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RESTRUCTURING OF PUBLIC ENTERPRISES UNDER POLITICAL CONSTRAINT*

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A typical public enterprise suffering from low productivity and overemployment may be reformed by removing protective measures and/or offering new incentive schemes. This paper addresses issues of resturcturing through incentive wage scheme. The key factor in the process of restructuring is the possible resistance of existing workers to reform plan. Hence, political constraint which requires utility level under reform to be at least equal to pre-reform level incurs substantial financial costs of reform. This paper follows to the spirit of Dewatripont and Roland (1992), but elaborates and enriches their model to analyse the optimal static and dynamic reform plan under general settings along game theoretic approach.

I. INTRODUCTION

Restructuring of public enterprises together with privatization attract much attention of reform minded economists and policy authorities in capitalist and socialist economies. In the latter, major concern is related to the transition from plan to market economy, while in the former major concern is related to the transformation of big government to small but efficient one. The performance of typical public enterprise in capitalistic regime can be depicted as low productivity and overemployment due to some protective measures and/or lack of adequate incentives. Hence, general feature of restructuring is to enhance the productivity by offering new incentive scheme or removing protective measures. Restructuring, however, incurs massive layoffs in the process.[1] This paper addresses only the issues

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[1] Privatization of public enterprises in usual sense refers to transferring its ownership and managerial control from government to private sector. Despite that one of goals of privatization is to enhance efficiency through restructuring, privatization plan does not usually include restructuring. An ex-

of restructuring associated with incentive wage scheme.

The key in the process of restructuring is the possible resistances of existing workers.[2] Resistances of specific groups appear if reform proposal is expected to make them worse off. Under political constraint, disapproval of specific groups can be enough to prevent reform plans from being implemented. Hence, for reform proposals to be implemented, utility level of existing workers under reform should be at least equal to the pre-reform level. The very existence of political constraint in the process of reform seems to be innocuous in a sense that it is effective in securing the interests of both workers and firm.

In real world, restructuring is initiated by the firm who is in control of the agenda of reform proposal. The firm, however, due to lack of information on the characteritics of workers can not make personalised proposal to each worker. In terms of game theoretic approach, reform proposal constitutes an offer of optimal incentive scheme under information asymmetry and continuing relation. Under the circumstances, reform proposal is supposed to meet two constraints. One is ordinary incentive compatibility constraint, and the other is political constraint which is equivalent to participation constraint. If political constraint is violated, workers does not have to participate the reform (game). Furthermore, reform proposal is a screening device in a sense that the firm, uninformed agent, moves first to avoid adverse selection.[3]

The purpose of this paper is to analyse and clarify the arguments relevant to

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planation to the exclusion of restructuring may be that productivity improvements are made automatically in a competitive market environment once privatization has been done. In the situation, government runs risk of being perceived not to play any notorious role to downsize the firm. Consequently, privatization plan is strongly suggested to include restructuring. Restructuring had better precede privatization to achieve the higher firm value. Discussions on privatization are recent but diverse and vast. Refer to Kang (1988) and Kim (1994) among others. The extensive analyses on restructuring are flourished in Eastern Europe in the transition from plan to market economy. Refer to Carlin and Mayer (1992), Bolton and Roland (1992) among others.

[2] The economic aspects of resistance to reform has been the object of extensive analysis. Fernandez and Rodrick (1991) show that there is a bias towards the status quo (against efficiency enhancing reforms) whenever some of the gainers and losers from reforms can not be identified a priori. Thus, there are reforms which, once adopted, will receive adequate political support but would have failed to carry ex ante. Alternative explanation of resistance comes from the inference that gains and losses from reform are likely to be distributed over economic units in nonneutral way. In voting model (Mayer and Riezman, 1987), the median voter may prefer the status quo to reform that would increase economic welfare in aggregate due to the nonneutrality of distributional consequences.

[3] The literatures on self-selection are diverse and vast. The common features of a principal and multi-agents relations are how to design proper incentive schemes for the revelation of agent's true characteristics to avoid adverse selection (Myerson, 1979). In the restructuring process, the firm offers reform proposal which includes higher wage and higher effort level compared to pre-reform state. If some workers accept the proposal and others do not for their own interests, self-selection is made in the process of restructuring.

restructuring in a simplified static and dynamic model. Our analysis follows basically to the spirit of Dewatripont and Roland (1992). But, we elaborate and enrich their model to analyse the optimal reform plan under general settings along game theoretic approach.

In section II, we briefly describe the model. In section III, we analyse the condition regarding optimal employment level under reform in terms of static model. In section IV, we do comparative statics to show that increases in productivity inevitablely lead to layoffs and moderate shift in productivity is more preferable to steep shift under certain circumstances. In section V, we extend the model of section III to dynamic reform model with commitment, and derive optimal reform schedule and specify the condition under which optimal dynamic reform plan can be implemented. In section VI, we address summary and concluding remarks.

Ⅱ. DESCRIPTION OF MODEL

We present a model of a typical public firm in need of restructuring. Basic assumptions in our model can be listed as follows.

(A.1) There is a continuum of workers indexed by type x, and there is one worker per each type. The type x distributes uniformly over the range of $[x_{min}, x_{max}]$.

(A.2) There exits an asymmetric information regarding the types of workers.

(A.3) When worker does work, hours are fixed at unity and this can not be varied. Hence, the decision to work is a (0, 1) decision.

(A.4) Disutilities of unit labor depend on the effort level (level of work intensity) e, and the type of worker x. The disutility function of concerned worker can be seperable as in (1). In (1), c(x) refers to disutility of unit labor of type x and is a strictly increasing continuous function in x with constant elasticity, ε.

$$c(\cdot) = c(e, x) = e \cdot c(x) \qquad (1)$$
$$c'(x) > 0,\ c''(x) > 0,\ \varepsilon = c'(x) \cdot x/c$$

(A.5) Each worker's productivity measured by output per worker is invariant to types, but depends on the effort level e endeavoured by worker. Output per worker $q(e)$ has decreasing return to scale in e. For simplicity, the price of output is normalized to 1.

(A.6) Before reform, each worker employed works at $e_0 = 1$, and production technology can be denoted by $\{q(e_0), e_0 = 1\}$.

(A.7) Reform proposal is subject to political constraint, which implies that unanimity rule of existing workers is required for the implementation of reform plan.

The net utility of worker of type x with the level of effort e can be denoted by (2). Before reform, the firm pays an uniform wage w_0 and employs all the workers who are willing to work at the wage level. Initial employment level is denoted by (3),[4] and the pre-reform utility level of worker of type x can be written as (4), where information rents are negatively correlated with disutility of unit labor.

$$u(x) = w - e \cdot c(x) \tag{2}$$

$$x_0 = c^{-1}(w_0) \tag{3}$$

$$u_0(x) = w_0 - 1 \cdot c(x), \text{ for } x \leq x_0 \tag{4}$$

Ⅲ. ANALYSIS OF STATIC MODEL

3.1 Static Model Without Political Constraint

The firm acts as the agenda setter, having the initiative in offering reform proposals. As the intention of reform is to upgrade the productivity of worker, higher wage is paid in return for higher effort level. The analysis of this section on which political constraint is not imposed provides the basis for the next section.

A timeless static reform proposal is to offer the menu of $\{w_r, e_r\}$ where $w_r \geq w_0$, $e_r \geq e_0$.[5] Thus, reform proposal modifies the production technology $\{q(e_0), e_0 = 1\}$ under status quo to $\{q(e_r), e_r \geq 1\}$. As can be seen in ⟨Figure-1⟩, at w_r and e_r, only workers whose disutility is lower than w_r will vote for the proposal. In the meanwhile, all the workers whose type x holds $x_m < x \leq x_0$, where x_m is the marginal worker who is indifferent between being employed and unemployed under reform, will vote against the proposal. In the absence of political constraint, however, reform proposal can be implemented without full consent of

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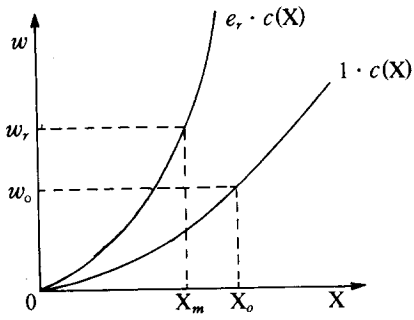
[4] In Korea, government invested public firms usually pay higher wage than the wage paid to public officials. Thus, w_0 may be higher than the reservation wage a worker can earn elsewhere. There is no moral hazard due to efficiency wage. The x_0 can be overemployment if the value of marginal product of unit labor is less than w_0 (i.e. q(1) $< w_0$).

[5] To the contrary of usual self-selection model, there is a single menu of $\{w_r, e_r\}$ in our model. Similar situations to our restructuring concern can be observed in real world. For example, an auto insurance company who suffers from operating loss tries to discriminate careless drivers by offerring new premium policy. The new premium policy may consist of 10% discounted premium rates coupled with tripled deduction in case of accident. Since careless drivers who may commit accident rather frequently would not accept the new policy for their own interests, the insurance company succeeds in picking up careless drivers from the insurance pool.

[Figure 1]



existing workers, and furthermore exit bonus, b need not even be paid to the workers who quit.

The firm tries to maximize the net allocative surplus (net social welfare) minus the distortionary costs of government subsidies. The objective function of the firm, $V^*(w_r, e_r)$ can be formulated as in (5).[6]

$$V^*(\cdot) = \underset{x_m}{\text{Max}}\,[q(e_r) \cdot x_m - e_r \cdot \int_0^{x_m} c(x)dx] - \lambda \cdot [w_r \cdot x_m - q(e_r) \cdot x_m]$$

$$s.t.\ w_r = e_r \cdot c(x_m) \qquad (5)$$

The first order condition regarding the optimal employment level x^{**} for given e_r can be written as (6).[7] An intuition of (6) is straightforward. The first term is the marginal revenue related to employing one more unit of worker. Marginal revenue consists of increases in output and decreases in distortionary costs due to reduction in sudsidies by $q(e_r)$. The second term is the marginal cost of employing one more unit of worker. Marginal cost consist of extra wage bill required to attract one more unit of worker and increases in distortionary costs due to increases in subsidies. Hence, (5) is analogous to the traditional condition regarding optimal employment choice.

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[6] The specification of objective function follows that of Dewatripont and Roland (1992). As the concerned firm is state-run firm, allocative surplus is an important concern as well. If we rewrite (5), we have $V^*(\cdot) = [\cdot] + \lambda \cdot [q(e_r) \cdot x_m - w_r \cdot x_m]$. The second bracket term refers to operating profit. As profit of \$ 1 can substitute taxation of \$ 1, λ can also be interpreted as the costs of collecting taxes of \$ 1.

[7] Refer to appendix for the derivation of (6). In appendix, the general case with political constraint is analysed.

$$(1 + \lambda) \cdot q(e_r) - [1 + \lambda \cdot (1 + \varepsilon)] \cdot e_r \cdot c(x^{**}) = 0 \qquad (6)$$
$$\text{where } \varepsilon = c'(x) \cdot x/c$$

In the reform schedule of $\{w_r, e_r\}$, e_r is key variable. Once e_r is set to target level, the optimal employment level can be obtained by solving (6). Then, wage level can be obtained by backwards calculation. Specifically, wage level is chosen to induce the marginal worker (of optimal employment pool) to stay to work.

3.2 Static Model With Political Constraint

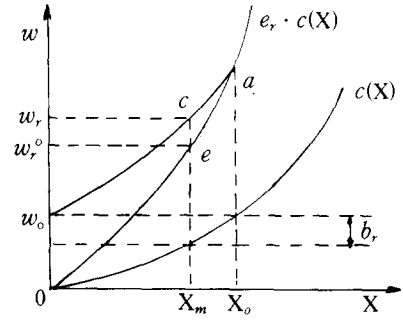
We will consider the case where timeless static reform proposal is subject to political constraint. Under political constraint, reform proposal is to offer the menu of $\{w_r, e_r, b_r\}$, where $w_r > w_0$, $e_r > e_0$, $b_r > 0$.

Under political constraint, reform plans can be implemented with full consent of existing workers. Therefore, reform proposal should guarantee each worker the pre-reform utility level. The curve '$w_0$ca' in ⟨Figure-2⟩ refers to the wage schedule required to satisfy the pre-reform utility level for e_r. To induce the worker of type x_m to stay to work, the firm has to pay $w_r = w_r^0 + b_r$, where w_r^0 refers to minimum wage compensation for the increased effort level. Otherwise, the marginal worker will quit to take exit bonus, b_r. Since incentive compatible constraint under the reform, $u(x) = \text{Max}\,[w_r - e_r \cdot c(x), b_r]$, should be met for all existing workers, the wage paid to workers who stay and the exit bonus paid to workers who quit are denoted as in (7).

$$w_r = e_r \cdot c(x) + b_r, \text{ for } x \leq x_m \qquad (7\text{-}1)$$

$$b_r = u_0(x_m) = w_0 - c(x_m), \text{ for } x_m < x \leq x_0 \qquad (7\text{-}2)$$

[Figure 2]



As the firm can not identify the types of workers, the worker of type x, where $x \leq x_m$, receives information rents in the form of excessive wage compensation and the worker of type x, where $x_m < x \leq x_0$, also receives information rents in the form of excessive exit bonus.

The firm's objective function, $V^*(w_r, e_r, b_r)$ can be formulated as (8).

$$V^*(\cdot)=\underset{x_m}{\text{Max}}\,[q(e_r)\cdot x_m - e_r\cdot\textstyle\int_0^{x_m} c(x)dx] - \lambda\cdot[w_r\cdot x_m + b_r\cdot(x_0 - x_m) - q(e_r)\cdot x_m]$$

$$s.t.\ w_r = e_r\cdot c(x_m) + b_r$$

$$b_r = w_0 - c(x_m) \tag{8}$$

The first order condition regarding the optimal employment level, x^* for given e_r can be written as (9).[8]

$$(1+\lambda)\cdot q(e_r) - [1+\lambda\cdot(1+\varepsilon)]\cdot e_r\cdot c(x^*) = -\lambda\cdot c'(x^*)\cdot x_0 \tag{9}$$

The difference between (5) and (9) is that the right hand side term is newly introduced under political constraint. The imposition of political constraint implies that the marginal net social gain from employing one more unit of worker is equal to some negative value. Hence, x^* with political constraint is greater than x^{**} without political constraint due to the positive financial costs of reform.[9] Trade off between employment level and financial costs of reform incurs overemployment, which results in net social welfare loss.

Proposition 1 The optimal employment level of the firm under political constraint is always excessive from the view point of social optimum.[10]

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[8] Refer to the appendix for the derivation of (8).

[9] The financial costs of reform can be decomposed into two parts. One is the exit bonus paid to workers who quit, which amounts to $b_r\cdot(x_0 - x^*)$. The other is the extra wage paid to workers who stay, which amounts to $[w_r - e_r\cdot c(x^*)]\cdot x^*$. If we add them up, the financial costs becomes $[w_0 - c(x^*)]\cdot x_0$, which implies a trade off between the level of employment and the financial costs of reform. Without political constraint, financial costs of reform will not be incurred.

[10] The proposition of overemployment can also be found in the analysis of implicit labor contract. The implicit contract model of employment attemps to explain the low variability (rigidity) of wage and overemployment compared to the outcomes of competitive labor market in terms of optimal risk sharing arrangements between firm and workers in the presence of uncertainty regarding output prices. The early discussions of implicit contract theory (Baily, 1974; Azariadis, 1975) were extended to the case of asymmetric information on output prices. The implicit contract models under asymmetric information (Grossman and Hart, 1983; Hart, 1984; Hart and Holmstrom, 1986) commomly have as outcomes rigid wage and "excess unemployment". Excessive involuntary unemployment comes from the fact that unemployed workers would like to be employed even at wage slightly lower than the going wage. Refer to Manning (1989) for the intuitive explanations on implicit contract theory.

As in the previous analysis, e_r is key variable in reform proposal. Once e_r is set to target level, the optimal employment level can be determined by solving (9). Then, wage level is chosen to induce the marginal worker to stay to work and exit bonus is determined at the level where the marginal worker is indifferent between being employed and unemployed. The specific value of x^* in (9) depends on the functional form of $q(e)$ and $c(x)$. In the derivation of (9), it is assumed that $V^*(e_r)$ in (8) is greater than $V(w_0, e_0 = 1)$ under the status quo. Otherwise, x^* should be equal to x_0, which implies that the firm need not reform.

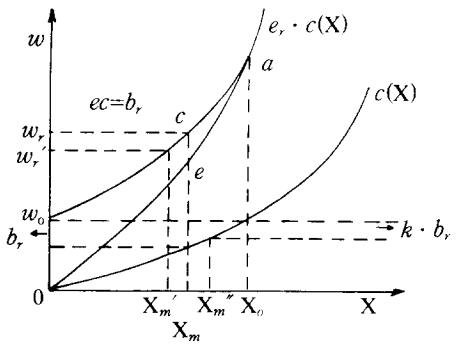
3.3 Static Model With Majority Rule

We will consider the case where static reform proposal is subject to majority rule by relaxing unanimity rule under political constraint. Contrary to unanimity rule, minorities can be hurt by reform proposal. Under majority rule, reform proposal can be summerized by $\{w_r', e_r, b_r'\}$, where $w_r' \leq w_r$, $b_r' \leq b_r$ holds.

If exit bonus is lowered to $b_r' = k \cdot b_r$, $(0 < k \leq 1)$ for e_r, the type of worker whose x value is around x_m will reject the proposal, since their utility level under reform is lower than the pre-reform utility level. In 〈Figure-3〉, the type of worker whose x value holds $x_m' < x < x_m''$ will vote against the proposal. When the objection rate, $(x_m'' - x_m')/x_0$, is less than the pre-determined critical value, reform proposal can be implemented regardless of the objections of minority group. Once exit bonus is set to $b_r' = k \cdot b_r$, the least incentive compatible wage level to induce x_m worker to stay would be (10).

$$w_r' = e_r\, c(x_m) + b_r' \tag{10}$$

[Figure 3]



Under the proposal of $\{w_r', e_r, b_r'\}$ with majority rule, all the x type where $x \leq x_m$ holds will stay to work and all the x type where $x_m < x \leq x_0$ will quit with exit bonus, b_r'. Thus, the first order condition of (9) can still be applied to the case under majority rule. The only difference between unanimity and majority rule is that reform proposal for the same level of effort, e_r can be implemented with less financial costs of reform. Notwithstanding, as the welfare loss of some group can not be justified by the simple reason that they belong to minority group, majority rule may not be feasible in the process of restructuring.

Proposition 2 When majority rule is applied for the implementation of reform proposal, nothing is changed to the optimal employment level except the reduction in the financial costs of reform.

Ⅳ. IMPLICATIONS OF STATIC REFORM MODEL

4.1 Relationship Between Productivity Increases and Layoffs

In the analysis of static model with political constraint, we already mentioned that e_r is key variable in the reform proposal of $\{w_r, e_r, b_r\}$. Once e_r is set to target level, wage rate and exit bonus compatible with optimal employment level can be determined recursively. Hence, the optimal value of objective function of the firm for given e_r can be denoted as $v^*(w_r(e_r), e_r, b_r(e_r))$. In this section, we are going to analyse the effects of increases in effort level, e on the optimal employment level, x^*.

Simple but rigorous proof regarding the effects of increases in effort level on the optimal employment level can be obtained by differentiating (9) with respect to e. By series of manipulation on (9), we get (11).[11]

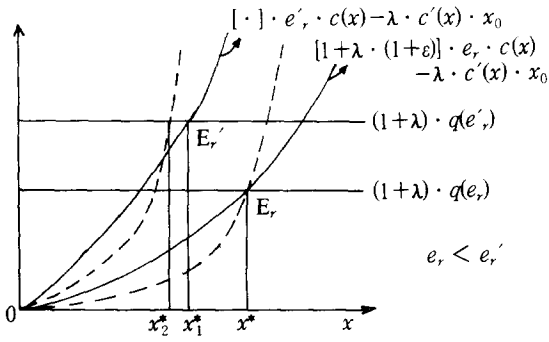
$$\frac{dx^*}{de} = \frac{(1+\lambda)\cdot[q'(e)-q(e)/e]-\lambda\cdot c'(x^*)\cdot x_0/e}{(1+\lambda+\lambda\cdot\varepsilon)\cdot e\cdot c'(x^*)+\lambda\cdot\varepsilon\cdot x_0\cdot[c/x-c'(x^*)]/x^*} < 0 \qquad (11)$$

Since $q(e)$ has decreasing return to scale in e, the scale elasticity, $\varepsilon_q = q'(e)\cdot e/q$ is less than 1. Hence, the negative sign of the bracket term in numerator makes whole numerator negative. Regarding the sign of denominator, if elasticity of disutility function ε is unit, then the bracket term vanish to zero and whole denominator becomes positive. By the plausible assumption that ε does not exceed 1 too much, we can get the negative sign of dx^*/de as in (11). Despite that specific value of (11) depends on the functional form of $q(e)$ and $c(x)$, we can infer

[11] Refer to the appendix for the derivation of (11).

that absolute value of (11) while maintaining negative sign becomes larger as ε_q becomes smaller and ε becomes larger. Hence, the increases in productivity due to higher effort level lead to massive layoffs with the property of strict convexity of $c(x)$ and strict concavity of $q(e)$. The above arguments regarding (11) can be depicted as in ⟨Figure-4⟩. In the figure, x^* refers to optimal employment level correponding to E_r, at which the curve of $(1 + \lambda) \cdot q(e_r)$ intersects the curve of $\{1 + \lambda \cdot (1 + \varepsilon)\} \cdot e_r \cdot c(x) - \lambda \cdot c'(x) \cdot x_0$. The increases in effort level from e_r to e_r' will shift the equilibrium point E_r to E_r'. It implies that x_1^* associated with e_r' will be smaller than x^*. Under the circumstances, if $c(x)$ shows more convexity, the corresponding optimal employment level, x_2^* will be less than x_1^*.

[Figure 4]



Alternative explanations for the result of (11) are based on the following intuition. First, we decompose the objective function of the firm into three parts as in (12). Each term of (12) can be interpreted as allocative surplus, operating loss, and financial costs of reform, respectively. The first two terms, if combined together, constitute "allocative efficiency" of reform.

$$V^*(w, e, b) = [q(e) \cdot x^* - e \cdot \int_0^{x^*} c(x) \cdot dx] - \lambda \cdot [e \cdot c(x^*) \cdot x^* - q(e) \cdot x^*] - \lambda \cdot [w_0 - c(x^*)] \cdot x_0 \quad (12)$$

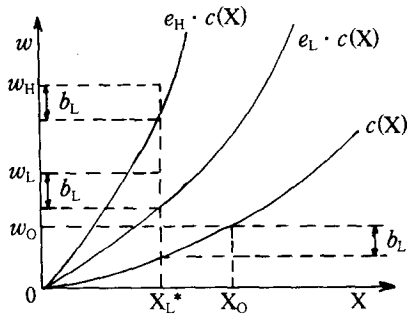
Let the optimal employment level under reform proposal of $\{w_L, e_L, b_L\}$ be x_L^*, where subscript L refers to "low level". In the situation, assume that the firm tries to increase e_L to e_H ($e_H > e_L$) while keeping the employment level x_L^* unchanged. As x_L^* is maintained, the financial costs of reform, $[w_0 - c(x_L^*)] \cdot x_0$ remains unchanged even if e_L is raised to e_H. Operating loss, however, is expected to increase substantially with e_H, since the output per worker, $q(e)$ increases in less proportion to the changes in e while the required wage rate to induce x_L^* to

work at e_H increases in proportion to the changes in e. As can be seen in 〈Figure-5〉, the firm has to pay wage up to w_H to maintain the employment level at x_L^*. Similar reasoning can also be applied to allocative surplus. Through the experiment, we can infer that the net effect of increases in e while keeping x_L^* unchanged on the objective function of the firm is negative. Therefore, the relation as of (13) can be derived. Relation (13) implies that the optimal employment level, x_H^* associated with high effort level, e_H should be lower than x_L^*. This relation is shown as (13-1). The analysis on the relative performance of two different reform proposals, $\{w_H, e_H, b_H\}$ and $\{w_L, e_L, b_L\}$ will be followed in next section.

$$V^*(w_L, e_L, b_L) \rangle V(w_H, e_H, b_L) \tag{13}$$

$$V^*(w_H, e_H, b_H) \rangle V(w_H, e_H, b_L) \tag{13-1}$$

[Figure 5]



Proposition 3 Increases in productivity through increases in effort level lead to layoffs even though political constraint alleviates layoffs to some extent. The extent to which layoffs are intended increases as ε becomes larger and ε_q becomes smaller.[12]

4.2 Relative Performance of Partial Reform and Full Reform

In the previous analysis, we found that the optimal employment level associated with high effort level, x_H^* should be lower than that of low effort level, x_L^*.

[12] Strictly speaking, unemployment in the process of restructuring is not an involuntary unemployment in the sense that the concerned worker prefers to quit with exit bonus.

Thus, it is a matter of choice whether the firm implements reform proposal of either $\{w_H, e_H, b_H\}$ or $\{w_L, e_L, b_L\}$. If the optimal value of objective function of the firm satisfies the relation of $V^*(w_H, e_H, b_H) > V^*(w_L, e_L, b_L)$, the firm will prefer the proposal of $\{w_H, e_H, b_H\}$, "full reform" to the proposal of $\{w_L, e_L, b_L\}$, "partial reform". Otherwise, reverse story holds true. At a glance, full reform seems to be better than partial reform since allocative efficiency is reached immediately under static full reform. But, the story is not so simple because of the financial costs of reform and extra wage bill to induce workers to work at high effort level. Thus, the relative performance of each reform proposal depends on the functional form of $q(e)$ and $c(x)$.

To determine the relative performance of two proposals, we have to find the optimal effort level, e_r^* which is consistent with the maximum value of the objective function, $V^*\{w_r(e_r), e_r, b_r(e_r)\}$. To get e_r^*, we differentiate (12) with respect to e_r and set $\partial V^*(\cdot)/\partial e_r$ to zero. By series of tedious manipulations, we obtain (14) regarding the optimal effort level.[13] In (14), ε_x refers to the elasticity of x^* with respect to e_r. The left hand side of (14) is related to the total outputs and the right hand side is related to the sum of wage bill and the financial costs of reform. The implication of (14) is that the optimal effort level e_r^* is determined at which the marginal gain of unit increase in e evaluated in terms of increases in total outputs is balanced with the marginal cost in terms of increases in total wage bill and financial costs of reform. From (14), we can infer that if $e_r < e_r^*$ holds, the firm is recommended to increase the intensity of reform up to e_r^*, otherwise to decrease e_r down to e_r^*.

$$q(e_r^*) \cdot x^* \cdot (\varepsilon_q + \varepsilon_x) \cdot (1 + \lambda) = e_r^* \cdot c(x^*) \cdot x^* \cdot [\varepsilon_x + \{1/(1 + \varepsilon)\}] \cdot [1 + \{\lambda/(1 + \varepsilon)\}] - \lambda \cdot \varepsilon \cdot \varepsilon_x \cdot c(x^*) \quad (14)$$

Even though we can not solve (14) explicitly for e_r^*, we can easily infer that the merit of increasing intensity of reform (i.e., increasing e_r from $e_0 = 1$) will be soon disappeared by the following reasons. As the financial costs of reform is strictly increasing in layoffs, enhancing e_r which results in massive layoffs incurs excessive financial costs. Thus, only if the gains in allocative efficiency resulting from increasing effort level outweigh the increases in the financial costs, more intensive reform is recommended. But, decreasing return to scale of $q(e)$ in e together with strong convexity of $c(x)$ would not make the efficiency gains dominant. Therefore, the optimal effort level would be low level e_L, which is apparently greater than e_0. Regarding e_r^* to be e_L leads to the proposition that partial reform is more preferable to full reform.

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[13] In the process of obtaining (14), we use the fact that $\int c(x)dx = c(x) \cdot x/(1 + \varepsilon)$.

Intuitively, the best scenario for full reform is that the firm can secure high level of per capita outputs, $q(e_H)$ with little impacts on the optimal level of employment. In the situation, the firm can produce more outputs without incurring substantial financial costs of reform. But, sustaining rather high employment level brings about tremendous increases in wage bill and total disutilities, which result in large amount of operating loss and small value of allocative surplus. Therefore, the allocative efficiency gain resulting from full reform can not outweigh the extra financial costs of full reform.

Proposition 4 The optimal effort level e_r^* consistent with the maximum value of $V^*(\cdot)$ is likely to be low level e_L if $q(e)$ has decreasing return to scale in e and $c(x)$ is strictly increasing function in x. Under the circumstances, partial reform is preferable to full reform [i.e., $V^*(w_L, e_L, b_L) > V^*(w_H, e_H, b_H) > V_0(w_0, e_0 = 1)$].

V. ANALYSIS OF DYNAMIC REFORM MODEL

5.1 Dynamic Reform Without Commitment

We now extend the timeless static model of reform to the two period dynamic model. In dynamic model, reform proposal is to offer the menu of $\{w_1, e_1, b_1; w_2, e_2, b_2\}$, i.e. wage level, effort level, and exit bonus in periods 1 and 2. We define the commitment regarding reform proposal as the firm's credibility to keep future wage and exit bonus as in the initial proposal. As long term contract resulting from commitment may introduce rigidities to the firm, commitment is not desirable for its own interests. Without commitment, reform proposal may be revised in the second period after observing the employment status chosen by workers in the first period.

For the clarity of the argument, assume that at the beginning of period 1, the dynamic reform proposal of $\{w_1, e_1, b_1; w_2, e_2, b_2\}$ is approved with full consent of existing workers (x_0), and some workers quit with exit bonus in period 1. In the situation where the firm does not pre-commit in advance to its reform plan, the firm in period 2 may deviate from the initial plan (w_2, e_2, b_2) and implement new reform plan (w_2', e_2', b_2') only with the approval of workers who stay in period 1. It implies that dynamic reform without commitment is not time consistent from the view point of workers. In other words, worker can not attempt to maximize the intertemporal utility over two periods.

We are going to analyse the dynamic reform model under the two cases; with commitment and without commitment. Without commitment, the best strategy for the firm is to offer the dynamic reform proposal of $\{w_L, e_L, b_L; w_L, e_L, b_L\}$ in period 1 and after observing some workers leaving in period 1, implement in period 2 the proposal of $\{w_L, e_L, b_L; w_H, e_H, b_H\}$ different from the one voted in per-

iod 1. The rationale can be summarized as follows. As partial reform is already shown to be preferable to full reform, the firm is expected to offer dominant partial reform proposal over two periods. Under the partial reform schedule in period 1 and 2, the workers of type x, where $x_L^* < x \leq x_0$ holds, will quit in period 1 with exit bonus $2 \cdot b_L$ [$= 2 \cdot (w_0 - c(x_L^*)$]. After observing the quits of the group in period 1, the firm can implement full reform in period 2 at less financial costs because exit bonus is paid only to those workers whose type x holds $x_H^* < x \leq x_L^*$. After screening first exit group in period 1 from employment pool, the firm can save the exit bonus granted to the group by the amount of $(x_0 - x_L^*) \cdot [c(x_L^*) - c(x_H^*)]$. The crucial argument, however, regarding dynamic reform without commitment is whether workers can be fooled or not. If workers are not fooled by the lack of commitment, workers will not participate dynamic reform game.

5.2 Dynamic Reform With Commitment

Because the dynamic reform schedule without commitment is not time consistent, dynamic reform can not even be voted in period 1. Hence, to implement dynamic reform, time consistency should be met for workers to be able to maximize utility over two periods. Indeed, for gradual reform to be feasible, reform proposal should be pre-commited and also satisfy the dynamic incentive compatible constraint. Assume that the firm pre-commits workers to obey dynamic gradual reform schedule of $\{w_L, e_L, b_L^*; w_H, e_H, b_H\}$. In the situation, there are two strategies of the first group ($x_L^* < x \leq x_0$) regarding the optimal timing of quit.

〈Strategy 1〉: Stay in period 1, even if wage level w_L under partial reform is not enough to compensate the increases in disutilities due to the increases in e from 1 to e_L. By staying in period 1, the first group can get large amount of exit bonus if the group quits with the second group ($x_H^* < x \leq x_L^*$) in period 2. The strategy can be summarized by {stay in period 1, quit in period 2}.

〈Strategy 2〉: Quit in period 1 under partial reform with exit bonuses of two periods, $2 \cdot b_L^*$. The strategy can be summarized by {quit forever in period 1}.

If the firm wants to implement gradual reform, the pre-commited exit bonus b_L^* to the first group should be large enough to make strategy 2 a better choice for the group. The condition which is called "dynamic incentive compatible constraint" is denoted in (15), where d is the discount rate of the first group. In the meanwhile, the political constraint of the group can be written as in (16), which means the utility level from the exit bonus, $2 \cdot b_L^*$ should be at least the pre-reform utility level.

$$\{w_L - e_L \cdot c(x)\} + d \cdot b_H \leq 2 \cdot b_L^*, \text{ where } x_L^* < x \leq x_0 \tag{15}$$

$$(1 + d) \cdot \{w_0 - c(x)\} \leq 2 \cdot b_L^*, \text{ where } x_L^* < x \leq x_0 \tag{16}$$

$$d \leq [\{w_0 - c(x)\} - \{w_L - c(x)\}]/[c(x) - c(x_H^*)] \; (= d_0 > 0) \tag{17}$$

From (15) and (16), we get (17), which refers to the condition under which dynamic gradual reform can be implemented.[14] The interpretation is that the discount rate should be less than the critical value, d_0 in order for the dynamic gradual reform to be implemented. In other words, time preference rate of the first group should be great enough to put small weight to future income stream. Otherwise, the first group could gain from not quiting in period 1 and from receiving exit bonus $b_H = \{w_0 - c(x_H^*)\}$, thus inflicting loss in allocative efficiency to the firm.

Proposition 5 With commitment, the firm can implement gradual reform by paying exit bonus b_L^* in period 1 consistent with dynamic incentive compatible constraint and political constraint to workers whose type of x satifies $x_L^* < x \leq x_0$. In the process, the discount rate of the group plays a crucial role.

VI. SUMMARY AND CONCLUDING REMARKS

Since most of public enterprises are likely to be inefficient due to lack of competitive pressures and/or by virtue of protective measures, public enterprises should be restructured to enhance productivity by reform plan. One feasible way to reform is to introduce new incentive wage scheme, i.e., higher wage is paid in return for higher effort level.

In the meanwhile, as the firm acts as the agenda setter, having the initiative in offering reform proposal, but does not have perfect information regarding the characteristics of workers, reform proposal is equivalent to a sort of screening device under asymmetric information and continuing relation. Some propostitions found in the analyses can be summarized as follows.

1. Political constraint together with information asymmetry levies financial costs of reform to the firm in the form of exit bonus and information rents. Political constraint also results in net social welfare loss due to overemployment.

2. Under the plausible assumptions of decreasing return to scale of $q(e)$ in e and the strong convexity of disutility function $c(x)$, increases in productivity

[14] The pre-commited exit bonus in period 1, b_L^* would be the maximum out of two values in (15) and (16). In deriving (17), the political constraint (participation constraint) is assumed to be binding, while the dynamic incentive compatible constraint to be non-binding. In dynamic reform model, discount rate is an important parameter. In general, discount rate in bargaining model plays a crucial role in deterring the protracted negotiation. Especially, in sequential bargaining with complete information, settlement occurs immediately. (Rubinstein, 1982)

through increases in effort level under political constraint leads to layoffs despite that political constraint usually incurs overemployment.

3. Partial (static) reform is likely to be preferable to full reform since the gains in allocative efficiency from full reform can not outweigh the increases in financial costs. Under the assumption of strict convexity of $c(x)$, political constraint incurring high financial costs of reform works as the hinderance to full reform.

4. From the view point of the firm, the optimal dynamic reform schedule, if possible, is to increase the intensity of reform in gradual manner to deprive the rent extraction motive of early quiting group. Without commitment regarding reform proposal, however, workers do not participate the reform game since reform plan is not time consistent. It implies that dynamic reform plan without commitment is not feasible.

5. Only with commitment, the firm can induce workers to participate the dynamic reform. By pre-commiting enough exit bonus in period 1 consistent with dynamic incentive compatibility constraint and political constraint, the firm can implement gradual reform over periods.

Even though our analyses shed some lights in clarifying the arguments related to restructuring, we leave a couple of questions unanswered. In our model, the productivity of unit labor is invariant to workers, and output per worker $q(e)$ is assumed to be a function of effort level only. Hidden informations in our model are the types of workers which determine the disutilities of unit labor. In reality, however, labor productivity may be variant to workers and hidden informations may be the intrinsic differences in labor productivity. Under the circumstances, the optimal incentive scheme may have different context.[15] Thus, it would also be fruitful to analyse the restructuring of public enterprises under the circumstances.

In our model, functional forms of $q(e)$ and $c(x)$ which play crucial role are not specified. To get more specific propositions, various hypothetic scenarios regarding the functional forms of $q(e)$ and $c(x)$ should be addressed. Last but not least, job training and continuing education for workers also should be carried out to reinforce the effects of restructuring. Other policy measures such as demonopolisation, trade and price liberalisation, and free entry of foreign capital may facilitate restructuring of public enterprises.

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[15] Since the productivity of workers is hidden information, incentive scheme should be designed to discriminate hidden types among workers. One possible scheme could be the wage function as of $\{a, w_f: w = a \cdot x + w_f\}$, where wage rate, w consists of two parts, one is the fixed wage, w_f and the other is variable incentive wage depending on output the worker produces.

APPENDIX

1. The (9) representing the first order condition regarding optimal employment level under reform proposal of $\{w_r, e_r, b_r\}$ can be obtained by following procedures. First, inserting constraints of (8) into the objective function yields (8-a). Differentiating (8-a) with respect to x_m yields (8-b), which can be simplfied to (8-c).

$$V(\cdot)=[q(e_r)\cdot x_m - e_r\cdot\int_0^{x_m} c(x)dx]-\lambda\cdot[\{e_r\cdot c(x_m)+w_0-c(x_m)\}\cdot x_m + \{w_0-c(x_m)\}\cdot(x_0-x_m)-q(e_r)\cdot x_m] \tag{8-a}$$

$$q(e_r)-e_r\cdot\partial\{\int_0^{x_m} c(x)dx\}/\partial x_m-\lambda\cdot[\{e_r\cdot c'(x_m)-c'(x_m)\}\cdot x_m+1\cdot\{e_r\cdot c(x_m) +w_0-c(x_m)\}-(x_0-x_m)\cdot c'(x_m)-\{w_0-c(x_m)\}-q(e_r)] = 0 \tag{8-b}$$

$$(1+\lambda)\cdot q(e_r)-(1+\lambda)\cdot e_r\cdot c(x_m)-\lambda\cdot e_r\cdot c'(x_m)\cdot x_m = -\lambda\cdot x_0\cdot c'(x_m) \tag{8-c}$$

As the elasticity of $c(x)$ with respect to x is assumed to be ε, from the definition of ε, we get $c'(x_m) = c(x_m)\cdot\varepsilon/x_m$. By substituting the above expression into the third term in LHS of (8-c), we get (9) in the text.

2. The (11) regarding the effects of increases in e on optimal level of employment x_L^* can be obtained by the following procedures. Differentiation of (9) with respect to e yields (11-a).

$$\frac{dx^*}{de} = \frac{(1+\lambda)\cdot q'(e)-(1+\lambda+\lambda\cdot\varepsilon)\cdot c(x^*)}{(1+\lambda+\lambda\cdot\varepsilon)\cdot e\cdot c'(x^*)-\lambda\cdot x_0\cdot c''(x^*)} < 0 \tag{11-a}$$

The numerator (NM) of (11-a) can be rewritten as (11-b). In the meanwhile, by definition $\varepsilon = c'(x^*)\cdot x^*/c(x^*)$, we have $c'(x^*) = c(x^*)\cdot\varepsilon/x^*$. Thus, plugging (11-c) into the denominator of (11-a) yields (11) in the text.

$$\begin{aligned} NM &= (1+\lambda)\cdot q'(e) - (1+\lambda+\lambda\cdot\varepsilon)\cdot c(x^*) \\ &= (1+\lambda)\cdot q'(e) - \{(1+\lambda)\cdot q(e) + \lambda\cdot c'(x^*)\cdot x_0\}/e \quad \text{[due to (9)]} \\ &= (1+\lambda)[q'(e) - \{q(e)/e\}]-\lambda\cdot c'(x^*)\cdot x_0/e \end{aligned} \tag{11-b}$$

$$c''(x^*) = d(c\cdot\varepsilon/x^*)/dx^* = \varepsilon\cdot[c'(x^*)/x^*-c/x^{*2}] \tag{11-c}$$

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