffs of two bargaining games of complete information. These two games are defined by matching one player's most impatient type with the opponent's most patient type.

than he would be in equilibrium with the roles reversed".[4] The next proposition follows from Lemma 1.

Proposition 1. *The wage bargaining outcome, $W^*(\underline{\gamma}, \overline{\gamma})$, satisfies the following inequalities:*

$$\overline{W} \cdot \left[\frac{\alpha(\varepsilon-1)(1-\underline{\gamma})+\varepsilon\underline{\gamma}}{\alpha(\varepsilon-1)(1-\lambda)}\right] \leq W^*(\underline{\gamma}, \overline{\gamma}) \leq \overline{W} \cdot \left[\frac{\alpha(\varepsilon-1)(1-\overline{\gamma})+\varepsilon\overline{\gamma}}{\alpha(\varepsilon-1)(1-\lambda)}\right]. \tag{5}$$

Notice that each wage satisfying these bounds can be the outcome by choosing appropriately the distribution over types. The lower (upper) bound is the wage outcome of the complete information game, when it is common knowledge that the union's type is $r_{\mathrm{u}}^{\mathrm{I}}$ ($r_{\mathrm{u}}^{\mathrm{P}}$) and the firm's type is $r_{\mathrm{f}}^{\mathrm{P}}$ ($r_{\mathrm{f}}^{\mathrm{I}}$) (and the union bargaining power is $\underline{\gamma}$ ($\overline{\gamma}$)). Expression (5) implies bounds on the firm's employment level, as well as on the firm's output, at equilibrium.

In complete information, an increase in the efficiency wage effects increases the equilibrium wage level. But once the union and the firm have private information, this complete information result does not necessarily hold.

Corollary 1. *In case of union-firm bargaining with private information, increases in the efficiency wage effects do not necessarily increase the wage level in equilibrium despite the presence of productivity enhancing effects of paying higher wages.*

We denote by $\overline{\lambda} \geq 0$ the efficiency wage effects parameter before an increase takes place; $\overline{\lambda} = 0$ is the case where originally there is no efficiency wage effect. Let θ be the increase in the efficiency wage effects with $\theta < 1 - \overline{\lambda}$. That is, $\lambda = \overline{\lambda} + \theta$ is the new value of the efficiency wage effects parameter. Corollary 1 is due to the multiplicity of equilibria. Suppose that, given a monitoring technology[5] and its associated efficiency wage effects parameter $\overline{\lambda}$, the union and the firm reach a wage agreement close to the upper bound in (5), i.e. the wage outcome of the complete information game when it is known that the union bargaining power is $\overline{\gamma}$. Suppose now that the firm adopts a more effective monitoring technology ($\overline{\lambda} + \theta$). This adoption modifies the bargaining environment and can induce the bargaining process to switch to an equilibrium close to the lower bound in (5). For

[4] Inefficient outcomes are possible, even as the period length shrinks to zero. Inefficiency can occur in two ways. First, players might agree to throw away some of the resource over which they are bargaining, even when agreement is reached without delay. Second, the negotiation may involve considerable delay, even if the eventual agreement is efficient on its own. The wage bargaining game may involve delay (strikes or lockouts), but not perpetual disagreement. See Watson (1998) and Mauleon and Vannetelbosch (2003).

[5] In shirking models, there are alternative mechanisms or technologies for the enforcement of discipline. A particular mechanism for the enforcement of discipline implies that individuals who are detected shirking are fired. Higher wages might discourage individual shirking, by giving the worker more to lose if he were caught and fired. Another mechanism by which discipline might be enforced is through the posting by workers of performance bonds. Under this arrangement the worker forfeit the bond if the firm detected him shirking. There is evidence that the cost of monitoring and the monitoring technology differ from industry to industry. See Shapiro and Stiglitz (1984) and Layard et al. (1991).

instance, since the firm has a better device to deter shirking, the firm may decide to update much more optimistically his beliefs about the union bargaining power (putting probability one on his weakest type) in case the union deviates from the equilibrium path. The new beliefs lead to a continuation game in which the union's prospects have diminished, which deters deviation in the first place and supports the equilibrium close to the lower bound in (5).[6] In this case, if the increase θ in the efficiency wage effects is not too large, then the new wage agreement might even be smaller than the one reached before the adoption of the new monitoring technology. Of course, there are always equilibria where this adoption leads to an increase of the wage level.

Let

$$\theta^* = \left(1 - \overline{\lambda}\right)\left[1 - \frac{\alpha(\varepsilon - 1)(1 - \underline{\gamma}) + \varepsilon\underline{\gamma}}{\alpha(\varepsilon - 1)(1 - \overline{\gamma}) + \varepsilon\overline{\gamma}}\right] \tag{6}$$

be the cutoff value on θ which is obtained from Proposition 1. Whenever $\theta < \theta^*$ then the standard result of complete information may not hold : an increase in the efficiency wage effects does not necessarily increase the wage level in equilibrium. The smaller $\overline{\lambda}$ is and the larger the amount of private information $\left|\overline{\gamma} - \underline{\gamma}\right|$ is, the larger the cutoff value θ^* is. So, when the increase θ is small, it is likely this increase may not lead to an increase of the equilibrium wage, because the increase of productivity enhancing effects may not dominate the indeterminacy of the wage bargaining with two-sided incomplete information. As already mentioned one can always find probability distributions over types such that the equilibrium wage is higher in the absence of efficiency wage effects or is decreasing whenever efficiency wage effects are increasing.

The necessary and sufficient condition such that the complete information result always holds is $\theta \geq \theta^*$.[7] That is, whenever an increase in the efficiency wage effects is sufficiently large, then the standard result of complete information is recovered : efficiency wage effects increase the wage at equilibrium, even in case of union-firm bargaining with private information.

Cutcher-Gershenfeld et al. (1998), in their study on how do labour and management view collective bargaining in the US, have suggested that union leaders see themselves as being under a broader range of pressures, and that these pressures are more severe than the pressures perceived by management counterparts. In this respect, it is generally assumed that workers are less patient than entrepreneurs giving the firms more negotiation power. Nonetheless, using a Spanish collective bargaining in large firms survey, Diaz-Moreno and Galdon-Sanchez (2000) have found that estimated values of the discount factors of workers and entrepreneurs are very similar.

[6] Perfect Bayesian equilibrium allows great latitude for such revision of beliefs, because it occurs off the equilibrium path.

[7] When the product demand is inelastic, it could be that there does not exist a cutoff value smaller than $1 - \overline{\lambda}$ such that any increase in the efficiency wage effects greater than the cutoff value leads for sure to an increase of the wage level.

When the product demand is elastic and it is commonly known that the firm is stronger than the union, then the cutoff value θ^* is bounded above by

$$\overline{\theta} = \left(1 - \overline{\lambda}\right) \left[\frac{\varepsilon - \alpha(\varepsilon - 1)}{\varepsilon + \alpha(\varepsilon - 1)}\right] < 1 - \overline{\lambda}.$$

Any increase $\theta \geq \overline{\theta}$ in the efficiency wage effects will increase for sure the wage at equilibrium. The more elastic the demand is the smaller $\overline{\theta}$ is.

Corollary 2. *Suppose the product demand is elastic* $(\varepsilon > 1)$ *and it is commonly known that the firm is stronger than the union* $(\overline{\gamma} \leq .5)$. *Then, any increase* $\theta \geq \overline{\theta}$ *in the efficiency wage effects increases for sure the equilibrium wage.*

So, when the product demand is very elastic, a small (but not too small) increase in the efficiency wage effects will increase for sure the wage level. The intuition behind this corollary is the following one. Incomplete information in the model takes into account two main features. The first one is the amount of private information in possession of the players. By the amount of private information we mean the size of the set in which player's discount rate is contained and which is common knowledge between the players. The second one is the uncertainty about who is the more patient player, i.e. who is the stronger player. When it is common knowledge that the firm is stronger, this second feature disappears, and information tends to play a less crucial role in the process of the negotiation between the firm and the union. Moreover, the more elastic the product demand is, the smaller the mark-up of price over marginal cost is, and the less uncertainty there is in the wage bargain. Therefore, the complete information result is recovered once it is common knowledge that the firm is stronger than the union and that the product demand is sufficiently elastic.

4 Wage bargaining with almost complete information

The previous analysis establishes bounds on the PBE payoffs, but it says nothing about the possible payoff vectors inside the bounds. Diaz-Moreno and Galdon-Sanchez (2000) have argued that assuming complete information may seem more sensible than assuming private information, because unions are represented in the board of directors in large companies. Moreover, large firms must be audited by law and that information is public and widely available.[8] So, it would be interesting to study the set of payoffs and the set of wages that are supported by perfect Bayesian equilibria in the wage bargaining game which is "close" to having complete information.

Watson (1998) has also studied the PBE payoff set of Rubinstein's alternating-offer game under arbitrary sequences of distributions over the players' types which

[8] However, Cutcher-Gershenfeld et al. (1998) have reported that union and management perceptions of factors heavily influencing negotiations are quite different. The data also indicates that low trust is a key factor to take into account during negotiations.

have the same (possibly wide) support[9], yet which converge to a point mass distribution. That is, he has examined bargaining games in which with high probability a player's discount rate is close to a certain value, yet there is a slight chance that the player's discount rate is much higher or much lower. He has shown that the set of equilibrium payoffs does not converge to that of the complete information, despite that the game converges to one of complete information. More precisely, the set converges from above but not from below in the sense that a player cannot gain if there is a slight chance that he is very patient (has a low discount rate), yet he can suffer if there is a slight chance that he is impatient. In other words, a slight chance of being a patient type can't help a player, whereas a slight chance of being impatient can certainly hurt. The limiting set of equilibrium payoffs is defined by each player's greatest possible discount rate and the limiting discount rates; the players' lowest possible discount rates do not play a role. Watson's main result and analysis can be extended to our wage bargaining.

Suppose that there is three possible types for both the unions and the firms: r_i^{P}, r_i^*, r_i^{I} where $r_i^{\mathrm{P}} < r_i^* < r_i^{\mathrm{I}}$, for $i =$u,f. Suppose the distribution over these types $\left(r_i^{\mathrm{P}}, r_i^*, r_i^{\mathrm{I}}\right)$ is $(\beta, 1-2\beta, \beta)$ for both the unions and the firms; β is the probability that player i's discount rate is r_i^{P}, $1-2\beta$ is the probability that player i's discount rate is r_i^*, and β is the probability that player i's discount rate is r_i^{I}. Then, we might wish to know how the set of PBE payoffs or the wage outcomes change as β converges to zero, where there is only a slight chance that player i is either of type r_i^{P} or type r_i^{I}. From Watson's (1998) Theorem 3, it follows that, as β converges to zero, PBE wage outcomes are such that:

$$\frac{\overline{W}\left[\alpha(\varepsilon-1)\frac{r_{\mathrm{u}}^{\mathrm{I}}}{r_{\mathrm{u}}^{\mathrm{I}}+r_{\mathrm{f}}^*}+\varepsilon\frac{r_{\mathrm{f}}^*}{r_{\mathrm{u}}^{\mathrm{I}}+r_{\mathrm{f}}^*}\right]}{\alpha(\varepsilon-1)(1-\lambda)} \leq W^*\left(r_i^{\mathrm{P}}, r_i^*, r_i^{\mathrm{I}}\right) \leq \frac{\overline{W}\left[\alpha(\varepsilon-1)\frac{r_{\mathrm{u}}^*}{r_{\mathrm{u}}^*+r_{\mathrm{f}}^{\mathrm{I}}}+\varepsilon\frac{r_{\mathrm{f}}^{\mathrm{I}}}{r_{\mathrm{u}}^*+r_{\mathrm{f}}^{\mathrm{I}}}\right]}{\alpha(\varepsilon-1)(1-\lambda)}.$$

This result tells us that the PBE wages do not converge to a single wage, despite that the distribution over types converges to a point mass distribution. The necessary and sufficient condition such that an increase in the efficiency wage effects increases for sure the equilibrium wage is

$$\theta \geq \left(1-\overline{\lambda}\right)\left[1-\frac{\alpha(\varepsilon-1)\frac{r_{\mathrm{u}}^{\mathrm{I}}}{r_{\mathrm{u}}^{\mathrm{I}}+r_{\mathrm{f}}^*}+\varepsilon\frac{r_{\mathrm{f}}^*}{r_{\mathrm{u}}^{\mathrm{I}}+r_{\mathrm{f}}^*}}{\alpha(\varepsilon-1)\frac{r_{\mathrm{u}}^*}{r_{\mathrm{u}}^*+r_{\mathrm{f}}^*}+\varepsilon\frac{r_{\mathrm{f}}^{\mathrm{I}}}{r_{\mathrm{u}}^*+r_{\mathrm{f}}^{\mathrm{I}}}}\right]=\widehat{\theta}.$$

This cutoff value $\widehat{\theta}$ is smaller than the cutoff value for the general case with two-sided incomplete information, θ^*.

Corollary 3. *There exists union-firm bargaining with almost complete information where increases in the efficiency wage effects do not necessarily increase the wage level in equilibrium.*

The convergence result is lopsided. Indeed, suppose that the firm's type is known, while the union's type is private information to him: the union's discount

[9] If r_i^{P} and r_i^{I} converge (for $i =$u,f) then the PBE payoffs of the incomplete information game converge to the unique SPE payoff vector of some complete information game.

rate is either $r_{\rm u}^{\rm P}$ or $r_{\rm u}^{\rm I}$ with $r_{\rm u}^{\rm P} < r_{\rm u}^{\rm I}$. Then, we have that: (i) if the probability of the patient type ($r_{\rm u}^{\rm P}$) is small then the PBE wages will be close to the unique SPE wage of the complete information game in which the union's discount rate is $r_{\rm u}^{\rm I}$; (ii) if the probability of the impatient type ($r_{\rm u}^{\rm I}$) is small then there is a wide range of PBE wages; there are PBE in which the wage is close to

$$\frac{\overline{W}}{\alpha(\varepsilon-1)(1-\lambda)} \cdot \left[\alpha(\varepsilon-1)\frac{r_{\rm u}^{\rm P}}{r_{\rm u}^{\rm P}+r_{\rm f}} + \varepsilon\frac{r_{\rm f}}{r_{\rm u}^{\rm P}+r_{\rm f}}\right]$$

and there are PBE in which the wage is close to

$$\frac{\overline{W}}{\alpha(\varepsilon-1)(1-\lambda)} \cdot \left[\alpha(\varepsilon-1)\frac{r_{\rm u}^{\rm I}}{r_{\rm u}^{\rm I}+r_{\rm f}} + \varepsilon\frac{r_{\rm f}}{r_{\rm u}^{\rm I}+r_{\rm f}}\right].$$

For this one-sided incomplete information game, the necessary and sufficient condition such that an increase in the efficiency wage effects increases for sure the equilibrium wage is

$$\theta \geq \left(1-\overline{\lambda}\right)\left[1-\frac{\alpha(\varepsilon-1)\frac{r_{\rm u}^{\rm I}}{r_{\rm u}^{\rm I}+r_{\rm f}} + \varepsilon\frac{r_{\rm f}}{r_{\rm u}^{\rm I}+r_{\rm f}}}{\alpha(\varepsilon-1)\frac{r_{\rm u}^{*}}{r_{\rm u}^{*}+r_{\rm f}} + \varepsilon\frac{r_{\rm f}}{r_{\rm u}^{*}+r_{\rm f}}}\right] \tag{7}$$

The right-hand side expression is the cutoff $\widehat{\theta}$ where $r_{\rm f}^{*}$ and $r_{\rm f}^{\rm I}$ have been replaced by $r_{\rm f}$. If there is a slight chance that the union is patient then condition (7) always holds. However, if there is a slight chance of being impatient then condition (7) might be violated.[10] This result is robust to other cases close to complete information, for instance when union's type is known while firm's type is private information. In this case the cutoff is given by $\widehat{\theta}$ where $r_{\rm u}^{*}$ and $r_{\rm u}^{\rm I}$ have been replaced by $r_{\rm u}$.

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[10] This lopsided convergence follows from the construction of PBE strategies, where players will punish one another if they depart from their equilibrium strategies. An effective form of punishment in the bargaining game is that when a player takes some deviant action, beliefs about him are updated *optimistically* -putting probability one on his weakest type. The existence of a very impatient type (a type near $r_i^{\rm I}$ as compared to r_i^{*}) allows the threat of such a revision of beliefs, however small is the probability of the impatient type. The existence of a very patient type has little effect, since it would not be used in punishing a player.

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