THE ANALYSIS OF EFFECTS OF A "WHITE COLLAR" EXEMPTION SYSTEM ON WORKING HOURS

Shojiro Yasui

Graduate School of Decision Science and Technology,
Tokyo Institute of Technology
2-12-1, Ookayama, Meguro-ku, Tokyo 152-8552, Japan

ABSTRACT

The present paper introduced the game model in extensive form for analysis of principal-agent bargaining problem, especially effects of a "white collar" exemption system on working hours of the agent. This present paper describes an extensive game model by which the payoffs are distributed to the agent and the principal under specific payment scheme, and analyzes necessary conditions that the strategy for which both the agent and the principal adopt the "white collar" exemption system becomes a sub-game perfect equilibrium (SPE). The main result is that the relatively high overtime payment is assumed to induce shorter working hours under the "white collar" exemption system in comparing with those under work-hour payment system, and the relatively low overtime payment is assumed to induce the opposite result.

Keywords: principal-agent model, "white collar" exemption, game in extensive form, subgame perfect equilibrium.

INTRODUCTION

A "white-collar" exemption system is the system that exempts workers who are regarded as "white-collar" from overtime payments protection. This system has been employed in the U.S. since late 1900s. Recently, introduction of this system becomes a controversial issue in Japan. Employers groups which intend to introduce this system insist that "in line with a performance-based payment system, creating a "white collar" exemption for certain employees would facilitate a shift towards compensating employees for the actual work that they do, not for the number of hours they spend at the work place"(The American Chanber of Commerce in Japan, 2007). However, workers groups who oppose the proposal, insist that the system increases incidences of "karoshi", a sudden death caused by excessive overtime working, because the system gives workers an incentive to work longer in order to get better wages. On this point, employers groups argue that the system would motivate "white-collar" workers to work more efficiently and productively. Unfortunately, there is no formal analysis of the effect of "white-collar" exemption system on working hours and workers' productivity. This present paper aims to fulfil this gap.

In order to analyse an incentive system which can motivate workers to conduct more efficient work, the principal-agent model is widely used. The principal-agent theory was first presented by Alchian and Demsetz in 1972. The economics of the principal-agent relationship were further developed, among others, by Sharvell, Holmstrom, Grossman and Hart in early 1980s. In the traditional principal-agent model, however, only two individual can be analyzed. Also, the model assumes that the principal can propose only one specific proposal and cannot choose the best proposal with the consideration of the agent's decision, although the agent can choose its effort to maximize its payoffs.

In order to overcome these deficiencies, the present paper employs the game in extensive form. The concept of subgame perfect equilibrium (SPE) enables us to analyze in which condition the "white collar" exemption can be the best response for both the principal and the agent (Selten,1975). Moreover, the game in extensive form can analyze bargaining problems among more than two players with the consideration of player's rationality to maximize their payoffs. Applications of the game theory to principal-agent bargaining are viewed such as an analysis of Stackelberg equilibrium in oligopoly situation (Basu, 1995), but it is rare for an analysis of individual working conditions.

The present paper aims to find out effects of the "white collar" exemption system on agent's working hours under which the strategy such that the principle selects "propose" and the agent selects "accept" constitutes a sub-game perfect equilibrium of the game. In doing so, working hours of the agent under the exemption system can be obtained.

In the present paper, an extensive game model is proposed in next section. Effects of the "white collar" exemption system on working hours are analyzed in following sections. Finally, the last section presents concluding remarks.

MODEL

The Traditional Principal Agent Model

The principal's gross wealth or output of agent's effort is denoted by

$$o = f(e,\theta)$$

, where e is the agent's effort, and θ is exogenous risk. Assume that realization of the principal's gross wealth or output of the agent's effort o can be observed by both agent and principal; the principal can offer a payment scheme $p(o)$. Let $c(e)$ be the agent's disutility of effort in terms of a money equivalent. Then, the agent's net wealth is denoted by;

$$w_a = p(o) - c(e)\,.$$

And the principal's net wealth is denoted by;

$$w_p = o - p(o)\,.$$

In the traditional principal-agent theory, the first choice is made when the principal selects a payment scheme $p(o)$ and suggests it to the agent. The second decision is made by the agent when the agent either accepts or refuses the scheme suggested. The agent makes its decision on acceptance in view of some other opportunities he might have and the best of which guarantees a certain reservation welfare m. As the third decision, if the agent accepted a reward scheme, the agent chooses its effort in order to maximize its payoffs. The fourth and final step of that sequence is a realization of payoffs of both the principal and the agent (Spremann, 1987).

Assumptions to apply the game theory

In this paper, we assume the followings additionally;

Assumption 1-1: We do not consider any exogenous risk to the principal's gross wealth $o = f(e,\theta)$. In other word, risk $\theta = 0$. Therefore, the principal and the agent can know their wealth based on the agent's efforts. Hence this paper does not consider an "expected value" of their wellness and does not have to employ "utility functions" to evaluate the agent's "risk averse" behaviour.

Assumption 1-2: The agent has been employed under a certain payment scheme $p_{sq}(o)$. Therefore, the agent decides whether it should accept or reject the proposed new payment scheme $p_n(o)$ by comparing payoffs under the current scheme with those under the proposed.

Assumption 1-3: The principal selects a payment scheme $p_i(o)$ which can maximize principal's payoffs by comparing with payoffs under the current scheme.

Proposed Game Tree

Under the above assumptions, the traditional principal-agent model can be described as games in extensive form as shown in Fig.1.

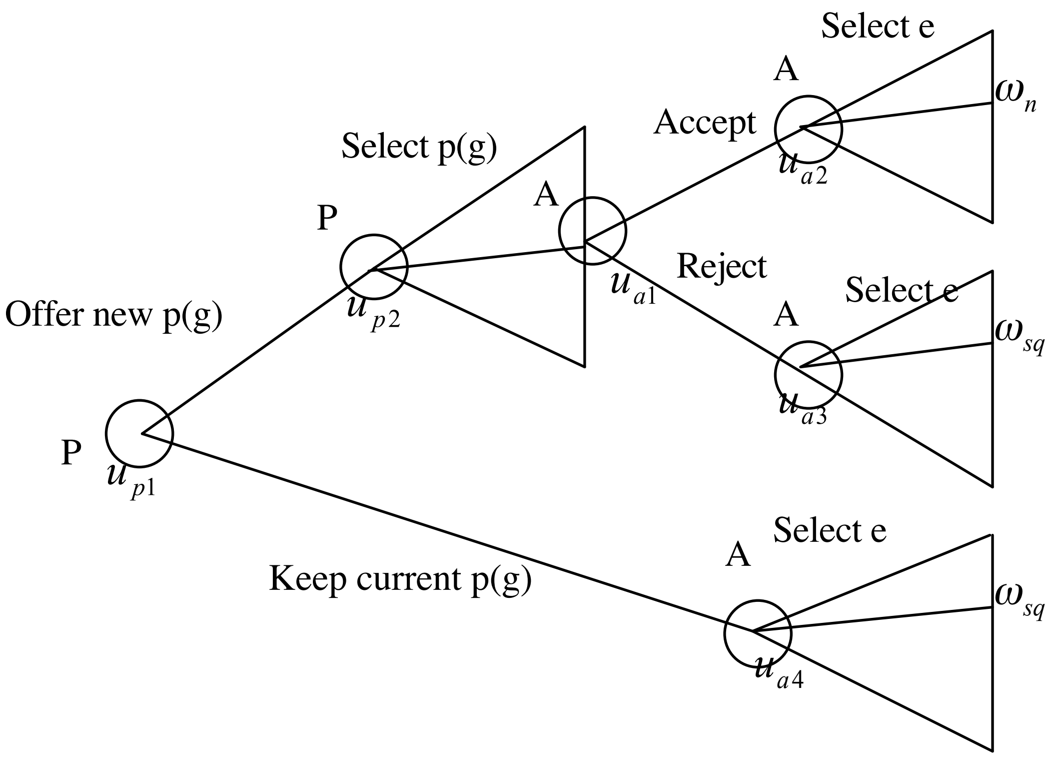

Figure 1. Game tree

In this game, the principal and the agent are players of the game. There are two type of terminal node ω_i. The game ends at ω_n if both the agent and the principal select a new payment scheme $p_n(o)$ such as the "white collar" exemption system. Otherwise, the game ends at ω_{sq} and the current work-hour payment scheme $p_{sq}(o)$ is selected. A list of strategy to reach a specific terminal node ω_i is denoted by $s_i \in S$. In each terminal node, payoffs of all players $H(s_i) = (h_p(s_i), h_a(s_i))$ are defined. Also, there are several information sets of players. The set of all information sets in which player's selection is denoted by $U_{jk} = \{u_{jk}\}$, where $j = \{a, p\}$, k is the number of selection. The set of all information sets in the game tree K is denoted by U.

According to the concept of subgame perfect equilibrium (SPE) , if there exists the combination of strategy s_i which reaches to ω_i, and if s_i satisfies an SPE, the selection of payment scheme $p_i(o)$ is the best response for both the player and the agent.

Assumptions to Analyze "White collar" Exemption System

Principal's Gross Wealth

Let me assume the principal's "gross wealth" or "output" $o = f(e,\theta)$. This type of output is modelled in traditional Linear-Exponential-Normal-Model (LEN model) (Spremann, 1987). The output is expressed as;

$$o_t = f_t(e,\theta) = e + \theta .$$

Because of Assumption 1-1, risk $\theta = 0$. This output hypothesize that agent's productivity is constant and does not change depending on working hours.

Payment Scheme

Assume that there are two type of payment scheme. The current payment scheme is the traditional work-hour payment scheme. The work-hour system consists of fixed payment and overtime payment, described as follow;

$$p_{sq}(o) = b + v(e_{sq} - h)$$

where, b is a fixed payment, v is a overtime payment, e is the agent's working hours, and h are agreed working-hours ($e_{sq} \geq h$). This formula shows that the agent does not have any direct incentive for increase its effort in this scheme.

The proposed new payment scheme is the one which the principal-agent theory has employed as LEN model. In this scheme, payment is a liner function of an output and expressed as follow, where, r is a fixed payment and d is a distribution factor of output ($0 \leq d \leq 1$).

$$p_n(o) = r + do$$

Agent's disutility function

We employ the LEN model's disutility function as follow;

$$c(e) = e^2$$

EFFECT OF "WHITE COLLAR" EXEMPTION ON WORKING HOURS UNDER CONSTANT PRODUCTIVITY

The present paper tries to reveal necessary conditions to realize the "white collar" exemption system as the best response for both the agent and the principal. In doing so, we try to find out whether working hours decrease or increase if the "white collar" exemption system is introduced.

Payoff functions

In this present paper, we assume that the agent's productivity is constant ($o_t = f_t(e_n, \theta) = e_n$) as the traditional LEN model assumes. According to the above assumptions and definitions, payoff functions in each strategy can be defined as follows;

$$h_a(s_{sq}) = w_a^{sq} = p_{sq}(o_t) - c(e_{sq}) = b + v(e_{sq} - h) - e_{sq}^2 .$$

$$h_a(s_n) = w_a^n = p_n(o_t) - c(e_n) = r + do_t - e_n^2 = r + de_n - e_n^2$$

$$h_p(s_{sq}) = w_p^{sq} = o_t - p(o_t) = e_{sq} - (b + v(e_{sq} - h))$$

$$h_p(s_n) = w_p^n = o_t - p(o_t) = e_n - (r - do_t) = e - (r - de_n)$$

Determination of the Agent's effort

Following the "backward induction" methodology, let us start from the agent's determination of its effort at u_{a2}.In this move, the agent chose its effort to maximise its payoff w_a^n. Such e_n^* satisfies following;

$$\frac{\partial w_a^n}{\partial e_n} = \frac{\partial (r + de_n - e_n^2)}{\partial e_n} = 0 \text{ then,} \quad e_n^* = d/2 \text{, } {}_{\max} w_a^n = r + d^2/4 .$$

In the same manner, the agent determines its effort at u_{a3}. Such e satisfies following;

$$\frac{\partial w_a^{sq}}{\partial e_{sq}} = \frac{\partial (b + v(e_{sq} - h) - e_{sq}^w)}{\partial e_{sq}} = 0 \text{ and } e_{sq} \geq h \text{, then,}$$

If $h < v/2$, $e_{sq}^* = v/2$, ${}_{\max} w_a^{sq} = v^2/4 - vh + b$.

If $h \geq v/2$,$e_{sq}^* = h$, ${}_{\max} w_a^{sq} = b - h^2$.

Selection of "accept" or "reject" the Proposed New Payment Scheme

Next, at the move of u_{a1}, the agent decides "accept" or "reject" the proposed new payment scheme. The agent chooses larger payoffs in this move. Therefore, the following formula is one of the necessary conditions under which the strategy s_n is an SPE of the game.

${}_{\max} w_a^n > {}_{\max} w_a^{sq}$, then,

If $h < v/2$, ${}_{\min} r = v^2/4 - vh + b - d^2/4$

If $h \geq v/2$, ${}_{\min} r = b - h^2 - d^2/4$.

Determination of the Proposed New Payment Scheme

Then, at move of u_{p2}, the principal determine details of proposed payment scheme (vale of *r* and *d*) in order to maximize the principal's payoff w_p^n, under the condition that the agent accepts the proposed new payment scheme ($e_n^* = d/2$), then,

$$w_p^n = e_n^* - (r - de_n^*) = -d^2/2 + d/2 - r .$$

The value of *d* which maximize w_p^n satisfies following;

$$\frac{\partial w_p^n}{\partial d} = \frac{\partial(-d^2/2 + d/2 - r)}{\partial d} = 0 \text{ then, } \quad d^* = 1/2 \text{ and } e_n^* = 1/4 .$$

The minimum *r* maximizes w_p^n, then,

$_{\max} w_p^n = -d^{*2}/2 + d^*/2 -_{\min} r$,

If $h < v/2$, then $_{\max} w_p^n = 3/16 - (v^2/4 - vh + b)$

If $h \geq v/2$, then $_{\max} w_p^n = 3/16 - (b - h^2)$.

Selection of "propose" or "not propose" the New Payment Scheme

Lastly, at move of u_{p1}, the principal choose "propose" or "not propose" the new payment scheme. Therefore, $_{\max} w_p^n >_{\max} w_p^{sq}$ is one of the necessary conditions under which the strategy s_n is an SPE of the game.

$_{\max} w_p^{sq} = e_{sq}^* - (b + v(e_{sq}^* - h))$. Then,

If $h < v/2$, $e_{sq}^* = v/2$, $_{\max} w_p^{sq} = -v^2/2 + v(h + 1/2) - b$

If $h \geq v/2$, $e_{sq}^* = h$, $_{\max} w_p^{sq} = h - b$

$_{\max} w_p^n >_{\max} w_p^{sq}$ is equivalent to the following;

If $h < v/2$, then, $1/2 < v < 3/2$, or $1/4 < e_{sq}^* < 3/4$

If $h \geq v/2$, then $0 < h < 1/4, or\ 3/4 < h$, or $0 < e_{sq}^* < 1/4, or\ 3/4 < e_{sq}^*$

Results

To conclude, under the assumption that the agent's productivity is constant ($o_t = f_t(e_n, \theta) = e_n$), a relation between working hours under "white collar" exemption system e_n^* and those under current work-hour payment system e_{sq}^* can be described as follow;

If $h < v/2$, $e_n^* < e_{sq}^* < 3e_n^*$

If $h \geq v/2$, $e_{sq}^* < e_n^*, or\ 3e_n^* < e_{sq}^*$

.

Therefore, under the assumption that the agent's productivity is constant, it is reasonable to conclude as follow;

a) If the overtime payment is comparatively high, working hours under the "white collar" exemption system can be shorter than those under work-hour payment system.
b) If the overtime payment is comparatively low, working hours under the "white collar" exemption may be longer than those under the work-hour payment system. According to the analysis, working hours under the "white collar" exemption can be three times less than those under the work-hour system, however, such a vast gap of working hours is not likely to happen in actual situation.

CONLUSION

The present paper proposed the game model in extensive form to analyse the principal-agent bargaining problem. The model has the several assumptions such as the agent is already employed by the principal under work-hour payment system, exogenous matters does not effect output of agent's effort, and a productivity of workers is constant. With the use of the model, this paper analyzes the necessary conditions that the strategy for which both the agent and the principal adopt "white collar" exemption system becomes an SPE of the game.

According to the results, the relatively high overtime payment is assumed to induce shorter working hours under the "white collar" exemption system in comparing with those under work-hour payment system, and the relatively low overtime payment is assumed to induce the opposite results.

The results of the present paper have lack of generalization caused by the assumptions above. Therefore, there is a substantial need of complementary study to reveal effects of productivity of the agent on working hours under each payment scheme.

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